Overview of ETM-APF with respect to fee based approach for once through use of seawater

• Definitions and major assumptions
• Models for assessing entrainment related impact
  – Adult equivalent loss (AEL)
  – Fecundity Hindcast (FH)
  – Empirical Transport Model (ETM)
• Area of Production Foregone (APF)
• Mitigation estimation using ETM/APF
• Volumetric approach to mitigation estimation
• A comment about efficacy of screening
Definitions and major assumptions

- **Entrainment** – organisms brought into plant as part of once through use of water
- **Plankton** – Organisms most subject to ‘ordinary’ entrainment
  - **Meroplankton** – a very small (often larval) stage in the life of certain organisms, for example: abalone, sea urchins, crabs, fish
    - *Such plankton are considered to potential suffer entrainment related impacts*
  - **Holoplankton** – a very small organism that is planktonic for its whole life, for example: diatoms, dinoflagellates, certain crustaceans
    - Vastly more abundant than Meroplankton
    - *Not generally considered in entrainment related impact studies*
    - *Populations considered to suffer no impact from entrainment*
- **100% through plant mortality** – all entrained organisms are assumed to die
Impact due to Brine, Impingement and Entrainment

Brine exits plant to open ocean

Desal Plant
Brine and high velocity kills small organisms and propagules (eggs, larvae and spores)

Traveling Screens impinge larger organisms

Trash (fish and other organisms lost to impingement)

Fish and Other organisms entrained in source water
1. Calculate volume of water entering the plant per year (V)

2. Measure concentration of larvae (number per volume) that are entrained (N)

3. Assume no survival of larvae through the plant – then

4. NV = the annual loss of larvae due to entrainment
Models for assessing entrainment related impact (FH and AEL)

Fecundity Hindcast (FH)

Adult Stock (Females)

Larvae

Loss of Adult fish

Adult Equivalent Loss (AEL)

Question: How to estimate losses to adult populations?
The problem with FH and AEL

For most species we have insufficient life history information (age specific mortality) to calculate FH or AEL. This means that Adult Equivalents cannot be estimated. Adult equivalents are the core of most impact assessments. The major exception is ETM.
Empirical Transport Model: Understanding “Source Water Population” (SWP) and “Proportional Mortality” ($P_m$)

The SWP is that spatial area that contains the larvae at risk of entrainment.
Understanding “Source Water Population” (SWP) and “Proportional Mortality” ($P_m$)

$p_m$ is the percentage of the larvae at risk that are entrained and killed (e.g. 2%).
Each species will have a different Source Water Population
Example: Queenfish (50.9 miles along coast)

Based on:
• Period of vulnerability to entrainment
• Distance larvae could have come from during the period of vulnerability

The source water population resides in the Source Water Body (SWB), which is an area. This can be used in the calculation of Area of Production Foregone (APF).
### ETM Results

1) Assume that target species represent other species that were not targets

2) These values represent the estimated rate of mortality for all species having a larval phase whose PM's were not directly determined

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Estimated Annual Entrainment</th>
<th>$2\cdot FH$</th>
<th>$AEL$</th>
<th>$P_M$ (SWB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIQ goby complex</td>
<td>113,166,834</td>
<td>202,538</td>
<td>147,493</td>
<td>1.0% (60.9 km)</td>
</tr>
<tr>
<td>northern anchovy</td>
<td>54,349,017</td>
<td>53,490</td>
<td>304,125</td>
<td>1.2% (72.0 km)</td>
</tr>
<tr>
<td>spotfin croaker</td>
<td>69,701,589</td>
<td>NA</td>
<td>NA</td>
<td>0.3% (16.9 km)</td>
</tr>
<tr>
<td>queenfish</td>
<td>17,809,864</td>
<td>NA</td>
<td>NA</td>
<td>0.6% (84.9 km)</td>
</tr>
<tr>
<td>white croaker</td>
<td>17,625,263</td>
<td>NA</td>
<td>NA</td>
<td>0.7% (47.8 km)</td>
</tr>
<tr>
<td>black croaker</td>
<td>7,128,127</td>
<td>NA</td>
<td>NA</td>
<td>0.1% (19.4 km)</td>
</tr>
<tr>
<td>salema</td>
<td>11,696,960</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>blennies</td>
<td>7,165,513</td>
<td>6,466</td>
<td>NA</td>
<td>0.8% (12.8 km)</td>
</tr>
<tr>
<td>diamond turbot</td>
<td>5,443,118</td>
<td>NA</td>
<td>NA</td>
<td>0.6% (16.9 km)</td>
</tr>
<tr>
<td>California halibut</td>
<td>5,021,168</td>
<td>NA</td>
<td>NA</td>
<td>0.3% (30.9 km)</td>
</tr>
</tbody>
</table>
Area of Production Foregone – a way to interpret loss

