Invited presentation at the 2018 Southern Agricultural Economics Association Annual Meeting, February 2-6, 2018, Jacksonville, Florida

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THE FEASIBILITY OF A LIONFISH MEAT MARKET IN THE U.S. VIRGIN ISLANDS: CONSUMER WILLINGNESS TO PAY

Skyler Simnitt (University of Florida)
Jennifer Sweeney Tookes (Georgia Southern University)
Sherry Larkin (University of Florida)
Paulita Bennett-Martin (Emory University)
Holden Harris (University of Florida)
Natalie Mioulis (University of Florida)
Katherine Groenevelt (Emory University)
Murray Rudd (Emory University)
Michael Page (Emory University)
Jason Boss (Emory University)
Tracy Yandle (Emory University)
THE PROJECT: ASSESS THE VIABILITY OF CREATING A MARKET FOR LIONFISH IN THE US VIRGIN ISLANDS

• Are consumers willing to consume and pay for lionfish?
• Are fishermen willing to harvest and sell lionfish?
• Economic, cultural, and regulatory barriers
INFORMATION GATHERING STRATEGIES

- **Consumers** – Structured intercept surveys
- **Fishermen** – Structured intercept surveys, semi-structured interviews, participant observation
- **Restaurant/Distributors** – Structured surveys, participant observations
TOPICS OF FOCUS

Consumers/Restaurants
• Knowledge of fish issues /lionfish
• Interest in new food/lionfish
• Willingness to pay
• Demographics
• Spatial Variables

Fishermen
• Fishing behavior
• Knowledge/observation lionfish
• Willingness to harvest lionfish
• Demographics
• Spatial Variables
INFORMATION GATHERING RESULTS

- Fisher men: 152 intercept surveys & in-depth interviews
- Restaurants: 61 interviews
- Tourist Consumers: 193 intercept surveys
- Local Consumers: 346 intercept surveys
Caught Lionfish? | Targeting Lionfish?
---|---
Yes | No

FISHERMEN’S INTEREST IN CATCHING LIONFISH
“Is the price of Lionfish high enough to cover your costs?”

- Yes: 27%
- No: 73%

“Do you have buyers for Lionfish right now?”

- Yes: 26%
- No: 74%

FISHERMEN’S WILLINGNESS TO HARVEST LIONFISH
RESIDENT CONSUMERS INTEREST IN NEW SEAFOOD

"I am interested in trying new kinds of seafood"

- A Lot: 31%
- Somewhat: 29%
- A Little: 15%
- Not at All: 25%

"How interested are you in eating lionfish?"

- Not at All: 59%
- A Lot: 14%
- Somewhat: 10%
- A Little: 17%
How interested are you in eating locally-caught seafood during your stay in the USVI?

- Not at All: 0%
- A Little: 5%
- Somewhat: 18%
- Very: 77%

How interested are you in eating lionfish?

- Not at All: 25%
- A Lot: 25%
- Somewhat: 27%
- A Little: 23%
“How interested are you in selling lionfish in the future?”

- A Lot: 25%
- Somewhat: 22%
- A Little: 15%
- Not at all: 38%

"If the price were reasonable would you buy lionfish to sell in your business?"

- Yes!: 85%
- No: 15%
RESTAURANT CONSUMPTION

Number of times individuals would eat lionfish
(month of June, 2016)
FRESH MARKET OR HOME CONSUMPTION

Number of times individuals would eat lionfish (month of June, 2016)

Frequency of Individuals

0 1 2 3 4
Has anyone in your household gotten sick from eating

Seafood is a healthy foot to eat

I am worried about mercury in seafood

People can get sick with fish poisoning from eating seafood like...

People can get sick with ciguatera from eating seafood like...

People can get sick with fish poisoning from eating seafod...

I am worried about mercury in seafood

Seafood is a healthy foot to eat

Has anyone in your household gotten sick from eating...
Worried about over-fishing

