Modeling Marine Debris Incidents Associated with the Hawai‘i-based Pelagic Longline Fishery

Amy V. Uhrin\textsuperscript{1}, William Walsh\textsuperscript{2}, and Jon Brodziak\textsuperscript{3}

\textsuperscript{1}NOAA Office of Response and Restoration, Marine Debris Division
\textsuperscript{2}University of Hawai‘i, Joint Institute for Marine & Atmospheric Research (retired)
\textsuperscript{3}NOAA Pacific Islands Fisheries Science Center, Fisheries Biology & Stock Assessment Branch

6\textsuperscript{th} International Marine Debris Conference - March 13, 2018

Acknowledgments: Eric Forney (PIROP), Mark Manual & Christy Kehoe (NOAA MDP), Stephanie Kung (Univ Hawai‘i), observers
### Hawai‘i-based Pelagic Longline Fishery

<table>
<thead>
<tr>
<th>Deep Sector</th>
<th>Shallow Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bigeye tuna</td>
<td>• Swordfish</td>
</tr>
<tr>
<td>• 243m depth</td>
<td>• 64m depth</td>
</tr>
<tr>
<td>• ≥ 15 hooks per float</td>
<td>• &lt; 15 hooks per float</td>
</tr>
<tr>
<td>• 2000 hooks total</td>
<td>• 1000 hooks total</td>
</tr>
<tr>
<td>• Deploy after dawn</td>
<td>• Deploy at sunset</td>
</tr>
<tr>
<td>• Annual</td>
<td>• Winter</td>
</tr>
<tr>
<td>• Below 30°N</td>
<td>• Above 30°N latitude</td>
</tr>
</tbody>
</table>

**Artwork:** Les Hata © Secretariat of the Pacific Community
Hawai‘i-based Pelagic Longline Fishery

Redrawn from Erik Ries
Honolulu Magazine, 2013
### NOAA Pacific Islands Regional Observer Program

- **Onboard longline observations initiated 1994**
  - Priority focus on longline gear and protected species interactions

- **Marine debris longline observations initiated late 2007**
  - Report debris interactions with longline gear & types of debris
Objectives

- Quantify abundance and type of marine debris by standardizing for fishery effort
- Similar to catch-per-unit-effort methods used in fishery stock assessments
- Control for effort to understand how debris catch represents debris abundance
Data Collection 2008-2016

- Marine Debris Encounter Reports
- Counts of marine debris by set
  1. net  
  2. rope/line  
  3. monofilament  
  4. metal  
  5. cloth  
  6. plastic sheeting
  7. floats / buoys  
  8. fish aggregating device  
  9. lumber  
  10. natural  
  11. other
- Merge with master observer database
- N = 40,572 longline sets
Statistical Analysis

- **Zero-inflated negative binomial model**
  - count data that is clumped
  - extra zeros from reporting error or survey error (or both)
  - 2 model components: positive counts + probabilities of extra zeros
  - standardized for number of hooks per set
  - sampling unit = individual longline set

**Response variables**
- Counts of marine debris

**Predictor variables**
- Year (2008-2016)
- Quarter (1st – 4th)
- Sector (shallow, deep)
- Observer type (high, low)
- Convergence zone (in, out)
- Begin-set latitude
- Begin-set longitude
How Much & What Type

- 858 sets with captured debris
- 1326 total items
  - 51.8% net
  - 26.7% rope, line
- 1.2 - 1.6 items per set
  - min: 1
  - max: 9
### Results

- **Total sets observed**
  - shallow: 8442
  - deep: 32,130

- **Sets w/ debris**
  - shallow: 440
  - deep: 418

- **Distribution**
  - shallow: above 30°N
  - deep: below 30°N
Negative binomial count model: expected positive counts per set

- Increasing counts through 2011, decreasing thereafter
- More counts in Q1 (Jan - Mar)
- Fewer counts in deep sector - 40.5% decrease in expected counts
- More counts as you move northward – 12% increase for 1-degree latitude
Logistic zero-inflation model: odds of zero counts per set

- Fewer zeros moving eastward - *5% decrease in odds (of a zero count)*
- Fewer zeros inside convergence zone - *56% decrease in odds*
- Fewer zeros reported by experienced observers - *79% decrease in odds*
- More zeros in deep sector - *127% greater odds*
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Approach</th>
<th>Results</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean Annual Catch-Per Unit Effort</td>
<td></td>
</tr>
</tbody>
</table>
Summary / Next Steps

• Bias toward derelict fishing gear, prevalent in convergence zone
  o opportunities for incentivizing removal

• Highest debris in 2011; declining thereafter
  o related to tsunami?

• More debris in shallow sector despite less effort
  o less at debris at deeper depths
  o target shallow sector for removal

• Experienced observers reported more debris, fewer zeros
  o evaluate training protocols