California Energy Commission

Huntington Beach Units 3 & 4 Entrainment and Impingement Study Results and Mitigation Options

Dr. Noel Davis, Dr. Pete Raimondi,
Rick York, and Joanna Reinhardt

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BACKGROUND

1995 – Units 3 & 4 retired due to non-use

2000 – AES files Application for Certification to retool Units 3 & 4

staff unable to assess impacts from entrainment and impingement

2001 – Energy Commission grants expedited certification

AES to fund 1 year study to assess impacts

provide funds to restore or create coastal habitat to mitigate impacts

CONDITIONS OF CERTIFICATIONS

BIO-4

Fund a study to assess impacts of entrainment and impingement

BIO-5

If impacts are significant, provide funds to restore or create coastal habitat to mitigate impacts

California Energy Commission

Huntington Beach Generating Station

STUDY DESIGN

Technical Working Group:

- California Energy Commission and Consultants
- California Coastal Commission
- Applicant and Consultants
- California Department of Fish and Game
- National Marine Fisheries Service
- Santa Ana Regional Water Quality Control Board
- US Fish and Wildlife

Provided input into sampling design and methods for impact analysis

Approved final study plan

Reviewed progress reports and approved final report in April 2005

Estimation of impacts due to use of cooling water at Huntington Beach Generating Station (HBGS)

