DETERMINANTS OF IMPORTED SHRIMP AND THEIR ROLE IN THE SOUTHEAST SHRIMP PROCESSING SECTOR

Walter R. Keithly, Ph.D.* and Kenneth J. Roberts, Ph.D.
Coastal Fisheries Institute*, Center for Wetland Resources
Louisiana State University, Baton Rouge, LA 70803

and

Office of Sea Grant Development, Center for Wetland Resources
Louisiana State University, Baton Rouge, LA 70803

and

Charles M. Adams
Department of Food and Resource Economics
University of Florida, Gainesville, FL 32611

U.S. imports of shrimp have increased significantly since the mid 1960s with the majority of this increase occurring during the 1980s. Imports averaging 260 million pounds (headless shell-on equivalent weight basis) during 1977-80 for instance, were only about 32% above the 1965-68 average annual imports of 197 million pounds. By 1981-84, imports had increased to 356 million pounds annually and increased again to 531 million pounds annually during 1985-88. Overall, 1985-88 annual imports exceeded 1977-80 imports by about 100% and were 170% above those reported during 1965-68.

The objectives of this paper are twofold. The first objective is to provide a model, developed within an appropriate economic and statistical framework, which explains the growth in the U.S. shrimp import market. The second objective of the paper is to evaluate the use of these increased imports in the Southeast shrimp processing sector.

To accomplish the aforementioned objectives, the paper proceeds as follows. First, the U.S. import market, along with other relevant information, is examined. This examination covers the 1965-88 period. Then, a statistical model used to describe the U.S. import market is presented with findings. Attention then turns to examination of the use of imported shrimp in the Southeast shrimp processing sector. The paper concludes with a summary which highlights significant findings.

REVIEW OF THE U.S. IMPORT MARKET

As noted in the introduction, U.S. imports of shrimp have been expanding since the mid 1960s with a major portion of this increase occurring during the 1980s. Data in support of this claim are formally presented in Table 1. As indicated, 1982 was a pivotal year in this expansion process as was 1986. Overall, imports increased more than 60 million pounds between 1981 and 1982 and increased by 100 million more pounds between 1982 and 1983. After remaining relatively stable during the next few years, imports increased by 40 million pounds between 1985 and 1986 and increased by another 90 million pounds between 1986 and 1987.

The value of U.S. shrimp imports, like poundage, has increased during the 1965-88 period. For instance, shrimp imports entered the U.S. at an average annual value of $142 million during 1965-68 compared to $1.51 billion annually during 1985-88; indicating an approximate ten-fold increase in value. While much of this increased value reflects the increased quantity of imports, the general upward trend in the shrimp import price, at least through the early 1980s, has also contributed to the observed increase in import value. Much of this price increase, however, is inflationary based. Removing this inflationary trend allows for the examination of the historical import value and price on a deflated, or real, basis. Expressed on a deflated basis, the value of
shrimp imports increased from an average of $354 million annually during 1965-68 (1980 represents the base year) to $1.11 billion annually during 1985-88 (Table 1); an approximate 2.1 fold increase. The deflated price per pound, after expanding rapidly during the mid 1960s and into the 1970s, peaked at $3.01 in 1979 and has since fallen sharply (Table 1). This decline, it is generally accepted, is the result of a rapid increase in the world production of shrimp and the subsequent export of much of this increased production to the U.S. and other leading markets.

The sustained growth in world shrimp production, and its more rapid rise during the 1980s, is shown in Table 1. As indicated, annual world production expanded slightly more than one-billion pounds (expressed on a headless basis) between 1965-68 and 1977-80; from 1.0 to 2.3 billion pounds. Since 1981, or in a matter of only seven years, world production has increased by another 1.1 billion pounds and equalled 3.3 billion pounds in 1988.

Expansion in the world production of shrimp during the 1980s, and the subsequent export of much of this increased production to the U.S. market, can be traced to the development of a cultured shrimp industry. For example, production of cultured shrimp in the Latin American region increased from an estimated 7 million pounds (headless) in 1979 to an estimated 110 million pounds (headless) in 1988. Most of this production is Ecuadorian based, as Aiken (1) shows. The rapid rise in U.S. imports of shrimp in the early 1980s, as discussed earlier, can be traced to this emerging shrimp aquaculture industry in Ecuador. Overall, U.S. shrimp imports originating from Ecuador increased from an annual average of 8.2 million pounds (headless shell-on equivalent basis) during 1973-76 to 40.4 million pounds during 1981-84 and equalled 79.1 million pounds during 1985-88.

Production of cultured shrimp in the Asian region, according to Aquatic Farms Ltd. (2), expanded from an estimated 82 million headless pounds in 1982 to about 570 million pounds in 1988. China has recently emerged as the dominant force in the production of cultured shrimp in both the Asian region and the world and is the main reason for the rapid expansion in U.S. imports of shrimp during the 1986-88 period. Overall, cultured shrimp production in China expanded from an estimated 10 million headless pounds in 1982 to more than 200 million pounds in 1988, while the U.S. imports of shrimp from China during the same period expanded from 3.6 million pounds to 117.8 million headless pounds (headless shell-on weight equivalent basis). The U.S. also imports significant quantities of cultured shrimp from Taiwan and Thailand. Overall, the percentage of world shrimp production represented by a farm-raised product equaled about 20% in 1988 compared to about one percent in the late 1970s.

Much of the world’s shrimp production is utilized by a relatively few countries. Among these countries, the United States utilized about one-quarter of total production in 1988 while Japan utilized another 22%. Both of these countries, by and large, show a preference for warm-water varieties of shrimp. Western Europe, which has traditionally shown a preference for cold-water shrimp varieties, utilized another 10-15% of the world’s 1988 shrimp output.

MODEL OF U.S. SHRIMP IMPORT MARKET

Several attempts at modeling the U.S. shrimp import market have been made in the past. These attempts have ranged from simple equation demand functions (3,4) to more complex models which use multiple equations (5,6). Prochaska and Keithly (8) have provided the most recent and complete analysis of the U.S. shrimp import market, and the analysis presented here is a reformulation and update of their model. The conceptual model, which consists of an import demand equation, an import supply equation, and an identity equation, is specified in the following three equations.
Table 1. Quantity and Value of Total U.S. Shrimp Imports Relative to World Production, 1965-88.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>QUANTITY IMPOR TED&lt;sup&gt;a&lt;/sup&gt;</th>
<th>CURRENT IMP. VALUE</th>
<th>DEFLATED IMPORT VALUE Price</th>
<th>WORLD PRODUCTION&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 lbs</td>
<td>----  $1,000s ----</td>
<td>$/lb</td>
<td>1,000 lbs</td>
<td></td>
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<tr>
<td>1965-68 avg.</td>
<td>196,522</td>
<td>142,100</td>
<td>353,649</td>
<td>1.80</td>
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<tr>
<td>1969-72 avg.</td>
<td>234,217</td>
<td>205,333</td>
<td>427,690</td>
<td>1.83</td>
</tr>
<tr>
<td>1973</td>
<td>230,780</td>
<td>281,587</td>
<td>521,984</td>
<td>2.26</td>
</tr>
<tr>
<td>1974</td>
<td>267,462</td>
<td>387,336</td>
<td>647,418</td>
<td>2.42</td>
</tr>
<tr>
<td>1975</td>
<td>231,522</td>
<td>346,239</td>
<td>530,393</td>
<td>2.29</td>
</tr>
<tr>
<td>1976</td>
<td>271,894</td>
<td>463,344</td>
<td>671,415</td>
<td>2.47</td>
</tr>
<tr>
<td>1973-76 avg.</td>
<td>250,415</td>
<td>369,627</td>
<td>592,803</td>
<td>2.37</td>
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<tr>
<td>1977</td>
<td>271,811</td>
<td>491,529</td>
<td>669,132</td>
<td>2.46</td>
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<tr>
<td>1978</td>
<td>240,414</td>
<td>421,724</td>
<td>533,469</td>
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<td>1979</td>
<td>269,263</td>
<td>713,238</td>
<td>809,653</td>
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<tr>
<td>1980</td>
<td>258,069</td>
<td>719,263</td>
<td>719,263</td>
<td>2.79</td>
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<td>1977-80 avg.</td>
<td>259,889</td>
<td>586,439</td>
<td>682,879</td>
<td>2.63</td>
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<tr>
<td>1981</td>
<td>259,112</td>
<td>723,875</td>
<td>656,100</td>
<td>2.53</td>
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<tr>
<td>1982</td>
<td>319,596</td>
<td>980,233</td>
<td>837,282</td>
<td>2.62</td>
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<tr>
<td>1983</td>
<td>421,179</td>
<td>1,223,522</td>
<td>1,012,820</td>
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<tr>
<td>1984</td>
<td>422,340</td>
<td>1,216,350</td>
<td>965,599</td>
<td>2.29</td>
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<tr>
<td>1981-84 avg.</td>
<td>355,557</td>
<td>1,035,995</td>
<td>867,950</td>
<td>2.44</td>
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<td>1985</td>
<td>452,232</td>
<td>1,152,912</td>
<td>893,860</td>
<td>1.98</td>
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<tr>
<td>1986</td>
<td>492,005</td>
<td>1,434,337</td>
<td>1,078,461</td>
<td>2.19</td>
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<tr>
<td>1987</td>
<td>583,030</td>
<td>1,710,224</td>
<td>1,240,402</td>
<td>2.13</td>
</tr>
<tr>
<td>1988</td>
<td>598,210</td>
<td>1,754,710</td>
<td>1,223,027</td>
<td>2.04</td>
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<tr>
<td>1985-88 avg.</td>
<td>531,369</td>
<td>1,513,044</td>
<td>1,108,938</td>
<td>2.09</td>
</tr>
</tbody>
</table>

Source: Compiled from unpublished Bureau of Census data maintained by NMFS and published and unpublished FAO data.

<sup>a</sup> All imports of shrimp have been converted to a headless shell-on basis using the following conversion factors: 0.63, breaded; 1.00, shell-on; 1.28, peeled raw; 2.52, canned; and 2.40, others.

