Modeling the Short-Run Impacts of Amendment 13 Management Measures
Overview

• Review Management measures considered
• Show Current Area Closure Configurations
• Review History of Area Closure Models
• Review Mortality reductions Needed
• Present NLP Model
• Show How Model was applied to Alternative 1
Management Measures Considered during Development of Amendment 13

- Further Area Closures
- Trip Limits
- Days at Sea Reductions
- Gear restrictions, minimum fish sizes
Area Closures in the Northeast Region
Northeast Region Grid Numbering System
History of Groundfish Modeling in the Northeast Region

- Used a simple Mixed Integer Programming model for Amendment 5.
- Expanded this model to a Linear programming Model for Amendment 7.
- Developed a “two-bin” model for Amendment 7.
- Developed a Non-Linear Programming Model for framework actions initiated under Amendment 7, and for reviewing options for Amendment 13.
History (Continued)

• Model is based on an article by Howitt (1995) which first appeared in AJAE, and is called “Positive Mathematical Programming”.

• Model was initially reviewed by the Plan Development Team

• A subsequent review by the Social Sciences Advisory Committee took place in May, 2001.

• A different version of the model was used by Jim Kirkley (VIMS) to look at area closures for the Squid, Mackerel and Butterfish fisheries.
### Mortality Reductions Needed for Rebuilding Selected Stocks under Amendment 13.

<table>
<thead>
<tr>
<th>Species</th>
<th>Stock</th>
<th>Assumed F</th>
<th>F rebuild</th>
<th>Needed Reduction in F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cod</td>
<td>GB</td>
<td>0.45</td>
<td>0.18</td>
<td>-60%</td>
</tr>
<tr>
<td></td>
<td>GOM</td>
<td>0.36</td>
<td>0.22</td>
<td>-38.89</td>
</tr>
<tr>
<td>Haddock</td>
<td>GB</td>
<td>0.2</td>
<td>0.25</td>
<td>+25%</td>
</tr>
<tr>
<td>Yellowtail Flounder</td>
<td>GB</td>
<td>0.14</td>
<td>0.23</td>
<td>+64.29</td>
</tr>
<tr>
<td></td>
<td>SNE/MA</td>
<td>0.74</td>
<td>0.18</td>
<td>-75.68</td>
</tr>
<tr>
<td></td>
<td>CC/GOM</td>
<td>0.95</td>
<td>.09</td>
<td>-90.53</td>
</tr>
<tr>
<td>American Plaice</td>
<td></td>
<td>0.26</td>
<td>0.15</td>
<td>-42.31</td>
</tr>
<tr>
<td>Witch Flounder</td>
<td>No Formal rebuilding program required</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter Flounder</td>
<td>GB</td>
<td>No Formal Rebuilding Program required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GOM</td>
<td>No Formal Rebuilding Program required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SNE/MA</td>
<td>0.45</td>
<td>0.25</td>
<td>-44.44%</td>
</tr>
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</table>
## Alternative 1

<table>
<thead>
<tr>
<th>Effort Reduction</th>
<th>Area Closures</th>
<th>Seasonal Closures</th>
<th>Trip Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>55%</td>
<td>Status-Quo Year Round</td>
<td>March -121,122,123 April 121-125, 129-133 May 124-125, 129-133, 136-140 June 132-133, 139-140, 141-147, 152 October 124,125 November 124,125</td>
<td>● GOM Cod -800 lb/day, 4,000 lb/trip. ● GB Cod – 2,000 lb/day, 20,000 lb/trip ● CC/GOM yellowtail – March1-May 31 250 lb. possession limit. June1-Feb. 28, 750 lb/day, 3,000 pounds per trip</td>
</tr>
</tbody>
</table>
Other Management Measures (non-modeled)

- Net Caps on Both Day and Trip Gillnet Vessels
- Gear restrictions based on area fished for Trawl Vessels
- Limits on total hooks for vessels based on area fished
- Minimum Size Limits by Species
- Changes in F brought about by these measures were estimated and incorporated into the results from the Area Closure model.
Estimating Mortality Changes Under Each Management Option