- Impingement
- Entrainment

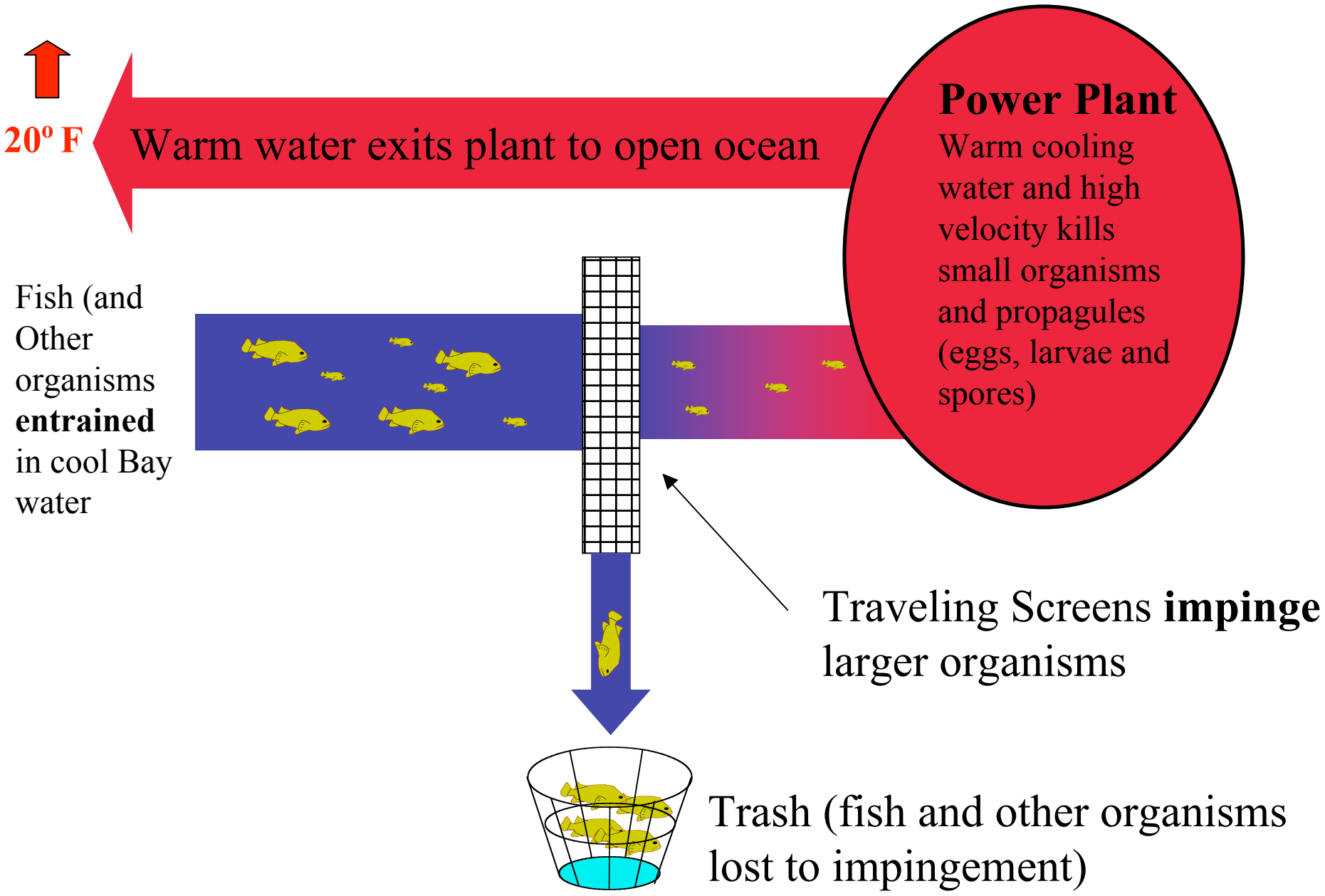
General Conclusions

1. The sampling design, methodology and basic analyses are consistent with recent 316B determinations and are adequate for the determination of entrainment rates
2. The entrainment assessment was conducted for a period of ~ one year. Of the three approaches used to estimate impact of entrainment only ETM calculations are “robust” to a sampling period this short. Note: one year of sampling is typical (in CA) for entrainment studies.
3. For reasons indicated above (and others discussed below) only ETM (as opposed to Fecundity Hindcast and Adult Equivalent Loss) estimates are valuable with respect to estimating entrainment impacts
4. Impingement rates were consistent with expectations for offshore intakes (relatively high compared to onshore low velocity intakes but much lower than say SONGS).

Entrainment and Impingement Losses

- **Definitions**
- Estimation of Impingement
- Estimation of Entrainment
- Estimation of Ecological Effects due to Entrainment and Impingement