People should eat lionfish to help the reef

Lionfish harm the marine environment

Combined mean score
Resident mean score
Tourist mean score

**

*
Interested in trying new kinds of seafood

Freshness of fish is important

Fish is expensive compared to other meat

It is difficult to cook fish

Wild caught is better

Likert Score, Interest in Seafood

- **both mean score**
- **resident mean score**
- **tourist mean score**

*** p < 0.001

** p < 0.01
WTP OR WTA FOR LIONFISH ESTIMATION METHODOLOGY

• Data collection, CVM double bound
• An initial price is proposed, then a higher or lower second price
• Turnbull lower bound on Mean WTP (1976)
• Responses are combined and probabilities computed for price interval
• The E(LB) or E(UB) bound is computed by summing up the multiple of each interval lower bound and its corresponding probability
• Provides a conservative estimate
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>no, no</td>
<td>( (I_{i}^{nn}) )</td>
<td>( \Phi ) — CDF of the standard normal</td>
</tr>
<tr>
<td>2.</td>
<td>no, yes</td>
<td>( (I_{i}^{ny}) )</td>
<td>( X_{i}' ) — vector of explanatory variables</td>
</tr>
<tr>
<td>3.</td>
<td>yes, no</td>
<td>( (I_{i}^{yn}) )</td>
<td>( \mathbf{B} ) — vector of coefficient estimates</td>
</tr>
<tr>
<td>4.</td>
<td>yes, yes</td>
<td>( (I_{i}^{yy}) )</td>
<td>( A_{L} ) — lower of two bids offered</td>
</tr>
</tbody>
</table>

\( \Phi \) — CDF of the standard normal
\( X_{i}' \) — vector of explanatory variables
\( \mathbf{B} \) — vector of coefficient estimates
\( A_{L} \) — lower of two bids offered
\( A_{H} \) — higher of two bids offered
\( A \) — true maximum WTP
LogL = $\sum \left[ I_i^{nn} \left( 1 - \Phi \left( X_i' \cdot \frac{\beta}{\sigma} - \frac{A_L}{\sigma} \right) \right) + I_i^{ny} \ln \left( \Phi \left( X_i' \cdot \frac{\beta}{\sigma} - \frac{A_L}{\sigma} \right) \right) - \Phi \left( X_i' \cdot \frac{\beta}{\sigma} - \frac{A}{\sigma} \right) \right] + I_i^{yn} \ln \left( \Phi \left( X_i' \cdot \frac{\beta}{\sigma} - \frac{A}{\sigma} \right) \right) - \Phi \left( X_i' \cdot \frac{\beta}{\sigma} - \frac{A_H}{\sigma} \right) \right] + I_i^{yy} \ln \left( \Phi \left( X_i' \cdot \frac{\beta}{\sigma} - \frac{A_H}{\sigma} \right) \right) \right]$
## Turnbull WTP lower bound estimation

<table>
<thead>
<tr>
<th>Price $</th>
<th>Yes</th>
<th>No</th>
<th>Fj</th>
<th>Fj Pooled</th>
<th>PDF</th>
<th>std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>2-4</td>
<td>3</td>
<td>3</td>
<td>0.5</td>
<td>0.194</td>
<td>0.194</td>
<td>0.066</td>
</tr>
<tr>
<td>4-6</td>
<td>26</td>
<td>4</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-7</td>
<td>7</td>
<td>8</td>
<td>0.53</td>
<td>0.500</td>
<td>0.306</td>
<td>0.103</td>
</tr>
<tr>
<td>7-8</td>
<td>13</td>
<td>12</td>
<td>0.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-9</td>
<td>12</td>
<td>15</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-10</td>
<td>3</td>
<td>9</td>
<td>0.75</td>
<td>0.569</td>
<td>0.069</td>
<td>0.105</td>
</tr>
<tr>
<td>10-11</td>
<td>7</td>
<td>5</td>
<td>0.42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-12</td>
<td>10</td>
<td>11</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-13</td>
<td>2</td>
<td>8</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13-14</td>
<td>4</td>
<td>6</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-15</td>
<td>6</td>
<td>9</td>
<td>0.6</td>
<td>0.571</td>
<td>0.003</td>
<td>0.093</td>
</tr>
<tr>
<td>15-17</td>
<td>3</td>
<td>2</td>
<td>0.4</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>17-19</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-21</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21+</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1.000</td>
<td>0.429</td>
<td>0.062</td>
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</table>

E(LB) = $11.80
<table>
<thead>
<tr>
<th>consumer</th>
<th>venue</th>
<th>$/lb</th>
<th>V(LB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>resident</td>
<td>home</td>
<td>$11.80/lb</td>
<td>8.117</td>
</tr>
<tr>
<td>resident</td>
<td>restaurant</td>
<td>$19.51*</td>
<td>6.297</td>
</tr>
<tr>
<td>tourist</td>
<td>lodging</td>
<td>$10.09/lb</td>
<td>1.658</td>
</tr>
<tr>
<td>tourist</td>
<td>restaurant</td>
<td>$22.83*</td>
<td>0.692</td>
</tr>
<tr>
<td>restaurant</td>
<td>N/A</td>
<td>$5.75/lb</td>
<td>1.032</td>
</tr>
<tr>
<td><strong>fisherman</strong></td>
<td><strong>--</strong></td>
<td><strong>$4.36 /lb</strong></td>
<td><strong>0.143</strong></td>
</tr>
</tbody>
</table>