<sup>b</sup> World production has been converted to headless basis using a factor of 0.62.
Import demand for shrimp is given as: \( QD = f(RPI, GSL, CL, BI, RDI) \) \( (1) \)

where \( QD \) is the quantity of imported shrimp demanded, given in millions of headless shell-on pounds; \( RPI \) is the real, i.e., deflated, price of imported shrimp (expressed on a headless shell-on basis) in U.S. dollars per pound (1980 equals the base year); \( GSL \) is the Gulf and South Atlantic, i.e., warm water, landings of shrimp in millions of headless pounds; \( CL \) is the U.S. landings of cold water shrimp in millions of headless pounds; \( BI \) is the beginning U.S. inventories of shrimp in millions of headless pounds; and \( RDI \) is the U.S. real disposable income (1980 equals the base year) in billions of dollars.

Export supply of shrimp to the U.S. is given as: \( QS = f(PI, REXC, JP, WL, FRI, D87) \) \( (2) \)

where \( QS \) is the quantity of foreign shrimp supplied to the U.S. market, expressed in millions of headless shell-on pounds; \( PI \) is the U.S. price of imported shrimp in current U.S. dollars per pound; \( REXC \) is an index of the real weighted foreign exchange rate among principal U.S. suppliers, i.e., foreign currency per U.S. dollar \(^1\); \( JP \) is Japan’s import price of frozen shrimp (predominately headless) in U.S. dollars per pound; \( WL \) is the world production of shrimp (less production by the U.S. and Japan) expressed on a headless basis; \( FRI \) is an index of real foreign income among the principal U.S. shrimp suppliers \(^2\); and \( D87 \) is a trend variable assigned a value of zero before 1987 and 1 and 2 for 1987 and 1988, respectively \(^3\).

Finally, a market clearing solution is imposed through the identity equation expressed by equation (3): \( QD = QS = IMP \) \( (3) \)

It is implicitly recognized with this equation, where \( IMP \) equals the equilibrium import quantity in millions of headless pounds, that the system is operating in equilibrium; i.e., the quantity demanded is equal to the quantity supplied.

The representation of the U.S. shrimp import market, as outlined in the previous three equations, was developed based on standard economic import theory that import demand is in response to insufficient domestic supplies. Since import demand and import supply are simultaneously determined through an equilibrium price, the model as outlined above was estimated using a two-stage least squares estimation technique as discussed by Pindyck and Rubinfeld (7). Estimation, using a linear functional form for the demand and supply equations, was based on annual observations for the 1965-88 period.

The estimated import demand and supply equations are provided below.

\[
QD = 39.205 - 108.41 RPI - 0.903 GSL + 0.0065 CL \\
(51.735) \quad (17.13) \quad (0.318) \quad (0.1906) \\
-1.444 BI + 0.420 RDI \\
(0.417) \quad (0.021) \\
R^2 = 0.971 \\
D.W. = 2.17 \\
\]

\[
QS = -128.850 + 80.788 PI + 288.80 REXC - 67.906 JP \\
(94.607) \quad (15.606) \quad (42.98) \quad (15.175) \\
+ 0.206 WL - 277.14 FRI + 87.728 D87 \\
(0.026) \quad (105.01) \quad (14.962) \\
R^2 = 0.983 \\
\]

The equations appear adequate as judged by the high \( R^2 \)'s and the statistical significance of the estimated coefficients (asymptotic standard errors are given in parentheses).
All coefficients in the import demand equation, with the exception of $CL$, exhibit the signs suggested by economic theory and are statistically significant. The demand for shrimp imports was found to be negatively related to their own real price ($RPI$) and the results indicate that a one dollar increase (decrease) in the real import price of shrimp would lead to an estimated 108 million pound decrease (increase) in the demand for imports, holding all other factors constant. Similarly, a one-million pound increase (decrease) in warm-water landings of shrimp ($GSL$) was found to result in a 0.903 million pound decrease (increase) in the import demand for shrimp while a one-million pound increase (decrease) in the beginning shrimp inventories was estimated to result in a 1.44 million pound decrease (increase) in import demand; again holding all other factors constant. Finally, the demand for imported shrimp was found to respond by 0.420 million pounds for a one billion dollar increase in real disposable income ($RDI$), ceteris paribus, indicating that increases in the demand for imported shrimp are forthcoming with rising disposable income.

All coefficients in the import supply equation exhibited the signs that would be anticipated based on economic theory and were statistically significant. A one-dollar increase in the current import price of shrimp ($PI$) was estimated to result in an 80.8 million pound increase in the import supply of shrimp, ceteris paribus, while a one-dollar increase in the Japanese import price of shrimp ($JP$) was estimated to result in a 67.9 million pound decline in the U.S. import supply of shrimp. The U.S. import supply of shrimp was found to respond by 0.206 million pounds to each one-million pound change in the world production of shrimp (less U.S. and Japan's production), ceteris paribus. The U.S. import supply of shrimp was found to be positively related to the real weighted foreign exchange rate ($REXC$) with a one unit increase in the latter resulting in a 288.8 million pound increase in import supply, ceteris paribus. A one unit increase in the index of foreign real income among principal U.S. shrimp suppliers ($FRI$) was estimated to result in a 277.1 million pound decline in the import supply, ceteris paribus; indicating increased utilization of shrimp among U.S. suppliers in relation to increases in their purchasing power. Finally, the trend variable $D87$ was included in the analysis to "capture" the rapid rise in the exports of Chinese shrimp to the U.S. market. The estimated coefficient was found to be positive and statistically significant, suggesting a structural change in the import supply market.

It is also useful to evaluate the parameters estimates in terms of elasticities. An elasticity is defined as the percentage change in the dependent variable, i.e., shrimp import demand or supply in this example, with respect to a one percent change in any of the independent variables, holding all other factors constant (for purposes of this paper elasticities have been evaluated at the mean values of each variable). The elasticity of the import demand for shrimp with respect to the real import price of shrimp ($E_{PI}$) was found to equal -0.779, indicating that a 10% increase (decrease) in the real import price of shrimp would be expected to lead to a 7.79% decrease (increase) in the import demand for shrimp, ceteris paribus. Estimated elasticities with respect to other variables in the import demand equation are as follows: $E_{GSL} = -0.455$, $E_{BI} = -0.327$, and $E_{RDI} = 2.432$. The relatively large growth in U.S. disposable income during much of the 1980s has significantly impacted the U.S. demand for imported shrimp as indicated by the large elasticity of demand for imported shrimp with respect to real disposable income. Estimated elasticities with respect to import supply are as follows: $E_{PI} = 0.489$, $E_{REXC} = 1.044$, $E_{JP} = -0.559$, $E_{WL} = 1.162$, and $E_{FRI} = -0.749$.

The condition that all other factors remain constant, i.e., the ceteris paribus condition, which was employed in analyzing the relative changes and elasticities as outlined above results in only partial effects because price is held constant in their calculations. The market clearing solution (equation 3), however, implies that quantity demanded must equal quantity supplied in equilibrium. Equilibrium is restored to the system, given a change in the level of any independent variable, through a change in the import price. For example, increases in real disposable income result in an outward shift in the import demand function which results in an increase in import price and a corresponding adjustment in the quantity of shrimp supplied to the U.S. market. The response in supply drives the import price back towards its original level.
Estimation of long-run, or reduced form, elasticities and changes in the system requires that the system be in equilibrium. This can be achieved by equating the import demand and supply equations and solving for an equilibrium price (since the import price in the demand equation is given in real dollars, it is necessary to convert it to a current basis, by inserting the mean value of CPI, before solving for PI). The resulting equation, where price is specified as a function of all independent variables, can then be inserted into either the estimated import demand function or import supply function, yielding the following equation:

\[ \text{IMP} = -108.41 - 0.341\text{GSL} + 0.0024\text{CL} - 0.546\text{BI} + 0.159\text{RDI} \\
+ 179.61\text{REXC} - 42.23\text{JP} + 0.128\text{WL} - 172.36\text{FRI} \\
+ 54.56\text{D87}. \]

In this equation, the equilibrium level of imports is expressed only in terms of independent variables and can be used for the basis of estimating long-run changes and elasticities.

The long-run impact on imports, resulting from a change in any independent variable, i.e., allowing for equilibrium to be restored to the system, is significantly less than the estimated partial effects. For example, a one million pound increase (decrease) in warm-water landings (GSL) results in only a 0.341 million pound decrease (increase) in the equilibrium import level compared to a 0.903 million pound decrease (increase) initial impact which is calculated before price is allowed to vary. Similarly, a million pound increase in WL results in only a 0.128 million pound increase in the equilibrium level of imports; significantly less than the 0.206 million pound estimated change occurring before price was allowed to vary accordingly.

The long-run, or reduced form elasticities, using the mean levels for imports and independent variables were found to equal \( E^*_{\text{GSL}} = -0.172, E^*_{\text{BI}} = -0.124, E^*_{\text{FRI}} = 0.921, E^*_{\text{REXC}} = 0.649, E^*_{\text{JP}} = -0.348, E^*_{\text{WL}} = 0.722, \) and \( E^*_{\text{D87}} = -0.466 \) (a * next to the E is used to differentiate the long-run elasticities). These are all significantly smaller in absolute magnitude than the short-run elasticities already discussed; especially among the import demand variables. These lower estimates are the result of a relatively lower price elasticity of import supply, 0.489.

**USE OF SHRIMP IMPORTS IN SOUTHEAST PROCESSING ACTIVITIES**

As indicated in the previous section of this paper, shrimp imports have been expanding during the past two decades and much of the expansion has occurred since the 1980s. In light of previous efforts by U.S. shrimp harvesters aimed at limiting imports, it is important to evaluate the use of shrimp imports in the Southeast shrimp processing sector and changes that can be attributed to their use. This section of the paper provides such an evaluation.

Some anecdotal evidence of the use of imported shrimp in the Southeast shrimp processing sector can be gleaned through the use of published statistics. During 1970-74, for instance, Southeast landings of shrimp averaged 146.8 million headless pounds annually while Southeast processing activities averaged 207.8 million pounds (headless shell-on equivalent weight basis); suggesting a deficit in domestic supplies of about 61 million pounds annually. By the 1980-84 period, processing activities had increased to 223.9 million pounds while landings remained relatively stable at 156.2 million pounds; indicating a deficit of about 68 million pounds. Processing activities expanded to an average of 268.4 million pounds annually during 1985-88 and the deficit increased to 90.5 million pounds annually. Based upon these observations, imports are obviously playing an increased role in Southeast shrimp processing activities.