Thermal Effects, Impingement and Entrainment



Huntington Beach Generating Station

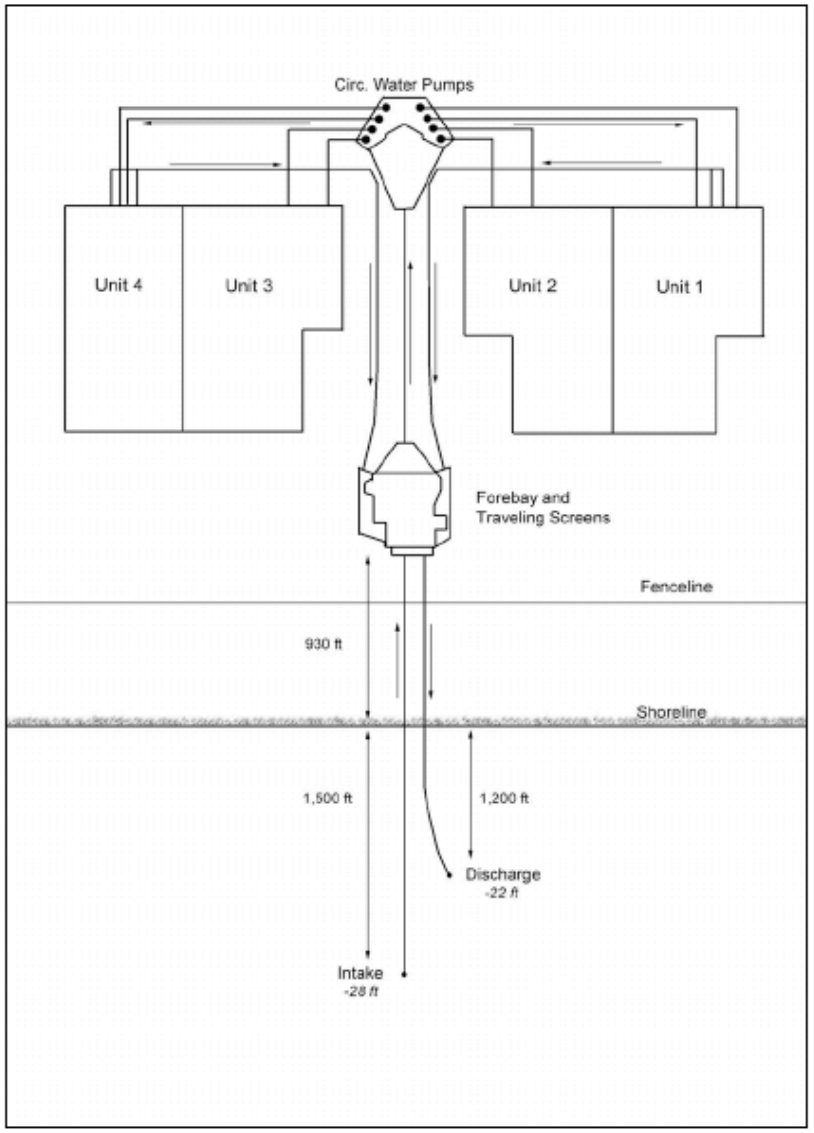


Figure 2-2. Schematic of the AES HBGS cooling water intake system.

HBPP Characteristics (Units 3 &4)

Characteristic	
Max Water Withdrawal	176,000 gallons per minute, 253 million gallons per day
Intake Velocity	1.9 – 3.7 feet per second
Screen opening diameter	3/8th inch
Number Pumps	4
Power capacity	225 MW each (units 3-4)

