Potential Biological Removal Management Framework under the Marine Mammal Protection Act

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Presentation to the Pacific Fishery Management Council
14 September 2014

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The 1994 Marine Mammal Protection Act (MMPA) reauthorization outlines the required management framework for incidental take of marine mammals in commercial fisheries.

- NOAA Fisheries must establish monitoring (observer) programs to estimate stock-specific mortality and serious injury (M&SI) due to commercial fishing operations.

- “Potential Biological Removal” (PBR) must be calculated for each marine mammal stock.

- If estimated human-caused M&SI (from all sources) exceeds PBR, or if the stock/species is Threatened or Endangered (ESA) it is deemed “strategic”.

- For strategic stocks, NOAA Fisheries must develop and implement Take Reduction Plans to reduce incidental fisheries M&SI to a level below PBR.

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1. What is Potential Biological Removal (PBR)?

- An upper limit to the level of mortality that would allow a stock to achieve abundance ≥ the Maximum Net Productivity Level (MNPL)*

  *Conceptually analogous to MSRA management framework for direct take of commercially-fished species*

- A stock whose abundance is at or above MNPL is referred to as being at “Optimum Sustainable Population” (OSP).
  - A goal of the MMPA
  - Assessing stock status relative to OSP is challenging because that determination rests on the ability to estimate abundance relative to $K$.

- Estimating bycatch and keeping it below PBR is analytically more feasible, more precise, and a more direct way of managing marine mammal stocks and ensuring that they reach/are maintained at OSP.**

**Taylor et al. 2000 Conservation Biology**

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2. How is PBR calculated?

\[ PBR = 0.5 \ R_{\text{max}} \ N_{\text{min}} \ F_R \]

This equation is defined by the MMPA.

Parameters determined, estimated, or calculated according to NMFS *Guidelines for Assessing Marine Mammal Stocks* (GAMMS)

- NMFS currently follows a second revision, referred to as GAMMS II*.

\[ \text{PBR} = 0.5 \, R_{\text{max}} \, N_{\text{min}} \, F_{R} \]

- Assumes that marine mammal population growth follows a logistic model: MNPL occurs at 0.5 K

- MNPL for marine mammals likely 0.6K - 0.8K (0.5 is precautionary)

*Taylor & DeMaster 1993*
PBR = 0.5 $R_{\text{max}} N_{\text{min}} F_R$

Maximum potential population growth rate

- May be estimated for individual stocks
- Default = 0.04 for cetaceans, 0.12 for pinnipeds

Wade 1998
PBR = 0.5 R_{max} N_{min} F_{R}

Minimum estimate of abundance

• Defined as the value at the 20^{th} percentile of the distribution of estimated abundance*

  *Typically obtained from surveys (remember for later)

Why the 20^{th} percentile?

• Shown through simulations to provide a high level of confidence that management objectives can be achieved in spite of uncertainty in parameters used to estimate abundance**

  **Wade 1998
\[ PBR = 0.5 \ R_{\text{max}} \ N_{\text{min}} \ F_{R} \]

**Recovery Factor**

- Used as a conservative buffer against various plausible biases or assumption violations

- Range: 0.1 – 1.0
  - Default = 0.5
  - = 0.1 – 0.3 for Endangered Species (depending on estimated abundance)

*Wade 1998*
3. How is abundance \( (N_{\text{min}}) \) estimated?

- For most cetacean stocks, we conduct periodic line-transect surveys aboard NOAA research vessels and estimate abundance using distance-sampling methods.

- Such surveys have been conducted seven times in the U.S. EEZ portion of the California Current since 1991 (including one occurring right now).
Abundance Estimation:

- Aerial surveys and distance sampling methods (harbor porpoises) or pup counts (pinnipeds)
- Small-boat surveys and mark-recapture methods (coastal bottlenose dolphins, blue whales)
- Shore-based surveys (eastern north Pacific gray whales)

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• Traditionally, NOAA Fisheries has used the most recent survey abundance estimate for each stock, or an average estimate from the two most recent surveys.