While the above observations help depict the potential use of imports in Southeast shrimp processing activities, the depiction is far from complete. To obtain a more complete picture of the use of imports in the region's shrimp processing sector, the authors conducted interviews with managers of shrimp companies that were thought to have used and/or are using imports in processing activities. Interviews with management of 31 Southeast shrimp processing
establishments (plants) were conducted in late 1988 and early 1989 and provides the basis for the ensuing discussion (see 9 for a more complete discussion). Because a small number of Southeastern shrimp processors were either not identified or declined to be interviewed, the estimates that are provided may be low. Also, managers of those companies which ceased processing operations prior to this study could not be contacted, and this suggests that information gathered on the earlier years is especially incomplete.

As Table 2 documents, at least 26 establishments were using imported raw material by 1988. A noteworthy aspect of the historical use is the lengthy, uninterrupted usage pattern among Florida Atlantic coast, Georgia, and Florida Gulf coast processors. The year 1982 was the benchmark for other states’ experiences. This is the same year that imports began to expand rapidly (Table 1). Alabama, Mississippi, and Louisiana processing industries experienced a large increase in the number of plants that use imports. Among the three states, companies in Alabama began using imports earlier. By 1988, however, the number in Mississippi exceeded the number in Alabama. The number in Louisiana matched that of Alabama by 1988. Much of the increase in the number of Mississippi and Louisiana processors using imported shrimp coincided with the expansion of Asian, particularly Chinese, exports of shrimp to the United States. However, many of the Louisiana companies indicated a much more seasonal basis of import usage than did the companies in Alabama and Mississippi.

The relative importance of imports was identified by comparing the region’s total production of processed shrimp and the estimated production of plants that use imported shrimp as raw material, as shown in Table 3. By 1984, the plants that use imports accounted for 56 percent of the region’s total processed shrimp output. In the initial year, 1974, they accounted for 31 percent of the total. The estimated use of imported shrimp increased five fold, from 8-9 million pounds in 1974-75, to 50 million pounds by 1986-87. Imported shrimp accounted for 36 percent of production among companies using imported shrimp in 1987 compared with 14 percent in 1974.

The significance of imports to processing plants in the region could also manifest itself through their product mix. Shrimp products were identified in our survey as raw headless shell-on, peeled raw, breaded, and other. Shrimp that are canned, peeled cooked, or dried comprise most of the “other” category. Plants using imported shrimp more than doubled their production during 1974-87, as measured on a raw headless shrimp equivalent weight basis (Table 4). The shell-on, raw peeled, and breaded categories exhibited large quantity increases among processors of imported shrimp (Table 4). By contrast, the other plants in the region experienced growth in only the raw peeled shrimp category during 1974-87 and experienced no growth in total (Table 5) because of a significant decline in breading and other activities. It is noteworthy that the raw shell-on category was a significant growth category for import-using processors during 1974-87 when non-import users had no growth in that category. Use of imported shrimp in the raw shell-on category does not necessarily indicate lack of value added in processing. Processors using imports responded to the usage question concerning their product mix by including repacked shrimp in the raw shell-on product category. In particular, farm-raised shrimp from Ecuador was repacked as raw shell-on product. Other farm-raised shrimp likely to be repacked as shell-on product included shrimp from Taiwan. White shrimp from mainland China were prominent in 1986 and 1987 U.S. Imports. The major uses of this supply included peeled raw and repacking.
Table 2. Processing Plants Using Imported Shrimp by States, 1974-88.

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<thead>
<tr>
<th>SOUTH ATLANTIC</th>
<th>GULF</th>
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</tr>
<tr>
<td>1988</td>
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</table>

Source: Primary data collected by authors.

Table 3. Processed Shrimp Products in the Southeast Region and Estimates of Imported Shrimp’s Role, 1974-87.

<table>
<thead>
<tr>
<th>PROCESSED QUANTITY (MILS. LBS., HEADLESS, SHELL-ON)</th>
</tr>
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<tbody>
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</tr>
<tr>
<td>------</td>
</tr>
<tr>
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<td>1987</td>
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</table>

Source: Compiled from primary data collected by authors and unpublished data provided by the National Marine Fisheries Service.
Table 4. Shrimp Products of Southeastern Establishments Using Domestic and Imported Shrimp as Raw Material, 1974-87.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RAW SHELL-ON</th>
<th>PEELED RAW</th>
<th>BREADED</th>
<th>OTHER</th>
<th>TOTAL</th>
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Source: Compiled from primary data and unpublished data provided by the National Marine Fisheries Service, Fisheries Statistics Division.

Table 5. Shrimp Products of Southeastern Establishments Using Only Domestic Shrimp as Raw Material, 1974-87.

<table>
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<tr>
<th>YEAR</th>
<th>RAW SHELL-ON</th>
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<th>BREADED</th>
<th>OTHER</th>
<th>TOTAL</th>
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Source: Compiled from primary data and unpublished data provided by the National Marine Fisheries Service, Fisheries Statistics Division.
SUMMARY

U.S. imports of shrimp have been increasing at record levels during the 1980s. The purposes of this paper were two-fold: (i) to develop and present a statistical model which explains the U.S. import market and reasons for the increased imports and (ii) to examine the use of these increased imports in the Southeast shrimp processing sector.

The import market model consisted of both an import demand and an import supply equation. Import demand was specified to be a function of five variables: (i) the real price of U.S. shrimp imports, (ii) Gulf and South Atlantic landings of shrimp, (iii) other domestic landings of shrimp, (iv) beginning inventories of shrimp, and (v) real disposable income. The supply of shrimp imports was specified to be a function of (i) the U.S. import price of shrimp, (ii) an index of the real weighted exchange rate between the U.S. and its principal shrimp suppliers, (iii) the Japanese shrimp import price, (iv) the world production of shrimp (less U.S. and Japan's production), (v) an index of foreign real income among the principal U.S. shrimp suppliers, and (vi) a trend variable taking on a value of 0 before 1987 and values of 1 and 2 for 1987 and 1988, respectively. The import demand and import supply equations were estimated simultaneously using a two-stage least squares technique.

The models performed quite adequately based on standard statistical tests and economic theory. Increases in real disposable income were found to have a very large and positive impact on the demand for imported shrimp while increases in either Southeast shrimp landings or beginning inventories were found to negatively impact the demand for imported shrimp. The real import price of shrimp was found to have a negative influence on the demand for imported shrimp, as would be expected, with a 10% increase in the former resulting in an estimated 7.79% decrease in the later, ceteris paribus.

All variables in the import supply equation were found to be statistically significant and exhibited the anticipated signs. As expected, the large increase in the world production of shrimp during the past decade has been a major contributing factor to the increase in the supply of shrimp imports. The price elasticity of import supply was found to equal 0.489 indicating a relatively unresponsive change in import supply with respect to price.

To examine the use of imported shrimp in the Southeast shrimp processing sector, the authors interviewed management of 31 Southeast processing plants, thought to have used or are using imported shrimp, in late 1986 and early 1990. Increases in processing activities of Southeast shrimp processors were positively linked to increases in shrimp imports. Florida and Georgia processors were found to exhibit a long history of imported shrimp use. By comparison, Alabama, Mississippi, and Louisiana processors started using processed shrimp, for the most part, more recently.

The study found that plants that used imported shrimp more than doubled their output during 1974-87, as measured on a raw headless shrimp equivalent weight basis. Plants not using imported shrimp, by comparison, showed no growth. Among processors of imported shrimp, the shell-on, raw peeled, and breaded activities all exhibited large quantity increases. Among plants not using imports, growth occurred only in the raw peeled shrimp category.
ENDNOTES

1 The index of the real weighted foreign exchange rate was computed based on ten largest suppliers of shrimp to the U.S. market during the 1974-79 period (mid point of the data series) using the following formula

\[ \text{REXC}_t = 100 \sum_{i} w_i R_{it} \]

where \( \text{REXC}_t \) is the real estimated weighted foreign exchange rate in year \( t \), \( R_{it} \) is the real foreign currency of country \( i \) per U.S. dollar in year \( t \) indexed to 1960. \( w_i \) is the weight assigned to country \( i \) based on the average annual 1974-79 import level of country \( i \). Weights are as follows: Mexico 0.427, India 0.255, Panama 0.055, Ecuador 0.052, Taiwan 0.040, Thailand 0.038, El Salvador 0.035, Nicaragua 0.034, Indonesia 0.033, and Colombia 0.030.

2 The index of foreign real income among principal U.S. shrimp suppliers was computed in a similar fashion as the real weighted exchange rate (see endnote 3). Gross domestic production data was used in lieu of income data due to unavailability of the latter.

3 Three reasons are advanced for including this trend variable. First, in the absence of a free market economy, there may be little reason to expect that China will direct exports in a manner that would maximize profits. Second, the shrimp that was introduced by China, the black tiger shrimp, represented a new variety to U.S. consumer and reportedly sold at a discount during its introduction to the U.S. market. Finally, the rapid increase in exports to the United States in 1987 and 1988 may have resulted in short-run disruptions in the U.S. import supply market.

4 The import supply equation has been corrected for serial correlation. Therefore, a Durbin Watson statistic is not given.

5 It is noteworthy that estimation of the import supply equation through 1986 without the trend variable (D87) yielded almost identical results as those reported in Table 2 for the 1965-88 period. The import supply equation estimated through 1986 and corrected for serial correlation is as follows:

\[ QS = -128.15 + 80.643PI + 290.24\text{REXC} - 67.07\text{JP} + 0.208\text{WL} - 285.42\text{FRI} \]
REFERENCES


MEASURING VALUE ADDED TO GULF OF MEXICO SHRIMP BY PROCESSING COMPANIES

Kenneth J. Roberts, Ph.D.*, Walter R. Keithly, Ph.D.
and Darrell Brannon
Office of Sea Grant Development*
Center for Wetland Resources
Louisiana State University
Baton Rouge, Louisiana
and
Coastal Fisheries Institute
Center for Wetland Resources
Louisiana State University
Baton Rouge, Louisiana

INTRODUCTION

The landings of shrimp from Gulf of Mexico and state waters are known to be large, often exceeding 240 million pounds (head-on equivalent). A distinguishing element of the industry's production is the wide range of sizes produced. The open ended category of 68+ tails to the pound has, in recent years, accounted for over one-third of brown and white shrimp landings National Marine Fisheries Service (9). The most recent data available (1989) had 68+ brown shrimp landings as 39.9 percent of total Gulf landings. The comparative white shrimp figure was 46.7 percent. During the 1978-1989 period an increasing percentage of white shrimp were in the 68+ category. Historical highs were set in 1988 and 1989. The same two years had 68+ brown shrimp below 40 percent. This occurred following six consecutive years of 68+ brown shrimp being 40 percent or more of landings.