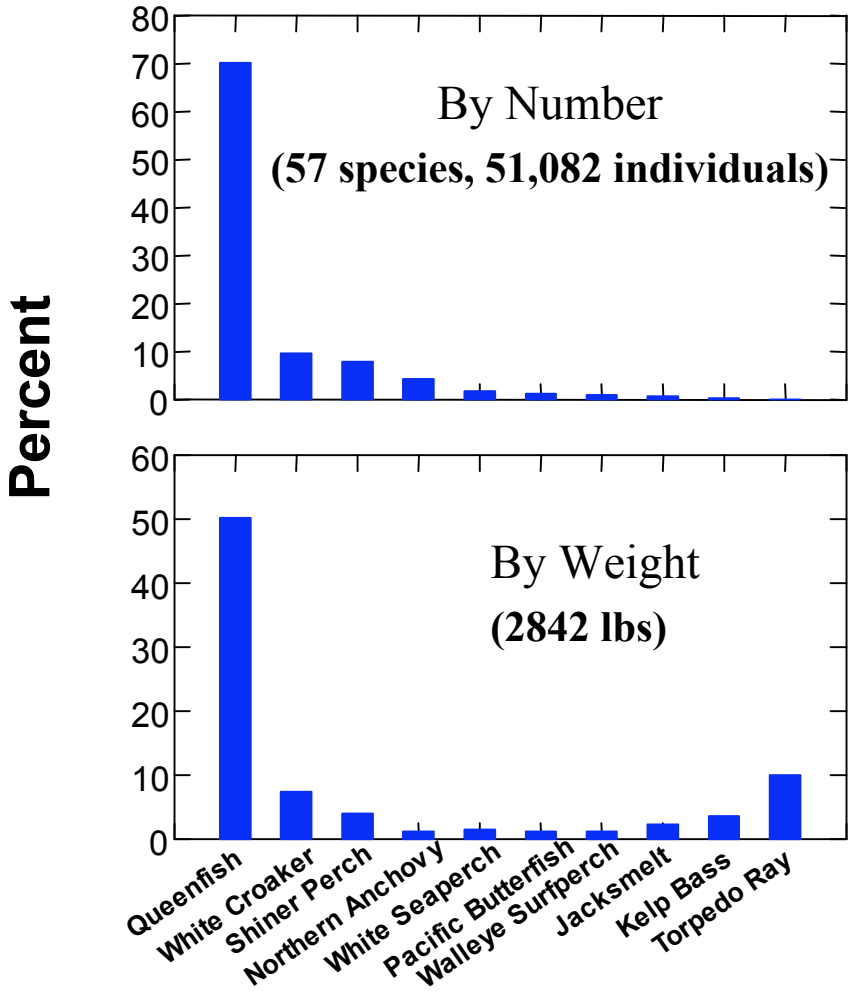
Relevant comparisons

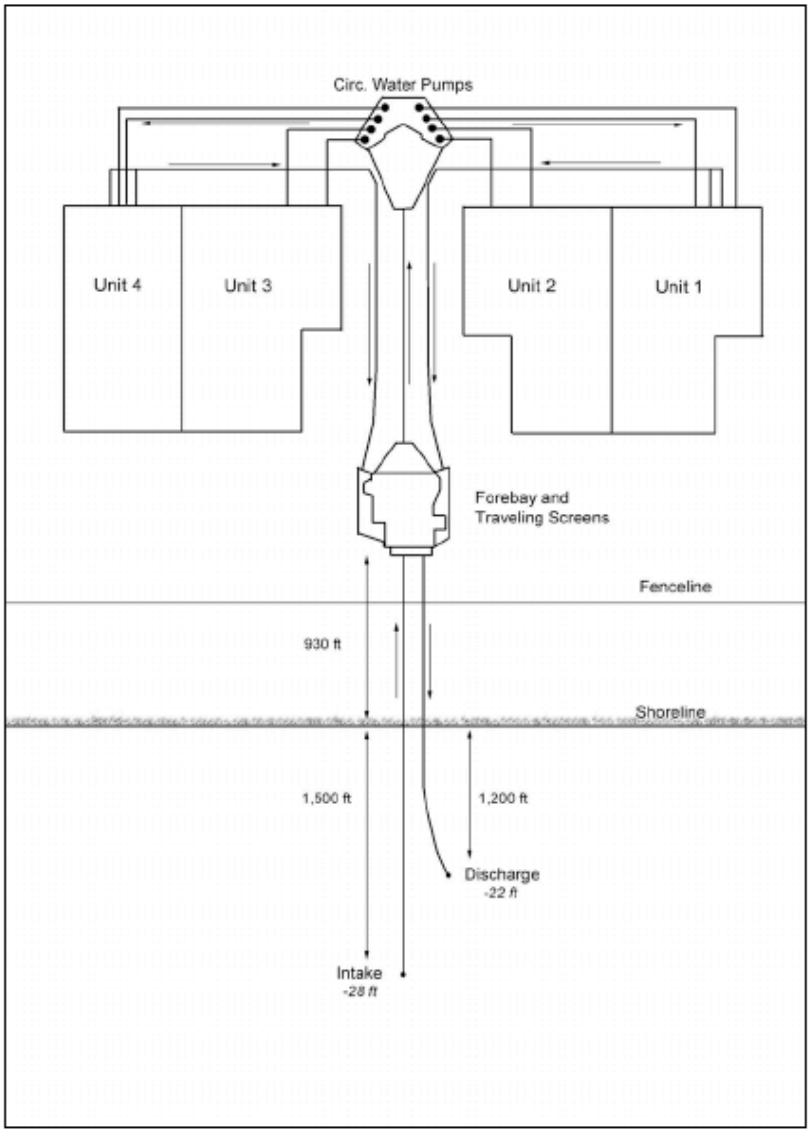
Characteristic	**Huntington Beach (Units 3,4)**	**El Segundo (Units 3 & 4)**	**New Moss Landing (Units 1 & 2)**
Water Withdrawal	176,000 gallons per minute	276,800 gallons per minute	250,000 gallons per minute
Intake Velocity	1.9-3.7 feet per second	0.8 feet per second	0.5 feet per second
Screen opening diameter	3/8th inch	5/8th inch	5/16th inch
Power capacity	225 MW per unit	335 MW per unit	530 MW per unit

Entrainment and Impingement Losses

- Definitions
- Estimation of Impingement
- Estimation of Entrainment
- Estimation of Ecological Effects due to Entrainment and Impingement

Impingement (2003-2004)





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Entrainment and Impingement Losses

