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)
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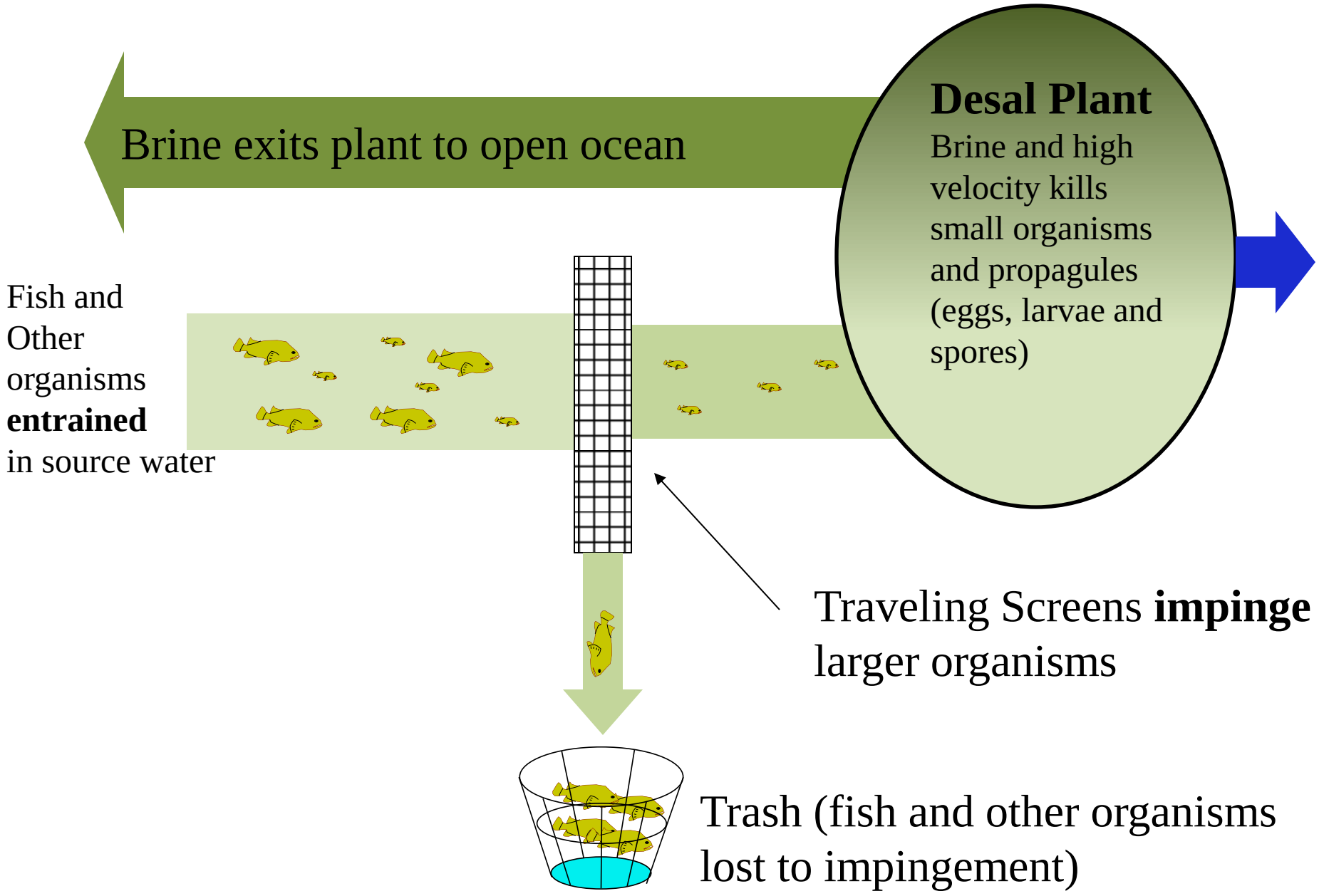
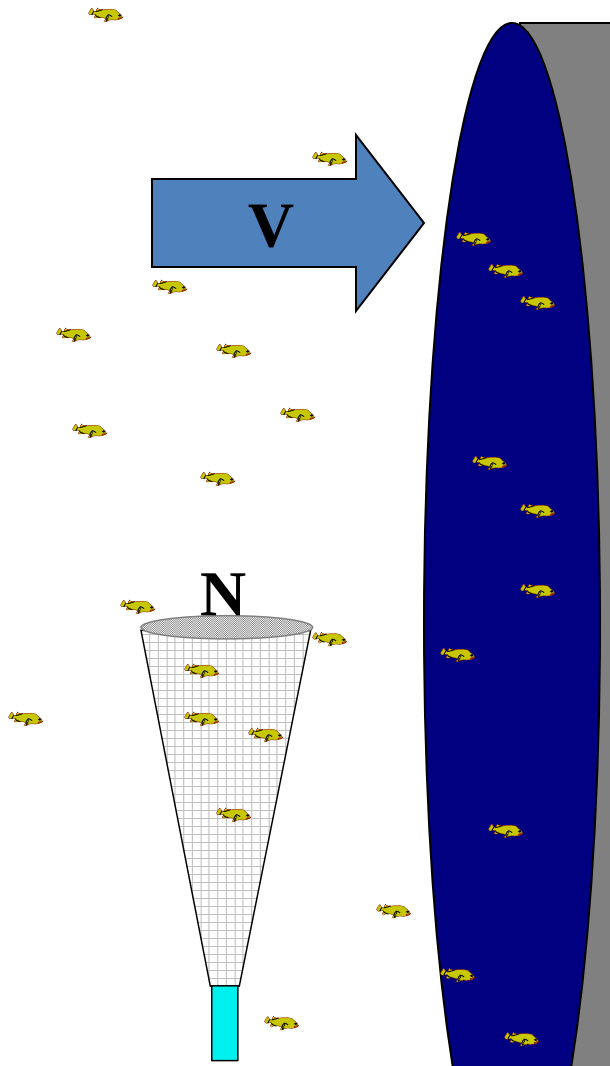
Definitions and major assumptions