• We are moving toward using trend-based models that use information from all past abundance surveys to estimate current abundance.
  
  o These estimates are generally more precise and more consistent through time (less prone to random sampling errors).

  o To date: fin, beaked, sperm whales (US EEZ – CA Current)
4. Example: Sperm whales

\[ PBR = 0.5 \; R_{\text{max}} \; N_{\text{min}} \; F_R \]

\[ PBR = 0.5 \; (0.04) \; N_{\text{min}} \; (0.1) \]

Conventional approach: \( N_{\text{min}} \) based on average estimate of abundance from two most recent surveys

<table>
<thead>
<tr>
<th>Year</th>
<th>( N )</th>
<th>( N_{\text{min}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>3140 (CV = 0.4)</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>300 (CV = 0.51)</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>971 (CV = 0.31)</td>
<td>751</td>
</tr>
</tbody>
</table>

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PBR = 0.5 \( R_{\text{max}} N_{\text{min}} F_R \)

PBR = 0.5 (0.04) \( N_{\text{min}} (0.1) \)

Model-based approach: \( N_{\text{min}} \) based on estimates of abundance from all previous surveys and Bayesian methods

\( N_{\text{min}}(2008) = 1332 \)

\[ \text{PBR} = 0.5 \ R_{\text{max}} \ N_{\text{min}} \ F_R \]

Conventional Approach
\[ \text{PBR} = 0.5 \ (0.04) \ (751) \ (0.1) = 1.5 \]

Model-based Approach
\[ \text{PBR} = 0.5 \ (0.04) \ (1332) \ (0.1) = 2.7 \]

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5. Estimating bycatch and comparing to PBR

Conventionally (following GAMMS recommendations) NOAA Fisheries has used running 5-year averages to estimate bycatch. **Why?**

- Annual bycatch estimates are variable (due to variation in true values and estimation uncertainty).

- MMPA management objectives depend on long-term average annual bycatch being below PBR.

- Pooling bycatch estimates across multiple years provides a more precise measure (especially for species caught infrequently).

- This also helps reduce management volatility.

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Example: Sperm whales

Estimated bycatch for the drift gillnet fishery

<table>
<thead>
<tr>
<th>Year</th>
<th>Observer coverage %</th>
<th>Observed M&amp;SI</th>
<th>Estimated M&amp;SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>19%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>16%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>14%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>13%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>12%</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>3.8</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{PBR} = 0.5 \ R_{\text{max}} \ N_{\text{min}} \ F_R \]

= 2.7

(model-based approach)

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For stocks for which bycatch is a rare event (e.g., sperm whales), NOAA Fisheries is moving toward pooling additional years of data or taking a model-based approach to estimate annual average bycatch. **Why?**

- To improve precision and reduce bias in the bycatch estimate

Characteristics of the drift gillnet fishery have been relatively stable since 2001. Therefore, pooling bycatch data since 2001 provides a more precise bycatch estimate.*

- $PBR = 1.3$ for sperm whales*
- $PBR = 2.7$
- These changes are reflected in the most recent draft Stock Assessment Report for sperm whales.

*Carretta & Moore. 2014. NOAA Technical Memorandum.*
6. Take Reduction Teams and Plans (TRTs and TRPs)

• Coordinated by Regional Offices (not Science Centers)

• One TRT for cetaceans of the U.S. West Coast: **Pacific Offshore Cetacean TRT**
  o principally bycatch of cetaceans in the CA Large Mesh drift gillnet fishery

• TRTs composed of individuals from fishing industry, management councils, U.S. Marine Mammal Commission, NOAA, coastal states, academia, and environmental organizations

• TRTs develop plans (TRPs) to minimize mortality and serious injury through consensus-based measures (voluntary + regulatory)

• Goal is to immediately reduce fisheries mortality to below PBR and to reduce it to < 10% PBR in the long-term (this is referred to as the Zero Mortality Rate Goal, ZMRG)
GAMMS, Stock Assessment Reports, Publications, Contact Information available at https://swfsc.noaa.gov/mmttd/