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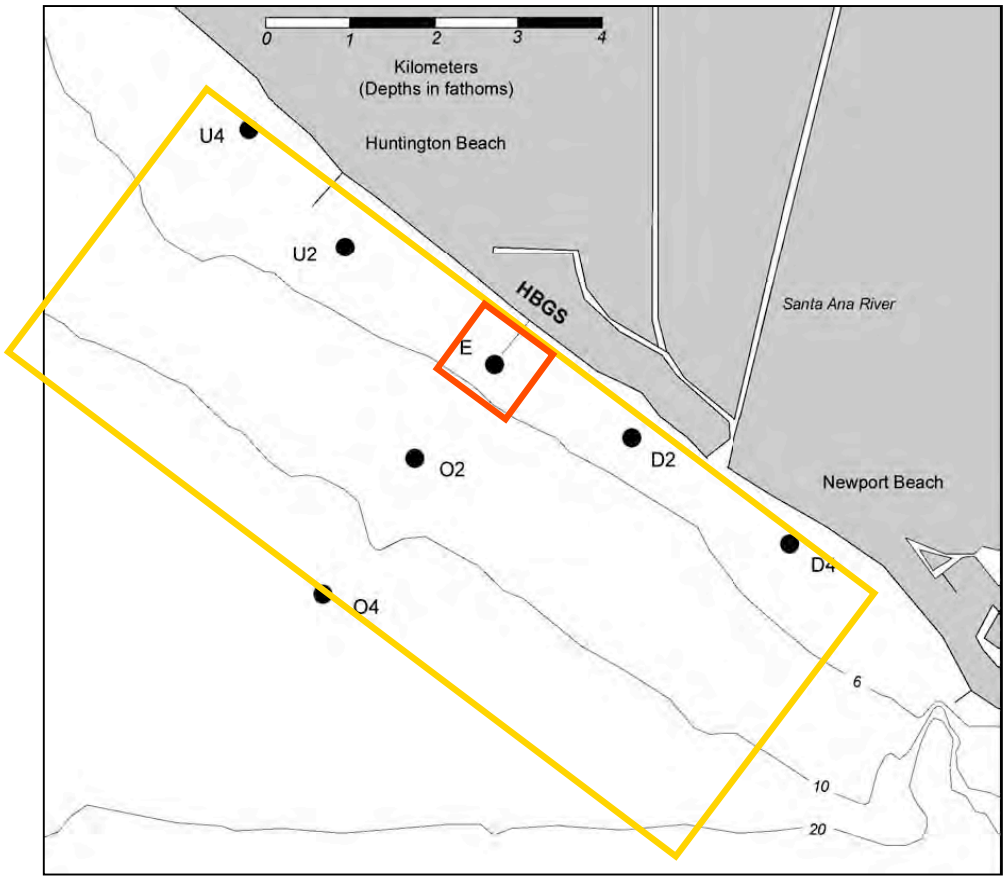
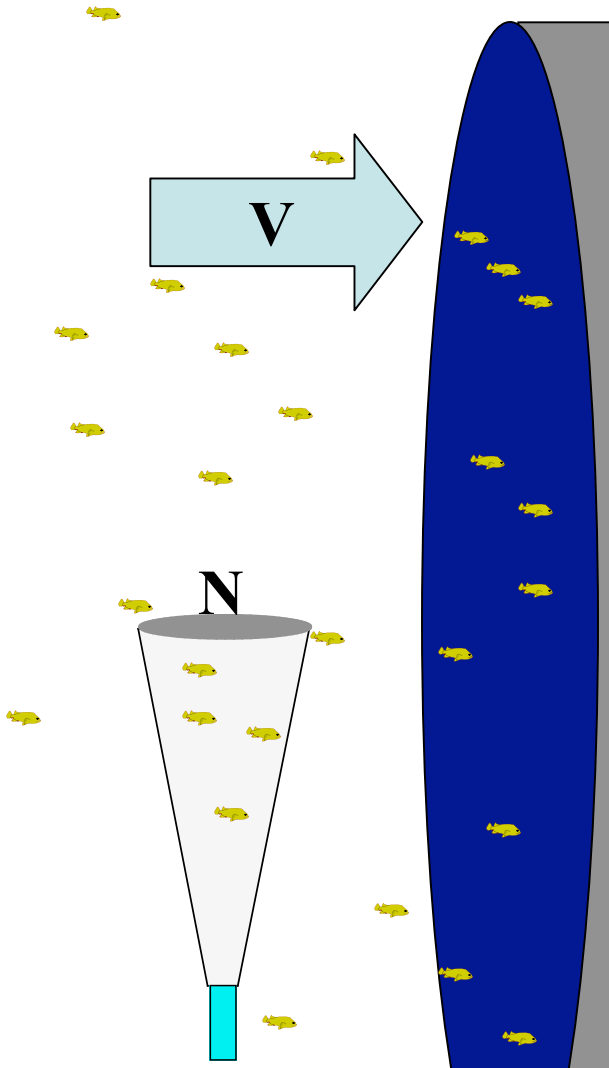
- Estimation of Ecological Effects due to Entrainment and Impingement