* Restaurant entrée
### FACTORS INFLUENCING CONSUMER WTP HOME CONSUMPTION (CVM.DB)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>M/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>6.390</td>
<td>1.657</td>
<td>$13.97 ***</td>
</tr>
<tr>
<td>age</td>
<td>0.013</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>sex (male)</td>
<td>-1.096</td>
<td>0.493</td>
<td>-$2.40 **</td>
</tr>
<tr>
<td>environmental concerns</td>
<td>0.191</td>
<td>0.122</td>
<td></td>
</tr>
<tr>
<td>safety concerns</td>
<td>-0.145</td>
<td>0.071</td>
<td>-$0.32 *</td>
</tr>
<tr>
<td>interest in seafood</td>
<td>-0.020</td>
<td>0.121</td>
<td></td>
</tr>
<tr>
<td>Knowledge about lionfish</td>
<td>-0.148</td>
<td>0.244</td>
<td></td>
</tr>
<tr>
<td>log(bid)</td>
<td>-0.457</td>
<td>0.060</td>
<td>***</td>
</tr>
</tbody>
</table>

Log-likelihood: -107.107

To conserve space did not report income, race, educational attainment, and residency (which are all significant).
<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>M/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>5.242</td>
<td>1.416</td>
<td>$17.97***</td>
</tr>
<tr>
<td>age</td>
<td>-0.006</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>sex (male)</td>
<td>0.090</td>
<td>0.391</td>
<td></td>
</tr>
<tr>
<td>environmental concerns</td>
<td>0.015</td>
<td>0.098</td>
<td></td>
</tr>
<tr>
<td>safety concerns</td>
<td>-0.074</td>
<td>0.051</td>
<td></td>
</tr>
<tr>
<td>interest in seafood</td>
<td>0.137</td>
<td>0.118</td>
<td></td>
</tr>
<tr>
<td>knowledge about lionfish</td>
<td>0.075</td>
<td>0.269</td>
<td></td>
</tr>
<tr>
<td>log(bid)</td>
<td>-0.292</td>
<td>0.037</td>
<td>***</td>
</tr>
<tr>
<td>Log-likelihood:</td>
<td>-156.601</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To conserve space did not report income, race, educational attainment, and residency (which are all significant)
## Estimating Aggregate Demand and Supply

<table>
<thead>
<tr>
<th>Consumer Variables</th>
<th>Mean # of times</th>
<th>Std Dev.</th>
<th>Max # times</th>
<th>N. Survey</th>
<th>Population St. Croix (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourist</td>
<td>1.12</td>
<td>(1.072)</td>
<td>6</td>
<td>138</td>
<td>8,504</td>
</tr>
<tr>
<td>Local</td>
<td>1.97</td>
<td>(1.356)</td>
<td>15</td>
<td>283</td>
<td>36,479</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fisher Variables</th>
<th>Mean</th>
<th>Std Dev.</th>
<th>Max # times</th>
<th>N. Survey</th>
<th>Population St. Croix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
<td>57%</td>
<td>--</td>
<td>--</td>
<td>151</td>
<td>181 de jure</td>
</tr>
<tr>
<td>lbs/ month</td>
<td>103.7</td>
<td>227.61</td>
<td>1400</td>
<td>142</td>
<td>1,124 arguendo</td>
</tr>
<tr>
<td>Think program will succeed</td>
<td>73%</td>
<td>--</td>
<td>--</td>
<td>145</td>
<td></td>
</tr>
</tbody>
</table>
ESTIMATED TOTAL VALUES

• Total demand approximately 45,000 lbs per month
• Total supply approximate 18,824 – 116,300 lbs per month
THANK YOU

• Research Participants in St. Croix and St. Thomas

• Undergraduate Students: Duncan Watson, Han Yang, Megan Withers, Jakob Perryman, Molly O’Neil, Kaetlyn Lee, Jeff Kraprayoon, Paige Crowl, Jason Boss, Madison Hilley

• USVI Department of Planning and Natural Resources (Division of Fish and Wildlife and Division of Environmental Enforcement), Caribbean Fisheries Management Council, CFMC District Advisory Panel of St.Criox

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Photo Credit: Paulita Bennett-Martin
SOURCES

