Review of Carlsbad Seawater Desalinization Project (CDP)

- General comments on report
- Assessment of calculations of Pm
  - Estuarine species
  - Open water species
- Assessment of mitigation alternative using APF calculations
  - Math
  - Habitats

General Comments

1) As written, the report could not be evaluated for the technical merits of the entrainment study or estimation of APF
   a) Tenera provided both a meeting to discuss the report and also provided the material needed to assess the entrainment study and APF calculations.
2) My assessment is based in part on calculations I did using material from the CDP report, the 316B report from Encina Power plant and from direct communication with Tenera
   a) Such calculations include: uncertainty analysis and APF for open coast species
3) The study design for entrainment sampling including source water sampling is consistent with recent entrainment studies conducted under 316B rules

General Comments

4) Calculations of Pm, SWB and APF are generally consistent with recent studies
   a) Note additional calculations shown in this presentation for uncertainty and open water species
5) Proposed mitigation at San Dieguito is the most likely alternative to lead to compensation for losses of estuarine larvae due to entrainment – if habitat created more closely mimics source water body
6) No mitigation was proposed for losses of larvae from open water habitats
   a) APF is small but non-zero
   b) Mitigation options with direct nexus to impact are difficult

Review of Carlsbad Seawater Desalinization Project (CDP)

- Assessment of calculations of Pm
  - Estuarine species
  - Open water species

Assessment of calculations of Pm

- Proportional mortality (Pm) estimates are calculated using standard methodology
- Source water estimation is complicated for estuarine species (but in my opinion – correct)
- Source water estimation is standard for open water species
- Estimation of error rates is mathematically correct but, in my opinion, not appropriate for use in APF calculations
  - More about this later
- Uncertainty of estimates, particularly as they affect APF calculations is not adequately discussed
  - More about this later

Understanding Proportional Mortality (Pm)

- Pm is the proportion of larvae at risk that are estimated to die as a result of entrainment
- Larvae at risk is determined by source water body (SWB) which differs for estuarine vs open water species
  - For estuarine species, it is generally the area of Agua Hediondo Lagoon that could produce larvae entrained
  - For open water species, it is the area from which larvae could have traveled from and then be entrained
    - Based on age of larvae entrained

Calculated Pm, Standard Errors (SE) and Source water body (SWB) estimates

Species	Pm	Calcuated SE	Ratio SE/ Pm	Source water body *	Units
Estuarine					
Blennies	0.08635	0.1347	1.56	302	Acres
Gobies	0.21599	0.3084	1.43	302	Acres
Garibaldi	0.06484	0.1397	2.15	302	Acres
Open Water					
White Croaker	0.00138	0.0028	2.04	45	Km along shore
Northern Anchovy	0.00165	0.0026	1.56	21	Km along shore
California Halibut	0.00151	0.0024	1.58	37	Km along shore
Queenfish	0.00365	0.0049	1.33	27	Km along shore
Spotfin Croaker	0.00634	0.0153	2.41	19	Km along shore

*The source water body for estuarine species is actually different from this value, however it is assumed that larval production is primarily from 302 acres in Agua Hediondo Lagoon

Review of Carlsbad Seawater Desalinization Project (CDP)

- Assessment of mitigation alternative using APF calculations
  - Math
  - Habitats

Use of Area of Production Foregone (APF) to estimate mitigation required to mitigate entrainment losses