Source Water Sampling at Huntington Beach



Estimation of larval losses due to entrainment



1. Calculate volume of cooling 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

BIOLOGY Table 1
Percentage of Fish Taxa Accounting for More than 1 Percent o f the Total Individuals in the Entrainment and Source Water Samples

Fish Taxon	Common Name	Percent of Individuals in Entrainment Samples	Percent of Individuals in Source Water Samples
Gobiidae (CIQ Complex)	gobies	36.95	36.82
Engraulidae	anchovies	17.98	17.62
Roncador steamsi	spotfin croaker	13.57	0.37
Genyonemus lineatus	white croaker	6.53	8.65
Seriphus politus	queenfish	4.55	9.90
Sciaenidae	unidentified croakers	3.63	3.78
Hysoblennius spp.	blennies	2.47	3.06
Xenistius californiensis	salema	2.28	0.35
Paralichthys californicus	California halibut	1.46	2.78
Atherinopsidae	silversides	1.44	2.32
Cheilotrema saturnum	black croaker	1.43	0.43
Hypsopsetta guttulata	diamond turbot	1.29	0.85
Paralabrax spp.	kelp/sand bass	0.71	2.85
Chromis punctipinnis	blacksmith	0	1.16
Sardinops sagax	Pacific sardine	0.06	1.03
Sphyraena argentea	California barracuda	0.21	1.01

Estimation of Ecological Effects due to Entrainment

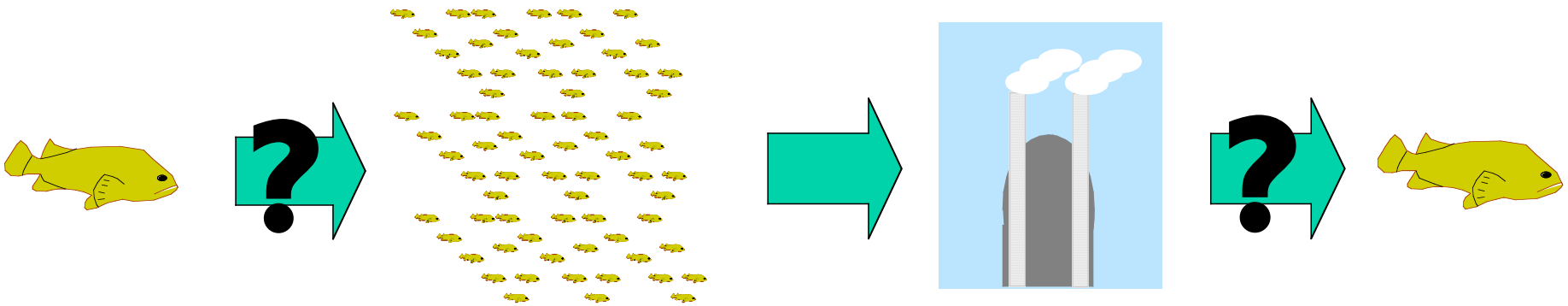
Methods of Estimation

- Fecundity Hindcast (FH)
- Adult Equivalent Loss (AEL)
- Proportional Mortality (PM)

Importance of larval losses due to entrainment

Fecundity Hindcast (FH)

Adult Equivalent Loss (AEL)



Adult Stock (Females)

Larvae

Loss of Adult fish

Question: How to estimate losses to adult populations?