The open-end nature of the 68+ category has an important additional characteristic. There could be a shifting toward smaller shrimp. Harvest of smaller shrimp could be occurring even though the relative role of the category remained unchanged. For example, a smaller average size brown shrimp could comprise the 68+ category even though the percentage share of the category did not increase. Review of data collected on brown shrimp harvests from inshore waters of Louisiana and Texas provided insight on the matter. In 1987, for example, 64 percent of the 68+ count brown shrimp landed in Louisiana's inshore fishery were over 100 count National Marine Fisheries Service (8). The corresponding estimate for Texas inshore brown shrimp landings was 80 percent. This exemplifies the multi-state nature of the "small" shrimp fishery. The receipt of "small" Louisiana heads-on shrimp by Mississippi and Alabama processors, while further exemplifying the multi-state nature of the "small" shrimp fishery, adds another dimension of "small" shrimp utilization Roberts, et al. (11). This dimension is the utilization of the shrimp in processing and marketing products for consumer use.

The emphasis on identifying size of shrimp in the 68+ category is warranted because of the prospect of fishery agencies managing for increased economic returns. A means proposed to achieve such returns is to manage for larger, higher priced shrimp. Two major impediments, among many, to an evaluation of the merit in pursuing such a goal are: 1) a lack of a working definition of the size counts considered to be "small", and 2) lack of a comprehensive measure of economic returns to shrimp use other than that reported at the dockside level. Vagueness associated with loosely worded critiques of shrimp harvesting in the gulf of Mexico likely lessen any prospects for change if it were necessary.

Shrimp value, of course, extends past the dock. Processing adds value to shrimp. Per unit harvest value and the per unit processed value can vary considerably depending on the type and extent of processing. Companies involved in processing Gulf shrimp, in turn, often depend
on the size-count of shrimp harvested. The business of processing shrimp certainly occurs in a
dynamic international economic environment. Shell-on headless imports have increased recently
to the point where they comprise 65 percent of imports compared to 55 percent ten years ago.
Aquaculture supplies, primarily imports, in the mid-counts are responsible for not only the shift
in the shell-on/peeled import mix, but also for a lessened role for “small” shrimp. Raw material
needs for peeling process lines are generally shrimp in the higher counts. From 1977 to 1986
peeled raw shrimp increased from 13 to 26 percent of Gulf processed shrimp share in terms of
poundage National Marine Fishes Service (7). Peeled shrimp production increased 40 million
pounds for the period or four times as much as the decrease in shrimp usage in canning. Peeled
raw imports were essentially static for the period while peeled cooked, mostly European product,
increased 20 million pounds. With increased aquaculture supplies from Asia expected to keep
pressure on mid-count shrimp prices, the role of “small” shrimp in determining economic returns
must be better understood.

Evaluation of public shrimp policy alternatives necessitates inclusion of considerations
beyond the harvest level. Size of shrimp at harvest will increasingly receive attention of industry
and management agencies. Ex-vessel price as the sole indicator of value or benefit from
management measures is a narrow and simplistic basis of comparison. Simplicity in the case of
the complex Gulf shrimp industry also translates to incompleteness. Pertinent elements of more
complete evaluations are the ramifications of imported products and domestic processing. A
shrimp import model was recently completed Keithly, et al. (6). The processing industry is the
focus on the material presented herein. The general objective was to propose, evaluate and
report on criteria central to the issue of economic value of “small” shrimp. Since the “small”
shrimp industry is primarily northern Gulf based, focusing on the Louisiana processing industry
provided a good indicator of the total situation.

APPROACH

National Marine Fisheries Service landings statistics and imported shrimp statistics were
used to depict size distribution. Import statistics could be represented by size for only the shell-
on and peeled product forms. These forms are the majority of imported shrimp. The landings
data have routinely ended with an open-ended size category. This category is the 68+ count tails
to the pound. All shrimp 68 count or smaller are reported in the category. Use was made of
Louisiana catch data which after 1985 disaggregated the 68+ category into three closed size
categories and another open-ended category designated 116+ count. There being no standard
for demarcation between preferred and “small” sizes of shrimp a subjective approach was
necessary.

To accurately estimate value in use requires that the double counting common to
processing sales figures be eliminated. Obviously, a processing company’s sales reflect success
or failure in markets. Sales revenue in the long-run must be sufficient to cover all expenses. Raw
material to make the product, labor costs, salaries, supplies, utilities, overhead, and many other
things comprise the expenses. To simply subtract from sales the purchase cost of a product or
raw material will not remove the duplication. A company to produce a salable product purchases
many things from other companies. Double counting of sales occurs when the supplying
companies’items are counted again in the sales of the selling companies. Removal of all material
and service purchases from a company’s sales leaves a residual amount called value added. It
is value added not gross margin (markup) that gives insight to net value created from a particular
use of a natural resource, shrimp in this case. Definitions highlight in a concise manner the
differences between gross margin (markup) and value added.

gross margin (markup): The purchase price of a product subtracted from the sale price
of the product yields the gross margin. Thus, gross margin is a term associated with two
levels in the marketing process. The most used measure is that of difference in purchase price and sale price between producer and the primary wholesaler.

*value added:* It is the part of gross margin that indicates payments to labor (wages), management (salaries), fringe benefits, capital (depreciation and profits), and taxes. The contribution an industry makes to an economy is identified by value added. Value added eliminates the double counting in a sales figure. A sales figure includes the products and services purchased from other companies. These purchases of raw material, containers, supplies, fuel and other items must be subtracted from sales to derive a company’s (industry’s) value added.

Since a company’s purchase and sale prices for a product are critical to the gross margin estimate, some product comparability must be identified. For seafood, a company’s purchase price is for raw, unprocessed product. The raw material becomes changed prior to a product being sold by the processor or wholesaler. A fundamental need is to have equivalent products upon purchase by the processor (wholesaler) and eventual resale. Differences between prices of equivalent weight can then be estimated and attributed to processing activities. Gross margin (markup) is the monetary differences between equivalent products sold by fishermen and then resold by processors (wholesalers). Value added as a component of gross margin is consequently also dependent on the equivalent product estimation procedure.

Standard conversions were available through the National Marine Fisheries Service Thompson, (12). Shrimp products evaluated in the project were headless, peeled raw, breaded raw, and canned. The NMFS keeps conversions for headless products on a species basis. Headless white shrimp poundage should be multiplied by 1.54 to attain the head-on quantity. The headless brown shrimp poundage should be multiplied by 1.61. Thus, brown shrimp yield from head-on to headless is less than that of white shrimp. Since quantity by species is not reported in the statistical system beyond the dock level, average for all species conversions were used. On average, it takes 1.59 pounds of head-on shrimp to produce a pound of processed headless shrimp. Corresponding multipliers for other processed products were similarly used to make value added estimates comparable. Such estimates are the best means of identifying the relative economic importance of processing activities Connor, (2). As will be noted in the analysis section, certain processed products are associated with small shrimp. Value added estimates will thereby yield a broader perspective of economic significance than does ex-vessel price.

**LITERATURE REVIEW**

The review of publications from previous research yielded information of limited usefulness. Previous research in some cases was not specific enough to the issues of interest. In other cases, the literature revealed that a high level of aggregation existed. That is, the research was not specific enough to reveal information of value to the Gulf value added situation.

Two studies based on 1982 as the analyzed period were found. The more comprehensive analyses actually resulted in reports dealing with headless, peeled, breaded, and canned shrimp products Hu (4). The other report is self-critical. That is, the investigator documents an analysis based on inadequate data Perkins (10). The studies reported by Hu were from a contract aimed at eliminating overregulation of seafood processors through regulatory analyses. Reports for the various processed products of southern shrimp included production, import levels, export levels, number of plants, sales employment, and cost components. The processing cost components were identified by size categories of shrimp plants. Value added is comprised of certain costs that reflect payments to labor, management, and capital plus profits. Hu’s studies do not provide a complete depiction of value added. The reports are nonetheless useful to indicate the 1982 levels of some value added components.
In the Perkins 1984 report many errors were made that negate the usefulness of findings. Value added was incorrectly defined as "the difference between the raw material cost and the plant sales value of processed shrimp." As noted previously this is actually the correct definition of gross margin not value added. The Perkins findings can not serve to identify the relative economic contribution of shrimp processing establishments. Perkins' findings are also of limited use because as stated in the report, "the responsiveness of processors regarding cost data was disappointing." This essentially necessitated that the processing costs be displayed in percentage of total processing cost terms. The actual processing cost per item or function was not reported. These problems collectively make the Perkins report of no use to those involved in shrimp industry management.

A contract report to NMFS by Danville Research Associates, Inc. (3) dealt with the shrimp processing industry of the southeast. This comprehensive report remains unpublished. It documents the supply procurement, production, transportation, sales and other factors that explain changes in industry structure. Mean processing cost per pound was identified for 1983. Processing costs were reported by state and for the region. A large number of companies were involved. However, this large number of cooperators were not able to attribute costs to functions and supplies. Operating costs were the only costs reported on a pound basis. Management salaries, depreciation, profit, and other components of value added were not reported by pound. The large number of companies reporting; green headless (54), breaded (4) and peeled (21) likely makes the aggregated operating costs reliable. The operating costs reported for the two canners appear very low and not recommended for use. With the exception of canned costs, operating costs increased as expected in relation to level of processing. Green headless processors reported an average of $2.22 per product pound operating cost. Peeled product, not distinguished as to raw or cooked, was reported to cost $3.36 per product pound. Breaded product, not distinguished as to raw or cooked, cost $7.76 per product pound. All operating costs are obviously exclusive of the cost of shrimp.

As described in Connor (2) value added has been recognized as a significant indicator of economic contribution to gross national product. The U.S. Bureau of the Census (1) annually produces a census of manufacturers inclusive of value added estimates. As would be expected the annual publication of the national economy must deal with numerous industries. Consequently, many industries must be grouped to form a manageable number of classifications to track. Only two of the Bureau's classifications are pertinent to this study: group 2091 for Canned and Cured Fish and Seafoods and group 2092 for Fresh or Frozen Prepared Fish and Seafoods. Canned shrimp are identified by the product code 20910-16. All other frozen shrimp products are included in product code 20925. This product code is further defined for headless (2095-21), peeled raw (20925-22), peeled cooked (20925-23), breaded (20925-24). The value added estimates, however, are only reported at the more highly aggregated 2091 and 2092 groups. Value added expressed as a percentage of 1987 canned and cured (2091) sales was 36.9 percent. The corresponding figure for fresh or frozen (2092) was 26.7 percent. These figures indicate that the more highly processed products generate more value added per dollar of sales. Unfortunately value added estimates for specific shrimp products are not calculated.