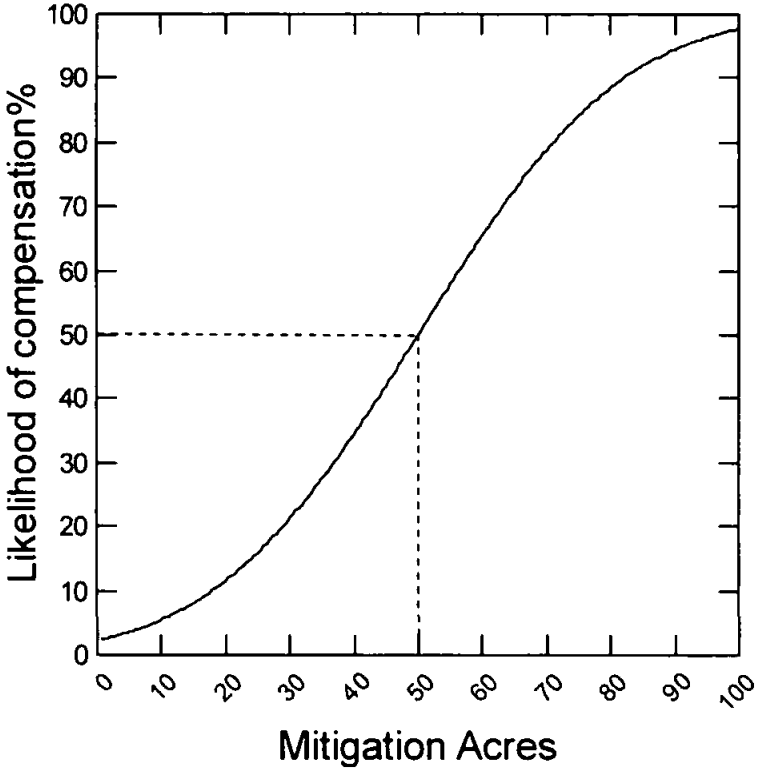
- Goal is to determine area required to provide sufficient habitat to produce larvae lost to entrainment
  - This area is the product of Pm and SWB
  - For example if the source water body (SWB) = 500 acres and Pm is 0.1 then the APF is

500 acres x 0.1 = 50 acres

  - This means that 50 new acres ***having a similar habitat mix as that in the SWB*** would produce larvae sufficient to make up for those lost to entrainment
  - This assumes no uncertainty in the estimation of Pm and SWB
    - The major issue is the error rate associated with estimation of Pm

Understanding uncertainty of compensation through mitigation using APF (direct impacts only)

For example: assume 500 acre SWB, Pm = 0.1, Standard Error / Pm = 0.5



For average likelihood (50%) , Acres ~ 50. This means that with the uncertainty associated with sampling, there is a 50% or greater likelihood that 50 new acres will provide full compensation for lost larval resources.

This assumes:

1. Mitigation acres are similar to those in SWB
2. Restoration is successful

Understanding uncertainty of compensation through mitigation using APF (direct impacts only)

Uncertainty in estimating compensation value of proposed mitigation is primarily related to error in estimation of Pm:

1)What is correct estimate of error?

a) Sampling error associated with estimation of Pm – *as shown in report*
   i. Source water concentrations of larvae – calculated error rates are very high and **probably not realistic** for use with respect to Pm
   ii. Entrainment concentrations of larvae – error rates are low and **probably not realistic** for use with respect to Pm

b) Error assuming each species' Pm is an independent replicate
   i. The most appropriate calculation of error, given the standard logic behind the use of APF

Now – consider the ratio of SE/Pm – which expresses uncertainty in terms of units of impact

Use of error in calculations

- Use of error to calculate cumulative confidence curves relies on decision as to which estimate of error is appropriate.
- I used a normal cumulative function to generate confidence curves.
  - This relies on mean value and estimate of the standard deviation of the population of means.
  - I concluded that sample standard deviation was inappropriate for use using this function and instead used the sample standard error as an estimate of the standard deviation of the population of means. Hence the calculation was:
    - Prob = ZCF((acres – mean acres)/calculated SE)
    - Where ZCF is the normal cumulative function
  - The use of SE led to more conservative (lower) estimate of (eg) 80% confidence limit than would have been the case if standard deviation was used.
  - This was evaluated using resampling approaches where possible (which make no assumptions about normality).

