From:	Peter Raimondi
To:	Peter MacLaggan
Cc:	Huckelbridge, Kate@Coastal; Neill, Ben@Waterboards; Eric Miller; Josie McKinley; RICHARD AMBROSE
Subject:	Re: SAP Questions Appendix K
Date:	Monday, May 21, 2018 8:14:14 AM
Attachments:	Some clarification of the ETM model calculations relevant to Appendix K May 2018.docx

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Attached is a short note that lays out what i would like to discuss regarding Appendix K. The goal is really to discuss this so that we understand how estimates were made. I am not sure how this could impact APF calculations - but that may come up as well

On Thu, May 17, 2018 at 1:47 PM, Peter MacLaggan <pmaclaggan@poseidonwater.com> wrote:

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Some clarification of the ETM model calculations relevant to Appendix K: CARLSBAD DESALINATION FACILITY: ENTRAINMENT ANALYSIS FOR DILUTION AND DISCHARGE OPTIONS (2015, MBC authored for Poseidon)

By Pete Raimondi
May 20, 2018
In my review of Appendix K , one of the documents submitted for review by Poseidon, there was a discussion of what looked like an omission of a term in the ETM calculation done (by me) in the consideration of impacts of entrainment relevant to the Poseidon Carlsbad faculty.

From second paragraph, page 7:
"Prior presentations of the APF calculated for the CDF suggest some deviation from the model described above. During the development of this analysis, Dr. Raimondi's example from his 2008 presentation to the California Coastal Commission was reviewed and found that his calculations of the coastal taxa ETM apparently did not include Ps. Recalculation of the available data could only arrive at Dr. Raimondi's proportional mortality (Pm) values if Ps was excluded from the model with respect to the five open coast taxa. These calculations were included in Appendix 4. Therefore, to remain consistent with prior APF assessments of the CDF and the modeling guidelines in Appendix E of the Substitute Environmental Document, both modeling approaches were used here."

The purpose of this document is to describe the basis of those calculations and also to clarify some terms that are often confusing in ETM models.

The core equation for ETM calculation was correctly noted by MBC in appendix K. It is

$$(1) \qquad Pm = 1 - \sum_{i=1}^{n} f_i (1 - Ps_i Pe_i)^d$$

Where:
Pm = proportional mortality
f_i = fraction of the total entrainment in period i
Ps_i = sample source water body (SSWB) /total source water body (TSWB)
Pe_i = estimated proportional entrainment: entrainment/abundance in SSWB
d = days of larval vulnerability
i = period sampled, generally monthly

What is often not understood is that there are really two meanings for Pe, the first and commonly used is that the value represents the proportion of the population *in the sampled area* that is entrained. This is actually the sample Pe. In order to produce the total Pe, which is the proportion of the population *at risk* that is entrained the coefficient Ps is applied. This is the ratio of the sample source water body /

total source water body. Hence, PsPe yields the total Pe. Unfortunately this is not often laid out in documentation of the ETM approach.

Moreover, while equation 1 is the core equation, it is in fact only useful when dealing with a simple and single water mass – meaning a situation where the source water comes from a single habitat (e.g. an estuary or shallow open coast). In situations where this is not the case total Pe is more complicated to calculate. This was the situation as described in the 2008 Encina Power Station (EPS) 316B (January 2008), Page 3-14.

$$P_M = 1 - \sum_{i=1}^{N} f_i \left(1 - \left[\frac{N_{E_i}}{\frac{N_{NS_i} - N_{NSOut_i}}{P_{S_i}} + N_{AH_i} + (N_{AHOut_i} \bullet q)} \right] \right)^q \quad (2)$$

where

f_i = estimated fraction of total source water larval population present during the i^{th} survey;

q = number of days the larvae are exposed to entrainment;

N_{E_i} = the estimated number of larvae entrained during the i^{th} survey;

N_{NS_i} = the estimated number of larvae in the nearshore sampled during the i^{th} survey;

P_{S_i} = the ratio of the length of the sampled nearshore area sampled during the i^{th} survey to the total alongshore current displacement over the period of q days that the larvae could be exposed to entrainment;

N_{NSOut_i} = an adjustment for the outflow from AHL calculated using the average concentration from the nearshore sampling during the i^{th} survey and the outflow volume;

N_{AH_i} = the estimated number of larvae in AHL during the i^{th} survey; and

N_{AHOut_i} = an adjustment for the outflow from AHL calculated using the average concentration from AHL sampling during the i^{th} survey and the outflow volume.

Note that q is used here to indicate number of days a larva is exposed to entrainment – in most descriptions this is d.

The key point here is that the portion of the equation within the inner brackets is total Pe. Recognizing this makes the rest of the calculations in the EPS 316B interpretable using the following derivative ETM equation.

$$(3) \qquad P_m = 1 - \sum_{i=1}^{n} f_i (1 - Pe)^d$$

Note that there is no Ps term in this model. This is because Pe here is the total Pe, not the sample source water Pe. Applying equation 3 to, for example, table 3-22 (an open coast species, white croaker) in the EPS 316B using the given Pe values yields the Pm values at the bottom of the table. This is true for all species in the 316B report.

In order to determine the Pm value that would be relevant for stand-alone operations at Poseidon Carlsbad I modified equation 3 as follows:

$$(4) \qquad P_m = 1 - \sum_{i=1}^{n} f_i \left(1 - \frac{304}{857} Pe\right)^d$$

Because the given Pe's were based on maximum flow (857), I used the quotient (304/857), which is the ratio of intake of the standalone operations for Poseidon relative to that at EPS, to calibrate Pe. The net effect of this is, as expected, to reduce Pe, increasing the value in the parentheses (the proportion not entrained) prior to compounding (the effect of d). Using equation 4 results in the Pm estimates that were used in the Poseidon Carlsbad assessment.