- **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



Estimation of larval losses due to entrainment

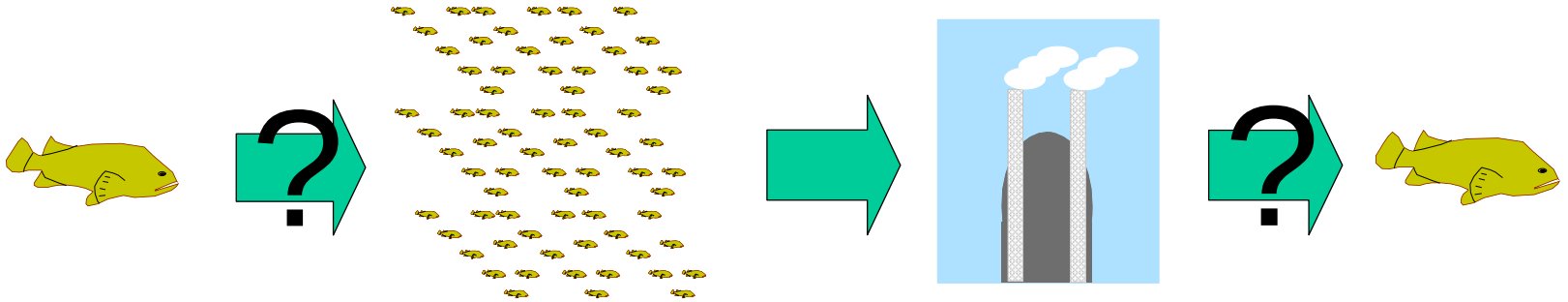


1. Calculate volume of water entering the plant per year (V)
2. Measure concentration of larvae (number per volume) that are entrained (N)
3. ***Assume no survival of larvae through the plant*** – then
4. NV = the annual loss of larvae due to entrainment

Models for assessing entrainment related impact (FH and AEL)

Fecundity Hindcast (FH)

Adult Equivalent Loss (AEL)



Adult Stock (Females)

Larvae

Loss of Adult fish

Question: How to estimate losses to adult populations?