A contract issued by NMFS to the research company Kearney/Centaur involved estimation of nationwide value added, margin, and expenditure estimates for marine fishery products Kearney/Centaur (5). Data for the report was from secondary sources. Consequently, value added estimates for shrimp products were not specific to the Gulf or shrimp size. The report did estimate 1985 gross margins for headless, peeled raw, peeled cooked, breaded raw, and breaded cooked. Gross margin was reported as a percent based on an arithmetic average. Portraying gross margin as a percent in relation to ex-vessel price is not useful to specific Gulf concerns over shrimp size. This conclusion is warranted because the national study lumped Pacific, New England, South Atlantic and Gulf of Mexico shrimp together. With gross margin expressed as a percent for ex-vessel price for such widely ranging shrimp fisheries, there can be
only limited application of results. The gross margin was also calculated without regard to weighting on the basis of product quantities. This further limits the usefulness of the Kearney/Centaur (5) report for shrimp fisheries involving three coasts and many processed products. Use of the findings about shrimp must be tempered by an understanding of the study’s procedures.

Awareness of weakness regarding the shrimp gross margin information is essential when reviewing the Kearney/Centaur value added estimates. The Census of Manufacturer’s estimates of value added for 2092 (fresh and frozen prepared fish and seafoods) was used for shrimp, all other shellfish, and finish. This aggregation results in estimates that can be used only with caution. Group 2092’s value added for 1985 was 57.3 percent of gross margin at the primary processing level. There are no secondary data sources available that can be used to separate Gulf shrimp processors and their different products from these national averages. The need in this project to delineate the first ever value added estimates for Gulf small shrimp then must be achieved by collection of primary data.

SURVEY OF PROCESSORS’ VALUE ADDED

Secondary data provided the ex-vessel and wholesale shrimp prices. Gross margin was then calculated for the various shrimp products. The value added component of gross margin could not be estimated for 1987 from secondary sources. As previously noted the literature search revealed that previous studies failed to yield value added estimates due to poor research methodology Perkins (10) or excessive aggregation Kearney/Centaur (5). Collection of primary data on costs involved in producing Gulf processed shrimp products was clearly necessary. Fifteen companies responded to a two-page questionnaire specifically designed to identify value added.

RESULTS

This analysis was based on 68+ tails per pound as the demarcation point for “small” shrimp. Essentially any point can be criticized as being somewhat arbitrary. There are shrimp management policies in the Gulf focused on size at harvest. Louisiana opens its brown season on the basis of 50 percent of the shrimp being at least 100 count head-on. A Louisiana landing law prohibits smaller than 100 count head-on white shrimp. The Gulf Council’s mid-summer brown shrimp closure off Texas produces an annual evaluation report. NMFS’s evaluation cites shrimp tails 68+ as small.

There are also trade/market practices that provide guidance. Mechanically processed head-on shrimp yield a peeled raw (PUD) product. Head-on shrimp larger than 41-50 are used only infrequently for PUD market (A. Cuccia, personal communication). This category is equivalent to 68-80 tails. The survey of Gulf processors also provided insight to industry practices. Processors responded to questions about most frequent sizes used in their product and raw material costs. Answers to each gave an indication from two perspectives of the sizes of shrimp used for peeled raw (PUD) breaded, and canned products. The 68+ shell-on tails category was reported to be representative of the PUD and canned products. A range of shrimp from 31-60 count shell-on tails was cited by the processors of breaded products. The most frequent count was 41-50.

Price quotes in NMFS Market News reports are readily available for the 90-100 count PUD produced from the 68-80 tails. The same reports indicate a lessening of price quote availability on shell-on headless for 70 count and smaller shrimp. Gulf supplies of shell-on headless smaller than 70 count shrimp are perhaps limited. The decision was made to denote 68+ headless shrimp as “small” for purpose of the analysis. This certainly would include the brown and white 100 count criteria established in Louisiana and supported by Gulf council action. It also fits the
cited "small" shrimp terminology in the annual report prepared on the Texas brown shrimp closure. From a processed product viewpoint, the 68+ tails choice serves to delineate the shell-on headless and PUD product. Canned product clearly involves use of shrimp in the proposed 68+ category. Just as clearly the breaded products involve use of shrimp larger than 68+ tails in most cases.

Value-in-use of landed shrimp has been portrayed as best estimated as part of the gross margin of initial processors. The focus is on identifying that portion of the margin that represents new value, i.e., value added. Processors responding to a survey provided a direct estimation of value added through delineation of all unit costs. Components of value added are labor expenses, salaries, employment taxes, other taxes, depreciation, rent, interest, and profit. Direct estimation of value added produced numbers by shrimp product that could then be compared to the gross margins. The ex-vessel price of shrimp used in products when subtracted from the processed price received yields the gross margin. Value added is then divided by the gross margin to identify the percentage attributable to value added. This coefficient can then be applied annually to the gross margins by product. Only ex-vessel and processed product prices are needed for the selected year.

Data on processed product quantities and value collected by NMFS are reported annually in Processed Fishery Products, Annual Summary. The most recent volume at time of report preparation was 1986. However, 1987 data were available via personal communication with the NMFS. This source allowed the use of 1987 as the year of most recent data available. Price received for the various Gulf processed shrimp products was derived from the quantity and value amounts. In this way, the primary processing market level’s gross margin could be calculated. Thus, the gross margin estimates for shell-on, peeled raw, breaded, and canned products came from NMFS data. This finding will be of use in subsequent analyses. Use of NMFS data will necessitate special requests for ex-vessel and processed product data. This should be anticipated so that potential time delays can be minimized. The Gulf average processed product prices per pound for 1987 were: shell-on headless $4.29, peeled raw $3.43, breaded $3.31, and canned $5.19 (or $35.03 per case).

The value added estimates from the survey of processors are: PUD $.59 per pound, canned $9.96 per case ($1.48 per lb.), and breaded $1.04 per pound (Table 1). Components of value added were grouped into six categories to show the relative contribution (Table 2). Labor costs were the largest category of value added for PUD and breaded products. Production of canned shrimp is more highly mechanized which leads to a lesser role for labor. Net profit at $2.70 and rents/fees at $2.53 are the major categories of value added. The significant role of rents/fees arises due to marketing costs. Gulf canned shrimp are a retail oriented product involving use of marketing services. The rents/fees of PUD and breaded shrimp generally reflect costs only through the primary processing or wholesale level.

Quantifying value added permits other shrimp use relationship factors to be estimated. Value added in relation to gross margin shows the new contribution that a particular processing activity makes to the economic impact of shrimp use. The shrimp cost to produce the product and processed product prices for 1987 provided the estimated gross margins. The value added component from the survey then allows the percentage of new economic activity to be calculated. Additional effort is necessary in order for comparisons among shrimp products to be accurate. This is because each of the final processed products requires different quantities of shrimp input. The shell-on headless amount of shrimp necessary to produce a pound of product was derived from standard NMFS conversions listed in Fisheries Statistics of the United States Thompson (12). Thus, the gross margin and value added estimates are stated on the common basis of shell-on headless in the last line of Table 1. The first four lines of the table relate to product pounds. Value added on a headless shrimp per pound basis was calculated by dividing value added per product pound by the pounds of headless shrimp necessary to produce the product pound. For
Table 1. Gross Margin and Value Added of Gulf Shrimp Processed Products, 1987.

<table>
<thead>
<tr>
<th>PEELED</th>
<th>UNDEVEINED</th>
<th>CANNED</th>
<th>BREADED</th>
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<tr>
<td>processed price</td>
<td>$3.43</td>
<td>$5.19</td>
<td>$3.31</td>
</tr>
<tr>
<td>shrimp cost</td>
<td>2.28</td>
<td>3.31</td>
<td>1.73</td>
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<tr>
<td>gross margin</td>
<td>1.15</td>
<td>1.88</td>
<td>1.58</td>
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<tr>
<td>value added</td>
<td>.59</td>
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<td>51.3</td>
<td>78.7</td>
<td>65.8</td>
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<tr>
<td>value added per pound of headless shrimp used in the product</td>
<td>.46</td>
<td>.73</td>
<td>1.65</td>
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</table>

The production of a pound of PUD product requires 1.283 pounds of shell-on headless at a price of $1.78 per pound for a shrimp cost of $2.28.

The production of a pound of canned product requires 2.02 pounds of shell-on headless at a price of $1.64 per pound for a shrimp cost of $3.31.

The production of a pound of breaded product requires .629 pounds of shell-on headless at a price of $2.75 per pound for a shrimp cost of $1.73.

Table 2. Total and Component Value Added Per Product Pound Estimated from Survey of Gulf of Mexico Shrimp Processors, 1987.

<table>
<thead>
<tr>
<th></th>
<th>PUD</th>
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<tr>
<td>labor</td>
<td>.234</td>
<td>.333</td>
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<tr>
<td>salaries</td>
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<td>.132</td>
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<tr>
<td>overhead</td>
<td>.072</td>
<td>.152</td>
<td>.157</td>
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<tr>
<td>rents/fees</td>
<td>.053</td>
<td>.374</td>
<td>.067</td>
</tr>
<tr>
<td>profit</td>
<td>.158</td>
<td>.400</td>
<td>.310</td>
</tr>
<tr>
<td>total</td>
<td>.593</td>
<td>1.476</td>
<td>1.037</td>
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</table>
PUD the $.59 value added was divided by 1.283 to derive $.46 value added per headless pound used to produce PUD shrimp. Following the same procedure for the product value added and the conversions yielded the estimates of $.73 for canned and $1.65 for breaded. These results give specific numbers that relate to each other as anticipated. That is, breaded products involve more processing steps and require less shrimp per product pound than either PUD or canned products. Note that canned value added per product pound is actually the highest of the three products. However, 2.02 pounds of headless shrimp are required to produce the canned pound. In making calculations of value in use beyond ex-vessel three findings must be explicitly recognized: 1. shrimp of different sizes are used in the products, 2. the processed products require different amounts of headless shrimp inputs, 3. the combined effect of different sizes with related prices and varied conversions can make the process of evaluation tedious.