Calculated Pm, Standard Errors (SE) and Source water body (SWB) estimates

Species	Pm	Calcuated SE	Ratio SE/ Pm	Source water body	Units
Estuarine					
Blennies	0.08635	0.1347	1.56	302	Acres
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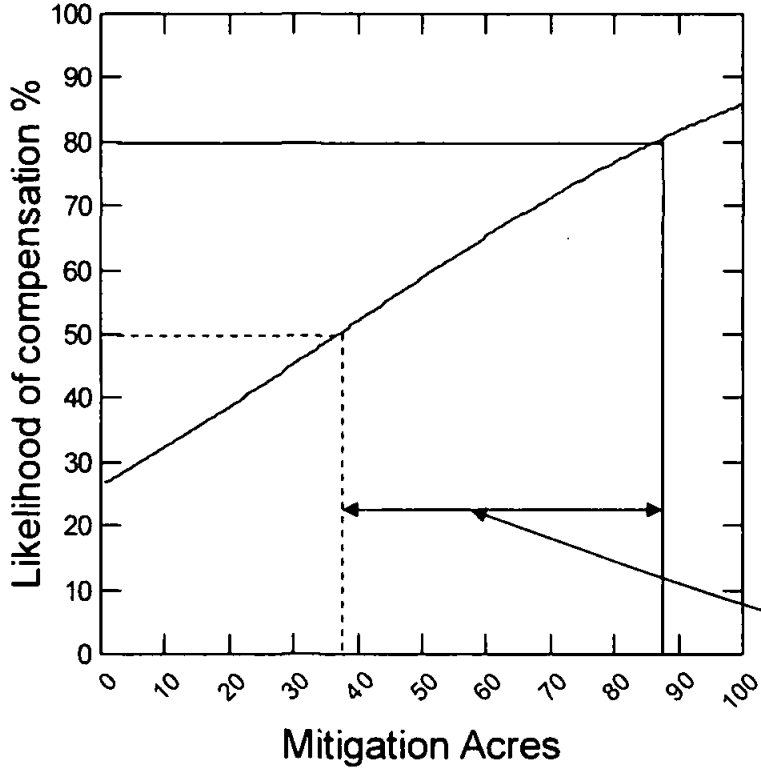
Queenfish	0.00365	0.0049	1.33	27	Km along shore
Spotfin Croaker	0.00634	0.0153	2.41	19	Km along shore

These are huge

Uncertainty of compensation through mitigation using APF

Estuarine Species (direct impacts only)

Case 1: using error rate calculated in report (SE dominated by source water concentration of larvae)



For average likelihood (50%)
Acres ~ 37

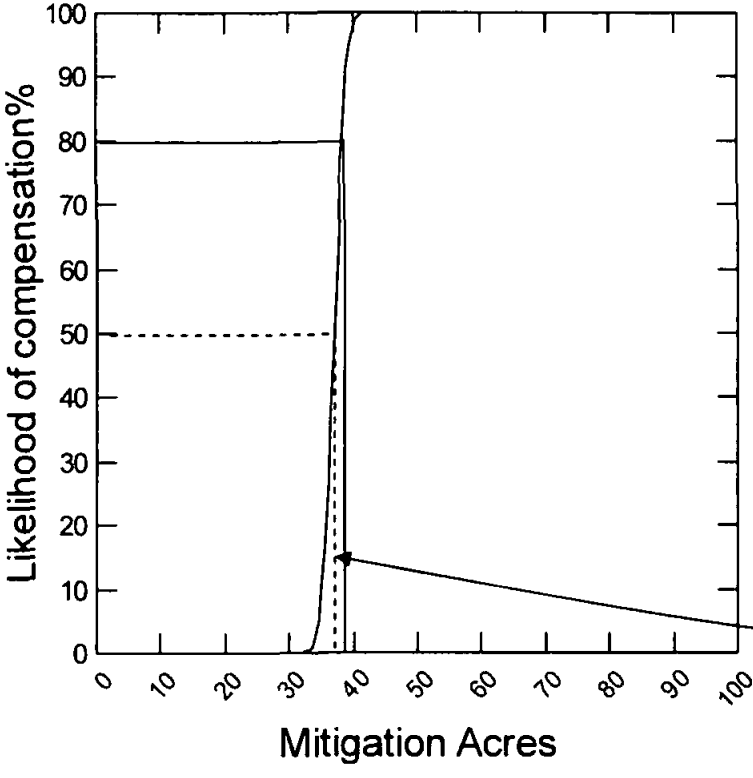
For 80% confidence level
Acres ~ 87

Big difference due to
Large SE/Pm ratio

Uncertainty of compensation through mitigation using APF

Estuarine Species (direct impacts only)

Case 2: using error rate calculated from entrainment estimates only (SE very low)