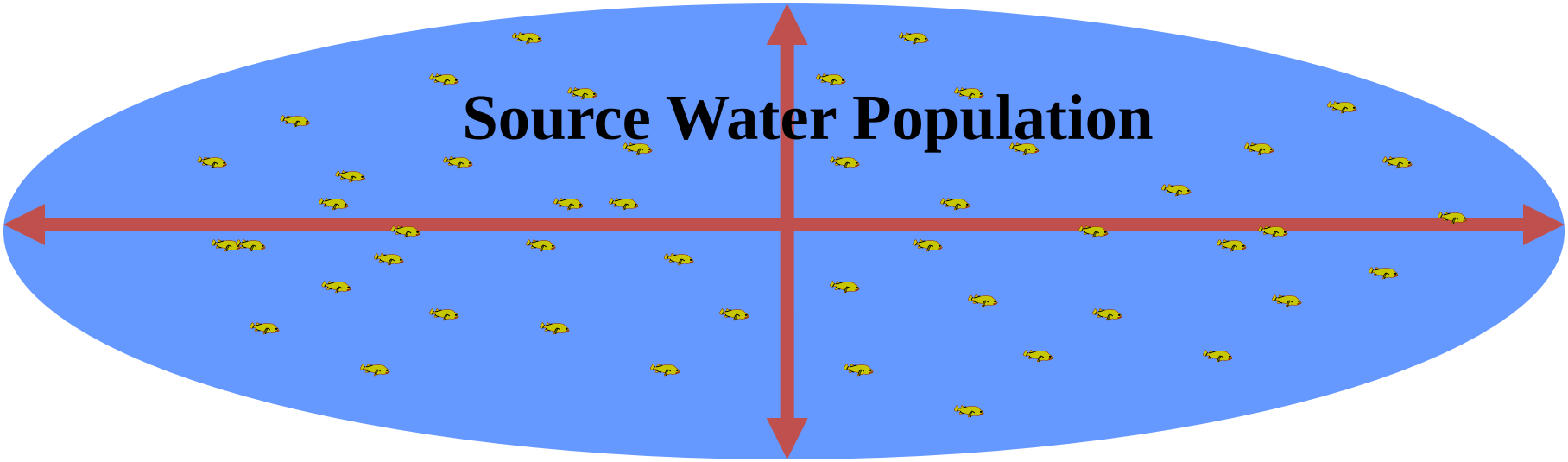
The problem with FH and AEL

Taxon	Estimated Annual Entrainment	2·*FH*	*AEL*
CIQ goby complex	113,166,834	202,538	147,493
northern anchovy	54,349,017	53,490	304,125
spotfin croaker	69,701,589	NA	NA
queenfish	17,809,864	NA	NA
white croaker	17,625,263	NA	NA
black croaker	7,128,127	NA	NA
salema	11,696,960	NA	NA
blennies	7,165,513	6,466	NA
diamond turbot	5,443,118	NA	NA
California halibut	5,021,168	NA	NA

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

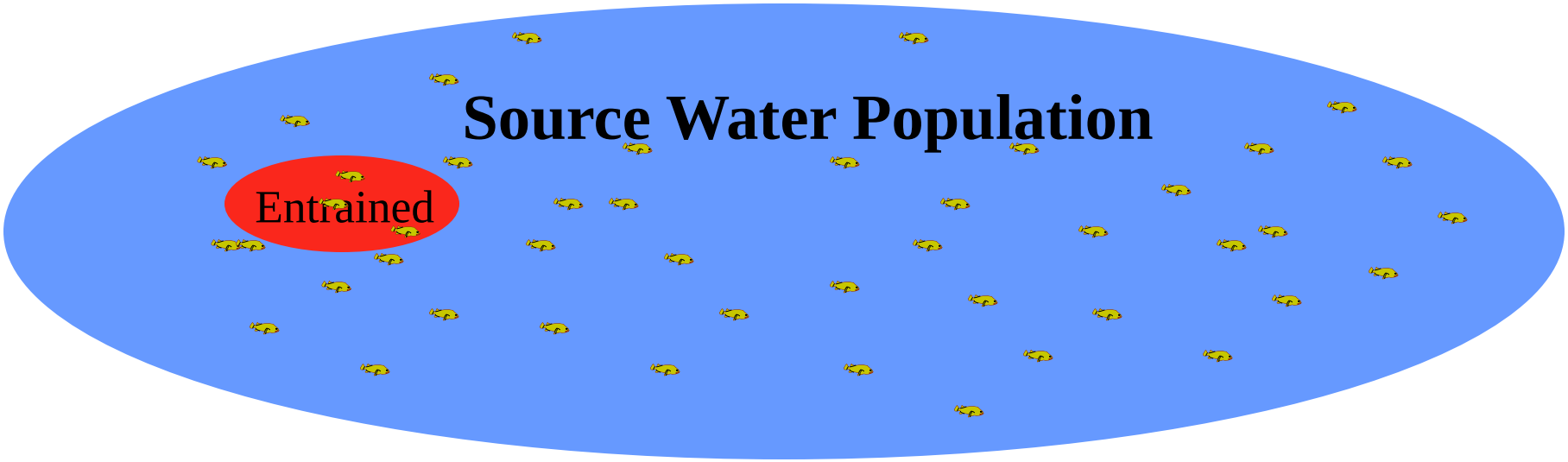
Empirical Transport Model: Understanding "Source Water Population" (SWP) and "Proportional Mortality" (P_m)