The production of frozen shell-on headless shrimp by processing companies is associated with value added generation. A focus of the research was "small" shrimp previously defined as 68+ count. PUD, canned and some breaded products are associated with shrimp in the category. However, the headless product was previously identified as involving little use of 68+ raw material. Processing of this product is a straight forward matter of grading, boxing, and freezing in five pound units. Gross margin and value added levels are comparatively lower in practice than more highly processed products. PUD, canned, and breaded shrimp products utilize more procedures to yield products that serve both the food service and retail sectors of seafood product supply and use. Frozen headless as a product serves the food service aspect of the market. This market is one focused on minimal changes in raw material and large package size. The gross margin for headless products in 1987 was calculated from secondary data. The average ex-vessel price for Gulf shrimp 67 count and larger was $3.91. A gross margin of $.38 per pound results from use of the average headless wholesale price of $4.29 (S. Koplin, personal communication). This verifies the statement that headless product would have lower gross margin than more highly processed products oriented to more finished product uses. Consequently, value added per product pound will also be low in absolute terms. An estimate of headless product value added was made from secondary data Kearney/Centaur (5). Value added as a percentage of gross margin was identified in the report as 57.3 percent. The arithmetic mean of peeled, canned, and breaded products collected as primary data from the survey was 65.3 percent. Using these measures to depict a range for value added of processed headless shrimp yields $.218 to $.248 per pound. These values can be compared to the value added findings in the last row of Table 1. It is the conversion of product weights to a raw material weight basis that facilitates the comparisons. The comparisons or rankings on a raw material basis are consistent with the proposition that more value derives from multi-step processing. Research has quantified the value added and, importantly, identified the amounts by which shrimp product value added differs.

CONCLUSIONS

The focus of the research project was the identification and delineation of the situation in the small shrimp component of Gulf shrimp fisheries. Emphasis was on generation of new economic information from the perspective of value added in processing. The process adds two elements to the deliberations about shrimp size count management. The first is that managers and industry must develop and use information beyond the harvest level. Ignoring the primary processing level in management attempts to improve economic conditions will lead to incomplete information. Decisions would not be based on the best scientific information available. Secondly, size count management must proceed with value added estimates as opposed to price alone. Value added was noted to be more useful in measuring economic results of change. The basis for the statement is that price conveys gross effects while value added specifies new net economic results.
Research results do not determine management objectives. Participants in the management process contribute to statements of objectives. This project contributes results that should broaden and make more accurate both the development and evaluation of objectives. Viewing the data and analysis of this initial research into value added leads to the following conclusions:

1. The contribution an industry makes to an economy can be identified by the measurement of value added.

2. The use of value added methodology necessitates acquiring data from both primary and secondary sources. Routine data collection by agencies will not provide an adequate basis for analysis. Interview data from processors and harvesters is necessary to complete value added research.

3. Agencies should continue to report prices by as large a number of sizes as possible. Future decisions may be far more specific than one involving 68+ tails versus all larger shrimp.

4. The analysis indicated that processed products likely to involve "small" shrimp use generated more value added per pound than other products. Value added on a headless input basis for the various products was estimated to be: $.46 per pound for PUD, $.73 per pound for canned, $1.65 per pound for breaded, and from $.22 to $.25 pound for frozen headless. The PUD and canned products essentially involve use of "small" shrimp. Breaded products involves some use of such shrimp. The frozen headless product essentially reflects use of larger shrimp.

ACKNOWLEDGEMENT

The authors acknowledge funding support of the MARFIN Program for the project "The Role of Small Shrimp in Determining Economic Returns".

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THE NORTH ATLANTIC SWORDFISH FISHERY:
PROBLEMS, TRENDS AND THE ECONOMICS OF MANAGEMENT

E. Lee Bouchelle, Eric Thunberg, Ph.D., Charles Adams, Ph.D.
and James L. Seale Jr., Ph.D.
Department of Food and Resource Economics
University of Florida
Gainesville, FL

The North Atlantic swordfish (Xiphias gladius) has recently been the subject of an increasing number of proposed domestic and international regulatory measures. These measures are designed to reduce current fishing mortality which is believed to place the swordfish stock in danger of recruitment failure. A proposed amendment to the existing swordfish fishery management plan (FMP), as well as an international agreement to limit swordfish harvest, will contribute to the formulation of management measures that are intended to rebuild the spawning stock to a level that will reduce the likelihood of recruitment failure. These new management initiatives are the result of an evaluation of the swordfish stocks by scientific panels, international negotiations, input from public hearings and economic analysis.

This paper will begin with an historical overview of the swordfish fishery. The problems that have developed within the fishery and the growing importance of imports become evident as we discuss production trends. The evolution of the original swordfish management plan is then traced to today's impending regulations. Since the U.S. is the primary importer of swordfish, the role of imports is described within a simple economic model. The economic model is then used to analyze the potential impacts of these proposed regulations on domestic harvesters and consumers of swordfish. The international trade aspects of the proposed regulations will also be discussed.

INDUSTRY BACKGROUND

The swordfish is a slow growing billfish, first spawning at five or six years and living about nine years. These characteristics are typical of species that are susceptible to biological overfishing (2). However, its global distribution, large spawning areas and prolific nature have contributed to the relative resilience of the species. The primary habitat of the North Atlantic swordfish is the Gulf Stream, which flows northeasterly along the U.S. coast, then turns eastward into the Atlantic across the Grand Banks. Tag-recapture data, geographic distribution of Japanese by-catch and larvae distribution suggest that the stock structure of the North Atlantic swordfish is continuously distributed across the Atlantic. Trans-Atlantic migration has been found to be minimal, however, north-south movement along the eastern seaboard is recognized to be very significant (7).

The domestic fishery for the North Atlantic swordfish has historically been dominated by the New England fleet, which fishes along the Atlantic coast from New England to Florida and into the Gulf of Mexico. The Florida fleet, which evolved from techniques and gear used by Cuban-American longliners, is a more recent development. The New England vessels traditionally have been larger than their Florida counterparts because of the distances traveled and time spent at sea. Typically a New England longline vessel, usually 60 to 80 feet long, fishes off New England in the summer and fall, and works its way south as winter approaches. The vessel may fish off Florida's east coast or in the Gulf of Mexico for as long as two weeks at a time (1).

The Florida fleet was developed by shark longliners who began to land a significant amount of swordfish as by-catch. The Florida fishermen saw the high value of swordfish and the large catches by the northern boats as enticements to enter the fishery. However, they also
found that the longline gear used by the New England boats was not as efficient in the swift currents of the Florida portion of the Gulf Stream. In the mid-70’s Cuban-American fishermen developed a type of longline that led to more efficient catches in Florida waters. These migrant fishermen were familiar with a traditional swordfish fishery existing for years along the coast of Cuba. The vessels in the Florida fleet are usually 35 to 50 feet long and are geared to make one or two night trips (1).

Virtually all commercially landed swordfish are caught by longline gear. This gear consists of baited hooks attached to a main line suspended by a series of floats. The longline can be up to forty miles long. The introduction of artificial lights or lightsticks called "Cyalume" was an important innovation in swordfish longlining. The sticks contain chemicals that emit a glowing green light which, when attached to the hook, attracts swordfish. The lightsticks may also attract bait fish which may enhance the ability to attract the swordfish. The lines generally are released at sunset and hauled in at sunrise to take advantage of the nocturnal feeding habits of the swordfish (1).

The differences in the harvest methods of the two fleets have become less distinct as the fishery has evolved and expanded. As the fishery has expanded into the Caribbean Sea, the Florida vessels have become larger and better equipped for longer trips. The New England boats have utilized shorter longlines with fewer hooks per mile (1). The fishery has also expanded eastward across the Atlantic competing for stocks with Spain, Japan and Canada. The rapid growth of the fishery has led to intense competition between domestic and foreign longliners.

PRODUCTION TRENDS

Historical data indicate four distinct time periods over which significant changes in North Atlantic swordfish harvest occurred. For the period between 1959 and 1970 the average annual catch for the domestic and international fleet targeting the management unit fishery was 8.0 thousand mt. (7). This decreased to 6.3 thousand mt. for the period 1971-1977. Part of this decrease can be explained by the Mercury scare which caused demand to decline and effort to be reduced. The average annual catch increased to 12.8 thousand mt. for the period 1978-1985 as consumers' fear of mercury contamination waned and consumption increased (6). The expansion of the fishery, both in terms of areas fished and fishing effort, led to a stock-wide average annual catch of 19.1 thousand mt. for the period 1986-1988. Most of the tremendous increase in the late 1980's can be attributed to an increase in Spanish effort and to a lesser extent to an increase in U.S. effort in the fishery. Figure 1 depicts the substantial increase in numbers of swordfish caught by the U.S. fleet from 1978 to 1989. Continued high levels of harvest could put the fishery in a situation similar to that of the Mediterranean Sea fishery. High levels of effort, low catch rates and almost complete dependence on one or two year classes of fish characterize the fishery in the Mediterranean Sea (7).

Swordfish imports from countries fishing Atlantic and Pacific stocks have increased from approximately .48 million pounds dr. wt. in 1980 to over 15 million pounds dr. wt. in 1989 (7). Chile has become the largest exporter of swordfish to the U. S. with over 5 million pounds dr. wt. coming from the southeastern Pacific stocks. Imports from Latin America and in particular the tiny Caribbean Island nations have increased substantially in the late 1980's (Table 2). This increase may more than offset the decrease of imports from Spain. In addition, Spain as well as Latin American countries such as Costa Rica, Panama, Mexico and Brazil fish from other stocks and this exacerbates the data collection problem since Atlantic, Pacific and Mediterranean swordfish are virtually indistinguishable. Spain has since moved out of the North Atlantic fishery because of decreased yields (4). Figure 2 shows the growing importance of imports from the management unit as compared to domestic landings from the same region. Imports from the management unit increased from 379,000 lbs. in 1980 to 5.5 million lbs. In 1986, the peak year.