For average likelihood (50%)
Acres ~ 37

For 80% confidence level
Acres ~39

Small difference due to
Small SE/Pm ratio

Calculated Pm, Standard Errors (SE) and Source water body (SWB) estimates

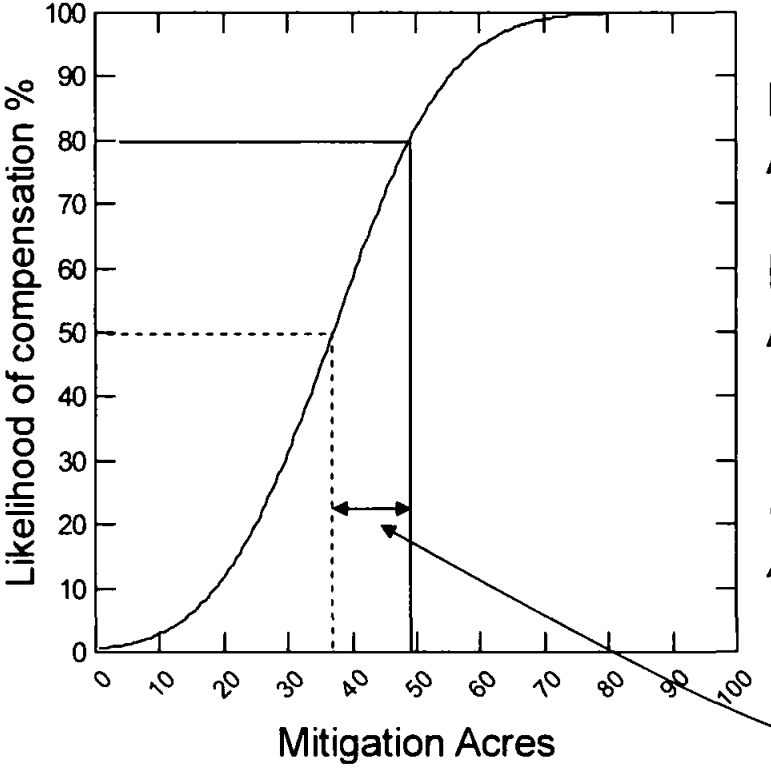
Species	Pm	Calcuated SE	Ratio SE/ Pm	Source water body	Units	APF	Source water body	Units	APF
Estuarine									
Blennies	0.08635	0.1347	1.56	302	Acres	26.0777			
Gobies	0.21599	0.3084	1.43	302	Acres	65.2290			
Garibaldi	0.06484	0.1397	2.15	302	Acres	19.5817			
Average	**0.12239**	0.1942				**36.9628**			
SE						**14.2570**			
Ratio SE/Pm						**0.3857**			
Open Water									
White Croaker	0.00138	0.0028	2.04	45	Km along shore*	0.0621	33365	Acres	46.0440
Northern Anchovy	0.00165	0.0026	1.56	21	Km along shore*	0.0347	15570	Acres	25.6912
California Halibut	0.00151	0.0024	1.58	37	Km along shore*	0.0560	27477	Acres	41.4907
Queenfish	0.00365	0.0049	1.33	27	Km along shore*	0.1000	20309	Acres	74.1289
Spotfin Croaker	0.00634	0.0153	2.41	19	Km along shore*	0.1175	13739	Acres	87.1029
Average						**0.0740**			**54.8916**
SE						**0.0151**			**11.2209**
Ratio SE/Pm						**0.2044**			**0.2044**

*** to a depth of 75 meters - average about 3 Km offshore**

Uncertainty of compensation through mitigation using APF

Estuarine Species (direct impacts only)

Case 3: using error rate calculated from species Pm estimates (*probably most accurate*)