The SWP is that spatial area that contains the larvae at risk of entrainment.



Understanding "Source Water Population" (SWP) and "Proportional Mortality" (P_m)

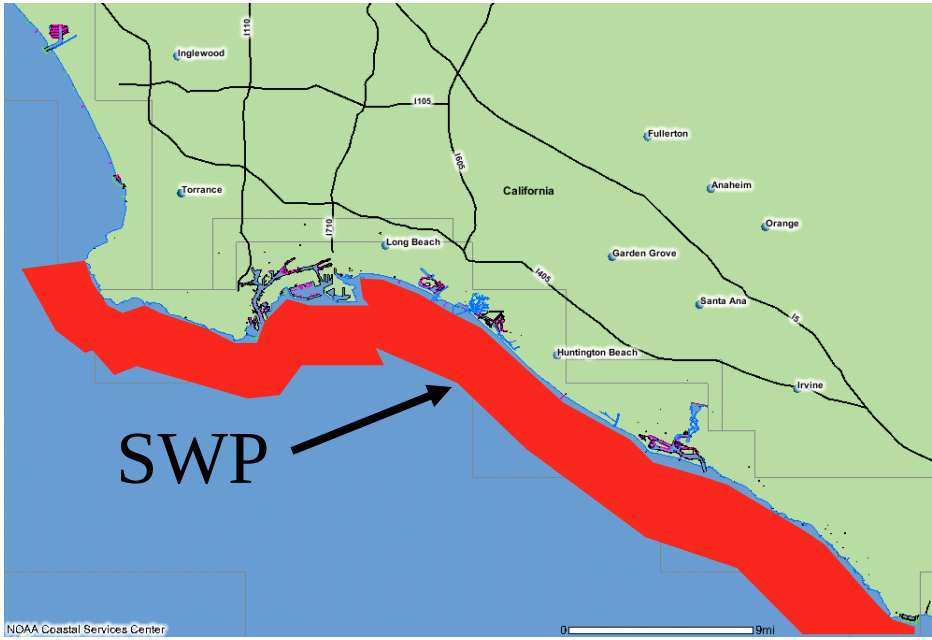
P_m is the percentage of the larvae at risk that are entrained and killed (e.g. 2%).



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

Taxon	Estimated Annual Entrainment	2·*FH*	*AEL*	P_M (SWB)
CIQ goby complex	113,166,834	202,538	147,493	1.0% (60.9 km)
northern anchovy	54,349,017	53,490	304,125	1.2% (72.0 km)
spotfin croaker	69,701,589	NA	NA	0.3% (16.9 km)
queenfish	17,809,864	NA	NA	0.6% (84.9 km)
white croaker	17,625,263	NA	NA	0.7% (47.8 km)
black croaker	7,128,127	NA	NA	0.1% (19.4 km)
salema	11,696,960	NA	NA	NA
blennies	7,165,513	6,466	NA	0.8% (12.8 km)
diamond turbot	5,443,118	NA	NA	0.6% (16.9 km)
California halibut	5,021,168	NA	NA	0.3% (30.9 km)

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

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

Area of Production Foregone – a way to interpret loss

- Simple method allows for conversion of organismal loss to habitat

$$\mathbf{P_m \times SWB}$$

Entrainment Study – ETM Model results

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

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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

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