In 1989 swordfish imports from the management unit were approximately 3.9 million lbs. dr. wt.
Analysis of a recent stock assessment (1987) reflects the effects of the substantial increases in catch. The data indicates the adult spawning stock biomass (SSB) in 1987 was about 40% of the 1978 level, while the mean size of harvested fish has declined continuously from 115 lbs. to 60 lbs. dressed weight (dr. wt.) during the same time period (7) (Figure 3). A 60 lb. fish is approximately 2-3 years of age but not yet sexually mature. If these trends were to continue in the absence of any mitigating factors, yield and revenue projections indicate a dramatic decline in industry returns would result (Table 2). For example, domestic landings are predicted to fall from 10.3 million pounds in 1989 to 4.95 million lbs. dressed weight, which would yield $12.38 million in 1991. If the predicted downward trend in landings occurs due to continued overfishing, only 0.11 million lbs. dressed weight are projected to be harvested during the year 2000. Even taking into account higher prices offered due to decreased supplies, projected revenues would only be $.44 million (4). These reductions in total revenues do not incorporate other negative economic factors resulting from a decrease in catch, such as job losses in the production and processing sectors, and reductions in consumer and producer welfare. The projected landings decreases alarmed resource managers of the danger of recruitment failure and the need for prompt, if not immediate, action.

**MANAGEMENT HISTORY**

Prior to 1983 the North Atlantic Swordfish fishery was essentially unmanaged and unregulated. However, as landings and fishing effort increased during the late 1970’s and early 1980’s, the need for management of the fishery became evident. A permit requirement was instituted in 1983, however, no restrictions were imposed on the number of permits or who could obtain one. The number of permits issued have increased continuously with over 700 permits being issued in 1989. Of this number, an estimated 400-500 are active in the directed swordfish fishery, with the remaining permits being allocated among fishermen who target other species, such as tuna, on a full time basis and target swordfish in the off-season.

In 1985 the South Atlantic Fishery Management Council (SAFMC) was delegated the responsibility for development of a FMP for the North Atlantic swordfish. SAFMC biologists estimated that fishing mortality for female swordfish had, in 1980, reached the estimated level that maximizes yield per recruit. Based on this estimate, the Council’s primary objective was to reduce the harvest of small swordfish [fish < 50 lbs. (dr. wt.)] to the 1980 level. The initial FMP was approved on August 22, 1985. Implementation of Variable Season Closures (VSC’s), was a key
TABLE 1. U.S. swordfish imports from the management unit (fresh and frozen in thousands lb dr wt)

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*All or part probably from outside the management unit.
Source: NMFS Fisheries Statistics Division
FIGURE 2 Domestic landings vs. Imports from the Mgmt. unit (lb dr wt)

Millions


- Domestic landings
- Imports

Source: NMFS Fisheries Stat. Division

FIGURE 3 Reported U.S. landings from mgmt. unit (mean lbs dr wt)


- Mean Weight

Source: NMFS-ERFC, 11/23/90
component of that plan but this provision was subsequently sunnsetted by the Secretary of Commerce who felt the action was not necessary (7). The VSC would have closed each region a sufficient amount of time so as to reduce the number of small swordfish caught to be within the desired limits imposed by the FMP. As the swordfish FMP is currently written, the only regulations for the fishery are a required permit and a data collection provision. This provision requires mandatory logbooks and dealer reporting of landings data such as total weight, total numbers and average weight.

After reviewing documents concerning Atlantic stocks of swordfish from the National Marine Fisheries Service (NMFS), Southeast Fisheries Center (SEFS) (NMFS-SEFC 1988) and the International Commission for the Conservation of Atlantic Tunas (ICCAT) (ICCAT 1988), the SAFMC developed a revised set of swordfish management objectives. The key objectives were to rebuild the adult biomass to levels that would prevent recruitment failure, and then to increase total yields by shifting fishing mortality to larger fish. The latter objective would be implemented only after significant biomass recovery and stabilization had occurred. Other objectives included the stabilization or reduction of the number of participants in the longline fleet, which may be over capitalised considering present yields. Additionally, the success of any unilateral management plan depends on the emphasis that other countries, who fish the same stock, place on conservation of the resource. Therefore, the SAFMC recommended the establishment of an international management regime to manage Atlantic swordfish.

Initial recommendations by the SAFMC to carry out these objectives would have reduced domestic landings by approximately 78%. This measure would have effectively closed the domestic directed swordfish fishery. Swordfish would then become a bycatch fishery because the total allowable catch (TAC) would be caught inadvertently by tuna fishermen. The announcement of the SAFMC recommendations resulted in hundreds of protest letters and petitions and increased participation in public hearings along the eastern seaboard. Questions arose about the legal and trade implications. The wording of the scientific review panels' reports was also questioned. In response, alternative management proposals by the New England and Mid-Atlantic Councils (NEFMC & MAFMC) contributed to the development of a revised amendment to the swordfish FMP which is now known as Amendment 1. The regulatory measures incorporated in the SAFMC version of Amendment 1 included a three-year phase-in of reduced landings instead of the immediate 78% reduction. A new permit system, gear restrictions and import controls were also proposed. The SAFMC regulations would have become effective
in April 1991, but two very significant events occurred affecting the management process of swordfish regulation.

On November 15, 1990 the 22 nations of ICCAT (International Commission for the Conservation of Atlantic Tunas) agreed to reduce harvest of swordfish in the northwest Atlantic ocean. The principal components of the ICCAT recommendations are as follows: (i) A 15% reduction in fishing mortality on fish greater than 25 kg. (54 lbs. whole weight or 41 lbs. dressed weight) was negotiated, with 1988 as the index year. (ii) A prohibition on the landing of swordfish less than 25 kg. was introduced with a 15% tolerance to account for unavoidable catches of small fish. This minimum size restriction was not part of Amendment 1 because of the fear of undersized discards (4).

Domestically, the Magnuson Fishery Conservation and Management Act was reauthorized, transferring management jurisdiction of the large migratory species (swordfish, tuna, billfish) from the regional fishery management councils to the Secretary of Commerce. The Secretary has three alternatives for management strategies at his disposal: (i) utilize the recommendations prepared and submitted by the SAFMC, (ii) implement ICCAT recommended measures or (iii) incorporate a combination of elements from both institutions into yet another revised amendment. Complicating the decision process is the provision in the amended Magnuson Act that no domestic conservation plan may be more restrictive than its international counterpart.

The three-year phase-in of Amendment 1 will allow fishermen to continue to fish swordfish as a directed fishery, although at a reduced rate. The phased-in reductions protect the resource and allow for the rebuilding of the spawning stock biomass (SSB). The phase-in mechanism will be a harvest quota and an appropriate allowable level of harvest will be set for each year. The U.S. total allowable catch (TAC) can be computed by multiplying the ABC by the U.S. proportion of the stock-wide catch in 1989. Assuming a 60% proportion (see stock boundary discussion below) the U.S. TAC for 1991 is 7.28 million pounds dr. wt. This represents a 31% reduction, as opposed to the initial recommendation of a 78% reduction, from the 1989 catch (7).

In an attempt to better measure effort in the swordfish fishery, Amendment 1 proposes a new permit system. Although this does not limit entry into the fishery, a control date of August 16, 1999 was established for possibly limiting entry in the future. This means that all vessels participating in the directed fishery on or before that date will not be excluded in the event some form of limited entry is adopted. This control date mechanism was designed to prevent speculative entry that would occur if a limited entry scheme was announced. Speculative entry would unfairly penalize present participants.

Amendment 1 also prohibits the use of drift gillnets because of the Marine Mammal Protection Act. Only an estimated 20 vessels, of the more than 700 permitted to land swordfish, use this type of gear (7). Other gear restrictions include prohibition of artificial lights or lightsticks after the season is closed.

One of the more problematic and controversial decisions the SAFMC made was concerning import restrictions. The purpose of instituting import restrictions is to prevent an increase in foreign catch from the same stock to replace the sudden domestic shortfall. The management unit or stock boundary has been the subject of controversy as well. The boundary is now defined as the area north of 5 degrees N latitude, west of 30 degrees W longitude and bounded by the continental land mass on the West (7). Using 1989 landings data the U.S. caught approximately 60% of the total swordfish catch in this region. Amendment 1 suggests reducing U.S. imports caught from the management unit via a quota by the same percentage as domestic landings were reduced by the harvest quotas. The reductions would be computed by applying the quota to a previous three-year average when the imports occurred (i.e. 1987-1989). Imports in the first year of the regulations will be reduced 31% across the board. (Table 3) Total U.S.
imports of swordfish caught within the management unit would fall from 3.9 million lbs. in 1989 to 2.5 million lbs. in 1991. Because there may be inaccuracies in the import figures, any quotas imposed would be subject to revision upon receipt of adequate documentation.

**TABLE 3. U.S. swordfish imports from the management unit (fresh and frozen in lbs dr wt)**

<table>
<thead>
<tr>
<th></th>
<th>1987-1989 AVG.</th>
<th>1991 QUOTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADA</td>
<td>1,000,079</td>
<td>690,055</td>
</tr>
<tr>
<td>COSTA RICA*</td>
<td>57,651</td>
<td>39,765</td>
</tr>
<tr>
<td>HONDURAS</td>
<td>5,503</td>
<td>3,797</td>
</tr>
<tr>
<td>PANAMA*</td>
<td>7,477</td>
<td>5,159</td>
</tr>
<tr>
<td>TURKS &amp; CAICOS</td>
<td>17,446</td>
<td>12,038</td>
</tr>
<tr>
<td>BR. VIRGIN ISLANDS</td>
<td>35,510</td>
<td>24,502</td>
</tr>
<tr>
<td>BARBADOS</td>
<td>102,517</td>
<td>70,737</td>
</tr>
<tr>
<td>TRIN. &amp; TOBAGO</td>
<td>188,478</td>
<td>130,050</td>
</tr>
<tr>
<td>NETH. ANTILLES</td>
<td>28,850</td>
<td>19,893</td>
</tr>
<tr>
<td>VENEZUELA</td>
<td>40,415</td>
<td>27,886</td>
</tr>
<tr>
<td>GRENADEL</td>
<td>11,761</td>
<td>9,443</td>
</tr>
<tr>
<td>ANTIGUA</td>
<td>13,686</td>
<td>9,580</td>
</tr>
<tr>
<td>ST. LUCIA</td>
<td>2,626</td>
<td>1,812</td>
</tr>
<tr>
<td>SPAIN*</td>
<td>624,337</td>
<td>430,795</td>
</tr>
<tr>
<td>MEXICO*</td>
<td>535,250</td>
<td>369,323</td>
</tr>
<tr>
<td>BRAZIL*</td>
<td>908,804</td>
<td>689,175</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>3,670,424</td>
<td>2,532,593</td>
</tr>
</tbody>
</table>

*All or part probably from outside the management unit.
Source: NMFS fisheries Statistics Division

**THE ECONOMIC CONSEQUENCES OF PROPOSED SWORDFISH MANAGEMENT**

Given the recent changes in authority regarding jurisdiction over swordfish management, the exact form of the eventual regulatory measures to be imposed on the North Atlantic swordfish fishery is unclear. However, Amendment 1 and the proposed ICAAT management measures have potentially significant impacts on domestic producers and consumers. There may be a substantial decrease in short-run swordfish supply originating from the management unit. The magnitude of this decrease depends, in part, on the ability or willingness of swordfish fisheries outside of management unit (e.g. Pacific, Mediterranean) to increase harvest to meet this shortfall in U.S. supply. For purposes of illustration the subsequent analysis will assume that the domestic and import quotas will be adopted. The effects of such a policy can be shown graphically using a simple conceptual model which highlights the effects of the proposed management harvest restrictions and import quotas.