• Simple method allows for conversion of organismal loss to habitat

\[ P_m \times SWB \]
## Entrainment Study – ETM Model results

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Estimated Annual Entrainment</th>
<th>$P_m$ Alongshore Extrapolation (Mean)</th>
<th>Length of Source Water Population (Miles)</th>
<th>Area (m$^2$) of Production Foregone (Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>spotfin croaker</td>
<td>69,701,589</td>
<td>0.30%</td>
<td>10.1</td>
<td>0.085</td>
</tr>
<tr>
<td>Queenfish</td>
<td>17,809,864</td>
<td>0.60%</td>
<td>50.9</td>
<td>0.911</td>
</tr>
<tr>
<td>white croaker</td>
<td>17,625,263</td>
<td>0.70%</td>
<td>28.7</td>
<td>0.583</td>
</tr>
<tr>
<td>black croaker</td>
<td>7,128,127</td>
<td>0.10%</td>
<td>11.6</td>
<td>0.039</td>
</tr>
<tr>
<td>Salema</td>
<td>11,696,960</td>
<td>NA**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blennies</td>
<td>7,165,513</td>
<td>0.80%</td>
<td>7.7</td>
<td>0.170</td>
</tr>
<tr>
<td>diamond turbot</td>
<td>5,443,118</td>
<td>0.60%</td>
<td>10.1</td>
<td>0.170</td>
</tr>
<tr>
<td>California halibut</td>
<td>5,021,168</td>
<td>0.30%</td>
<td>18.5</td>
<td>0.131</td>
</tr>
<tr>
<td>rock crab</td>
<td>6,411,171</td>
<td>1.10%</td>
<td>15.9</td>
<td>0.486</td>
</tr>
<tr>
<td><strong>AVERAGE (sq. miles)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0.325</strong></td>
</tr>
<tr>
<td><strong>AVERAGE (acres)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>208</strong></td>
</tr>
</tbody>
</table>

Based on units 3-4 (acres)

104 4882.5
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Area of Production Foregone – a way to interpret loss

• Simple method allows for conversion of organismal loss to habitat
• Works for species with very limited life history information
• Converts loss to habitat necessary to compensate for loss
• Covers both direct and indirect effects resulting from entrainment
• Currency is habitat, which can be monetized
• Hence, compensatory mitigation may be expressed in terms of water use
### Volumetric approach to mitigation estimation

<table>
<thead>
<tr>
<th>Facility</th>
<th>Intake Volume (MGD)</th>
<th>APF (acres)</th>
<th>Mitigation Type</th>
<th>Cost estimate</th>
<th>basis year</th>
<th>cost per daily intake (MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moss Landing Combined cycle</td>
<td>360</td>
<td>840</td>
<td>wetland</td>
<td>$15,100,000</td>
<td>2000</td>
<td>$41,944</td>
</tr>
<tr>
<td>Morro Bay</td>
<td>371</td>
<td>760</td>
<td>wetland</td>
<td>$13,661,905</td>
<td>2001</td>
<td>$36,825</td>
</tr>
<tr>
<td>Poseidon</td>
<td>304</td>
<td>37</td>
<td>wetland</td>
<td>$11,100,000</td>
<td>2009</td>
<td>$36,513</td>
</tr>
<tr>
<td>Huntington Beach</td>
<td>127</td>
<td>66</td>
<td>wetland</td>
<td>$4,927,560</td>
<td>2009</td>
<td>$38,800</td>
</tr>
<tr>
<td>Diablo</td>
<td>2,670</td>
<td>543</td>
<td>Rocky reef</td>
<td>$67,875,000</td>
<td>2006</td>
<td>$25,421</td>
</tr>
</tbody>
</table>

Average (wetland mitigation): $38,520  
Rocky reef mitigation: $25,421
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A comment about efficacy of screening

• Assume ETM approach
• Screening will reduce entrainment of those species having plankton with minimum dimension larger than screen opening
  – Will lead to lower $P_m$ values
• Effect of screening on impact can be estimated through use of weighted $P_m$ values weighted by proportion of plankton saved by screening
• Estimate of this proportion is $<1\%$
• Very small reduction of impact ($<1\%$), unless larger individuals are considered to have higher value.