• Desirable features:
  – A focus on 30 minute square blocks, and monthly time periods.
  – Estimate changes in mortality by species and stock area
  – The ability to incorporate days at sea changes, trip limit changes and area closures simultaneously.
  – A focus on the individual vessel level, and revenue changes.
Math Programming Model

\[
\text{Max } TR_a = \sum_i \sum_j \sum_s P_{js} \cdot (\beta_{ijs} - \delta_{ijs} \cdot E_{ij}) \cdot E_{ij} \quad (1)
\]

s.t.

\[
E_i \leq 30 \quad (2)
\]

\[
\sum_i \sum_j E_{ij} \leq EFF \quad (3)
\]

\[
E_{ij} \geq 0 \quad (4)
\]
Math Programming Model (continued)

• i=month, j=block, s=species
• P=Price
• B=Intercept
• δ=slope coefficient
• E=effort
• EFF = total allowable effort
Data

- Logbook data from the years 1998-2001 were used to determine landings, days at sea and CPUE per block.
- Vessel trip data were aggregated to a monthly level in each block.
- Price data were based on dealer records for the years 1998-2001.
- Prices were deflated to 1998 levels using the GDP implicit price deflator.
Data (Continued)

- 156 blocks, 12 months, 10 species.
- 1,872 distinct choices per vessel.
- Lack of Cost Data on an individual vessel level precluded using a profit maximizing framework.
- Revenue maximizing model may be better choice given the lay systems used for crew payments.
- A formal price model could not be incorporated because the models developed are on an annual, not monthly basis.
Procedure

- Run Model with the status-quo management options
- Run model again with the proposed new management options
- Compare landings under proposed management options and status quo to determine change in exploitation.
- Changes in revenue and distributional impacts were also provided.
- Model results should be interpreted as an ordinal ranking of alternatives. Information from the model helps managers choose alternative.
## Change in Exploitation Rates from Alternative 1

<table>
<thead>
<tr>
<th></th>
<th>Stock Areas</th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td></td>
<td>GOM</td>
<td>GB</td>
<td>SNE</td>
<td>CAPE</td>
<td>Mid-Atlantic</td>
<td>Other</td>
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<td>Cod</td>
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<td>-43.4</td>
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<tr>
<td>Haddock</td>
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<td>-44.2</td>
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<tr>
<td>Winter Flounder</td>
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<td>-36.3</td>
<td>-58.3</td>
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<td></td>
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<tr>
<td>Yellowtail Flounder</td>
<td>-38.9</td>
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<td>-60.3</td>
<td>-72.7</td>
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<tr>
<td>Windowpane Flounder</td>
<td>-31.6</td>
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<tr>
<td>American Plaice</td>
<td></td>
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<td>-52.9</td>
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<tr>
<td>Witch Flounder</td>
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<td>-50.6</td>
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<tr>
<td>Pollock</td>
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<tr>
<td>Redfish</td>
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<td></td>
<td></td>
<td>-49.3</td>
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<tr>
<td>White Hake</td>
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<td></td>
<td>-47.7</td>
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</tbody>
</table>
Limitations

• Model only allows vessel effort to shift into areas or times where the vessel has previously fished. Mortality reductions and revenue losses may be overestimated.

• Non-linear programming model assumes “perfect” planning and foresight. Will maximize revenue for every vessel in the model.

• Did not integrate non-groundfish activity in model, due to model size.

• Latent effort could not be incorporated into model.

• Provides an ordinal ranking of alternatives, not precise point estimates of impacts.
Summary

- Suite of Management Measures for Amendment 13 was analyzed using a non-linear math programming model.
- Model should be viewed as a yearly planning tool, and not one that gives advice for a long time horizon.
- Model should be used to rank alternatives with regard to mortality reductions, but planners should recognize the uncertainty around the estimates.