The economic effect of a change in fishery management policy is measured by changes in domestic consumer's and producer's surplus. Consumer surplus is defined as the consumer's willingness to pay for a product (in this case - swordfish) over and above the existing market price. Thus, the difference between what a consumer is willing to pay and what is actually paid is consumer surplus. Graphically, this is equivalent to the area bounded from below by the market price line and bounded from above by the demand curve shown in Figure 4a. Domestic producer surplus is defined as the amount of income received by producers in excess of all fixed and operating costs incurred to produce a product. Thus, domestic producer's surplus is delineated by the area bounded from above by the market price line and bounded from below by the domestic swordfish supply curve (Sus) shown in Figure 4a. Estimation of the net changes in these surplus values provides a measure of how U.S. consumers and producers fare as policy and market conditions change.
Figure 4a shows the fishery in its current situation without any harvest or import restrictions. Assumptions in the model include a relatively inelastic domestic supply curve (Sus). This means that domestic quantity supplied will respond with a less than proportional increase to a given price increase. The domestic supply of swordfish, as for other wild-caught species, is determined in the short-run primarily by environmental conditions and fixed harvesting/processing capacities (3,5).

The aggregate supply curve (Sus+Al+Pi) consists of imports from the Atlantic (Al) and Pacific (Pi), in addition to the domestic supply, and is obtained by horizontally summing these supply curves (Atlantic and Pacific stock supply curves are not shown). Supplies of swordfish from other sources (i.e. Mediterranean) are not considered. As such, the aggregate supply curve will be more elastic than the domestic supply curve. The aggregate world supply of swordfish may be more sensitive to price changes than domestic supplies due to the wide number of sources, less of a dependence on the environmental conditions for any given region, and a more diverse set of harvesting technologies and capacities. The U.S. price (Pus) of swordfish is derived from the intersection of the domestic demand curve (Dus) and the aggregate supply curve.

Consumer welfare, or surplus, (CS) is shown by the area above the price paid by domestic consumers (Pus) and below the demand curve. Producer surplus (PS) is delineated by the area below Pus and above the domestic supply curve. These values are shown in Figure 4a by the areas highlighted CS and PS. Collectively, these areas will be referred to as domestic surplus.

Initially, assume the Pacific stock supplies will not respond to reductions in Atlantic supplies. In this case, the Pacific stock supply curve is perfectly inelastic and not responsive to price increases resulting from changes in Atlantic stock supplies. Now, consider the quotas imposed by Amendment 1. In Figure 4b, the domestic quota (Q1) is shown as vertically intersecting the domestic supply curve, thus becoming the producers supply above Sus. Next, the domestic quota is combined with the Atlantic stock import quota (Q2) to show the total quota on aggregate supply. If supplies from the Pacific remain constant, then this quota line (Q2) becomes the aggregate supply where it extends above Sus+Al+Pi. When total supply is restricted, Pus increases to P' (the magnitude of the price increase depends on the price elasticity of domestic demand) with the following domestic welfare implications. The summation of the
areas marked "a", "b", "c", and "d" represents a loss in consumer surplus (these areas are no longer contained above P'). The consumer surplus loss occurs because of the increased price of swordfish.

Producers gain area "a" due to higher swordfish prices but lose area "e" because of the harvest quota. The net loss or gain to producers depends upon the relative sizes of areas "a" and "e". If the swordfish demand curve is inelastic, then the proportional change in swordfish prices will more than offset production losses; area "a" exceeds area "e". If swordfish demand is elastic, then swordfish price increases will not offset production losses and the net change in producer's surplus will be negative.

The net change in domestic surplus is measured by the value of the net changes in consumer and producer surplus less any surplus transfers. Thus the net loss in domestic surplus is the summation "b+c+d+e". Area "a" represents a transfer of surplus value from consumers to producers, hence area "a" does not represent any change in net domestic surplus. The actual change in domestic surplus due to potential changes in swordfish management depends, therefore, on the price elasticity of domestic demand and the responsiveness (output elasticity of supply) of the Pacific imports.

In the case where supplies from the Pacific stocks completely replace restricted Atlantic imports (Figure 4c), the effects are potentially less significant. This would occur if supplies from the Pacific stocks exactly offset the reduction of imports from countries fishing the Atlantic stocks. In other words, domestic consumers see no change in swordfish availability in the market. Since aggregate supply is not decreased, swordfish price (Pus) does not increase. Domestic producers are receiving the same price, but because of the domestic quota, are subject to reduced landings. This loss of revenue is represented by the area "e". The magnitude of this loss will again be determined by the domestic elasticity of supply, or the slope of Sus.
Figure 4c represents a more likely scenario where Pacific stock supplies respond partially to the reduced Atlantic supply. $S'$ now represents the aggregate supply curve. The intersection of $S'$ with the demand curve results in a price increase to $P'$. Loss of consumer surplus is measured by the value $a + b + c + d + f$. Again, producer surplus is decreased by area "e" and increased by area "a". A net gain to domestic producers accrues if "a" > "e" and is equal to the value "a-e". The net loss of domestic surplus is the value $b + c + d + e + f$. It is clear that consumers and/or producers will suffer net losses in the short-run, but this must be measured against increases in long-run yields, which is the intended objective of proposed regulation.
DOMESTIC AND INTERNATIONAL TRADE IMPLICATIONS

The proposed Amendment 1 restrictions effectively prevent other nations from increasing effort on the same stock since the U.S. is the primary importer and represents the primary stable export market. An opposing argument from the Caribbean nations to Amendment 1 is that these countries are only now developing their offshore fisheries. The restrictions may prevent them from achieving their goal of generating much needed foreign exchange, therefore violating the intent of the Caribbean Basin Initiative (CBI). The small Caribbean countries also complain that Amendment 1 was drafted with U.S./Caribbean trade data that substantially understates the amount of swordfish entering the U.S. from Caribbean sources. The region is consequently penalized by import quotas set at erroneously low levels. The import quotas, however, seem to be acceptable by the General Agreement on Tariffs and Trade (GATT) according to the NMFS's legal/trade representatives because the domestic catch and foreign imports are reduced in similar fashion. Problems with GATT would arise if the Department of Commerce acts in a way that could be construed as protection or promotion of the U.S. market.

An import quota was also chosen because of the potential for U.S. fishermen to re-flag or land their catch in Caribbean ports and export to the U.S., thereby circumventing the domestic quotas. Since early 1988, this has allegedly been occurring in Caribbean island nations such as the Turks & Caicos, the British Virgin Islands, Barbados, Trinidad & Tobago, the Netherlands Antilles, Grenada, Antigua and St. Lucia (4) (Table 2). The reasons for such a trend, in addition to avoiding impending regulations, may be that fishermen are searching for new fishing grounds or more cost effective ports. However, such action may still have a negative effect on the North Atlantic swordfish stocks and reinforce the necessity of import restrictions.

Tag-recapture data suggests that 45 degrees W would be a more appropriate eastern boundary. If this boundary is used in the future as the management unit, unilateral management by the U.S. may be more effective because U.S. fishermen are responsible for 80% of the total landings in this area. However, international cooperation in the management of the fishery remains an objective. The proposed limits agreed upon by ICCAT may have been the result of the stringent regulations proposed by the SAFMC to regulate the fishery. One of the main objectives of Amendment 1 was to encourage international management of the fishery and the success at the ICCAT meetings proves that at least one of those proposed objectives has been met.

Imports from countries fishing both the Atlantic and Pacific stocks account for approximately 45-50% of the total quantity available on the U.S. market, with the remainder coming from domestic landings in the Pacific (10%) and the Atlantic (45-50%). If domestic Atlantic landings and imports from the Atlantic stock are reduced by 31% via Amendment 1, there will be a substantial decrease in short-run supply. In addition, the proposed ICCAT reductions of landings by size class of swordfish will also reduce available supplies from the Atlantic. How will Pacific stocks be affected if effort is increased to replace a decreased supply from the Atlantic stock? If Chile, Ecuador and Mexico increase catch from the Pacific swordfish fishery to meet demand, the Pacific stocks could be depleted to the point where international management of Pacific stocks would be needed. Will overall supply (Atlantic & Pacific stocks) decrease and, given a constant demand, lead to higher wholesale prices and a decrease in consumer surplus? Assuming an inelastic Pacific supply curve and a relatively inelastic aggregate supply curve, the potential for loss of producer and consumer surplus is great given the proposed domestic harvest and import quotas.
SUMMARY

The North Atlantic swordfish stock has been determined by fishery scientists from the U.S. and other international agencies as being over-fished. A variety of management measures have been proposed by ICCAT, SAFMC and the U.S. Secretary of Commerce to rebuild the spawning stock biomass in the management unit to acceptable levels. These measures include percentage reductions in landings of fish within specific size classes, quotas on U.S. landings and restrictions on the importation of swordfish into the U.S. caught within the management unit. At present, the exact form of the management measures to be imposed upon the swordfish industry is uncertain. Regardless of whether the adopted measures are harvest or import restrictions, the U.S. market will likely experience a short run reduction in swordfish supplies.

This paper has shown, within the context of a conceptual economic model, that such a supply reduction will likely have an impact on the economic welfare of both domestic producers and consumers at least in the short run. The long run magnitude of this loss in consumer and producer surplus will depend on two important factors. First, the responsiveness of swordfish producers in other fisheries (Pacific swordfish) to meet the shortfall in the U.S. market must be considered. Second, the short run losses in domestic surplus must be weighed against the long run gains in fishery productivity. The conceptual model provides a means with which to assess the economic consequences of regulatory action in the North Atlantic swordfish fishery, whether Amendment 1 or the less stringent ICCAT proposal prevails.

REFERENCES