For average likelihood (50%)
Acres ~ 37

For 80% confidence level
Acres ~49,

Using resampling
80% confidence level
Acres ~ 50

Relatively small difference due to appropriate SE/Pm ratio

Calculated Pm, Standard Errors (SE) and Source water body (SWB) estimates

Species	Pm	Calcuated SE	Ratio SE/ Pm	Source water body	Units	APF	Source water body	Units	APF
Estuarine									
Blennies	0.08635	0.1347	1.56	302	Acres	26.0777			
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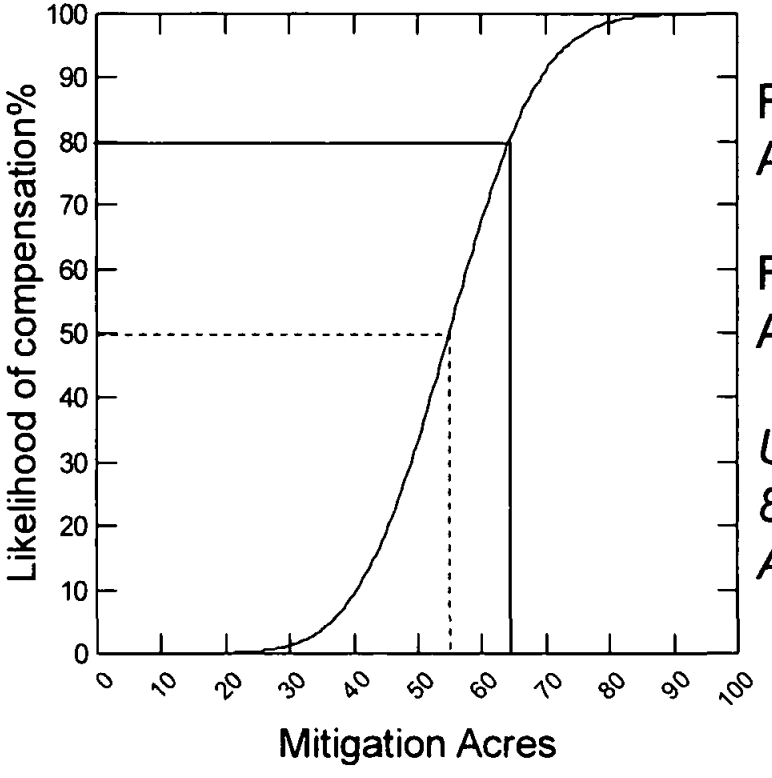
Average						**0.0740**			**54.8916**
SE						**0.0151**			**11.2209**
Ratio SE/Pm						**0.2044**			**0.2044**

*** to a depth of 75 meters - average about 3 Km offshore**

Uncertainty of compensation through mitigation using APF
Open Coast Species (direct impacts only)
Using error rate calculated from species Pm estimates
(*probably most accurate*)



For average likelihood (50%)
Acres ~ 55

For 80% confidence level
Acres ~ 64

Using resampling
80% confidence level
Acres ~ 63

APF summary

1) APF for estuarine species
    1) Mean APF = 37 acres
    2) 80% confidence limit = 49 acres
    3) Habitat mix for mitigation should include mudflat / tidal channel and open water habitat
2) APF for open coast species
    1) Mean APF = 55 acres
    2) 80% confidence limit = 64 acres
    3) Habitat is primarily open water, sandy bottom
    4) Relatively small area
    5) No mitigation options discussed
        a) Options that could lead to direct compensation are difficult

Proposed Wetland Mitigation

1) Logic of APF as applied to wetland mitigation is appropriate for estuarine species losses
2) In my opinion the most appropriate mitigation discussed is offsite wetland creation at San Dieguito
   a) The mix of habitats should mirror those used in calculating APF at Agua Hediondo – currently they do not (use of salt marsh at San Dieguito)
   b) The ongoing restoration at San Dieguito, along with inlet maintenance and required monitoring make this the area most likely to be successfully used for compensatory mitigation
   c) Mitigation at Agua Hediondo as described, is unlikely to provide direct compensation for lost larval resources

Comments on discussion of "conservative assumptions" for APF

1) "Assumes 100% mortality of all marine organisms entering the intake"
   a) This is true but it is the same assumption that is made in all recent entrainment determinations. Moreover there is no study of post-entrainment larval survival that has been conducted in field conditions
2) "Assumes 100 % survival of all fish larvae in their natural environment"
   a) No such assumption is made. The only assumption concerning survival is that there is no compensatory mortality that affects Pm calculations.

Comments on discussion of "conservative assumptions" for APF

3) "Assumes species are evenly distributed throughout the entire depth and volume of the water body"
   a) No such assumption is made. The major assumption is that creation of a similar mix of habitats to that found in the source water body will lead to compensation for all species lost due to entrainment.

4) "Assumes the entire habitat from which the entrained fish larvae may have originated is destroyed"
   a) No such assumption is made concerning the source water body. APF calculations are based on the idea of estimating the area that would need to be added in order to lead to the compensatory production of larvae lost to entrainment. Other features of the source water body are assumed not to have been damaged.