Table 5-1. Summary of entrainment modeling estimates on target taxa based on the three modeling techniques (*FH, AEL,* and *ETM* [P_M]). The *FH* model estimates an equivalent number of breeding adult females, therefore this estimate is multiplied by two for comparison with the AEL model that estimates an equivalent numbers of adults irrespective of sex. The comparison assumes a 50:50 ratio of males:females in the population. The shoreline distance (km) used in the alongshore extrapolation of P_M is presented in parentheses next to the estimate.

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
sand crab megalops	69,793	NA	NA
California spiny lobster	0	NA	NA
ridgeback rock shrimp	0	NA	NA
market squid	0	NA	NA
rock crab megalops	6,411,171	NA	NA

NA – Estimate not available due to either insufficient life history information or low abundance in entrainment samples.

Estimation of Ecological Effects due to Entrainment

Methods of Estimation

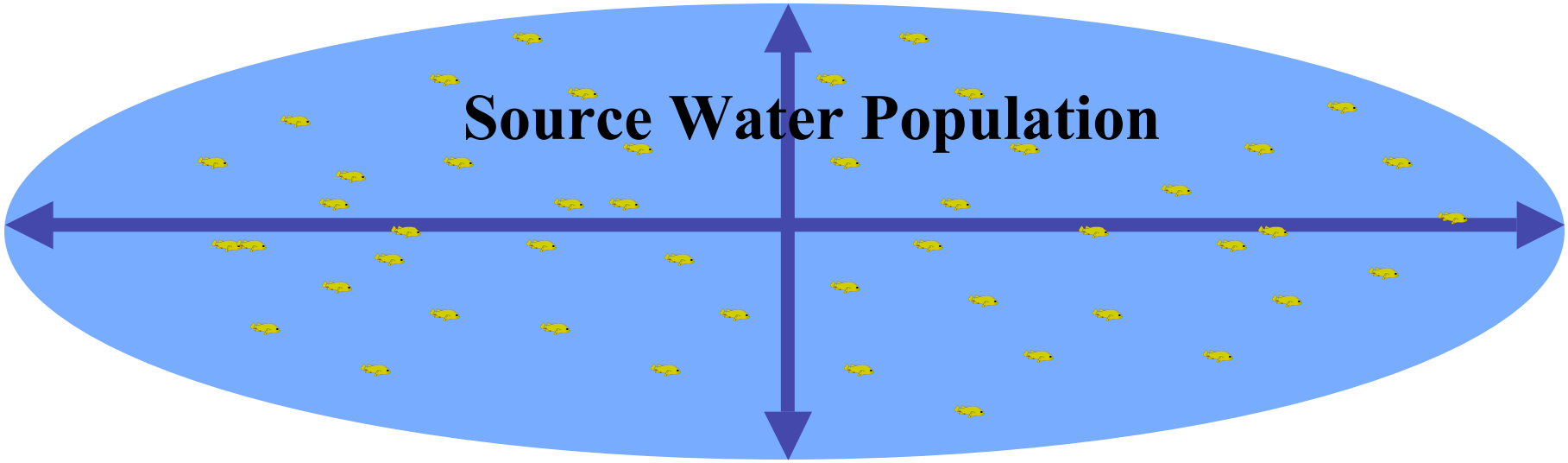
- **Fecundity Hindcast (FH)**
  - **Need estimate of average fecundity per female**
    - **Sometimes extremely variable estimates**
  - **Need estimate of mortality between reproduction and entrainment – unknown for most species**
- **Adult Equivalent Loss (AEL)**
  - **Need estimate of mortality between entrainment and maturity for most species – unknown for most species**
- **Proportional Mortality (PM) based on ETM**

How to interpret P_m (proportional mortality)

- What counts as significant?
  - Are low P_m values indicative of insignificant mortality rates?
  - To understand this idea – use an example

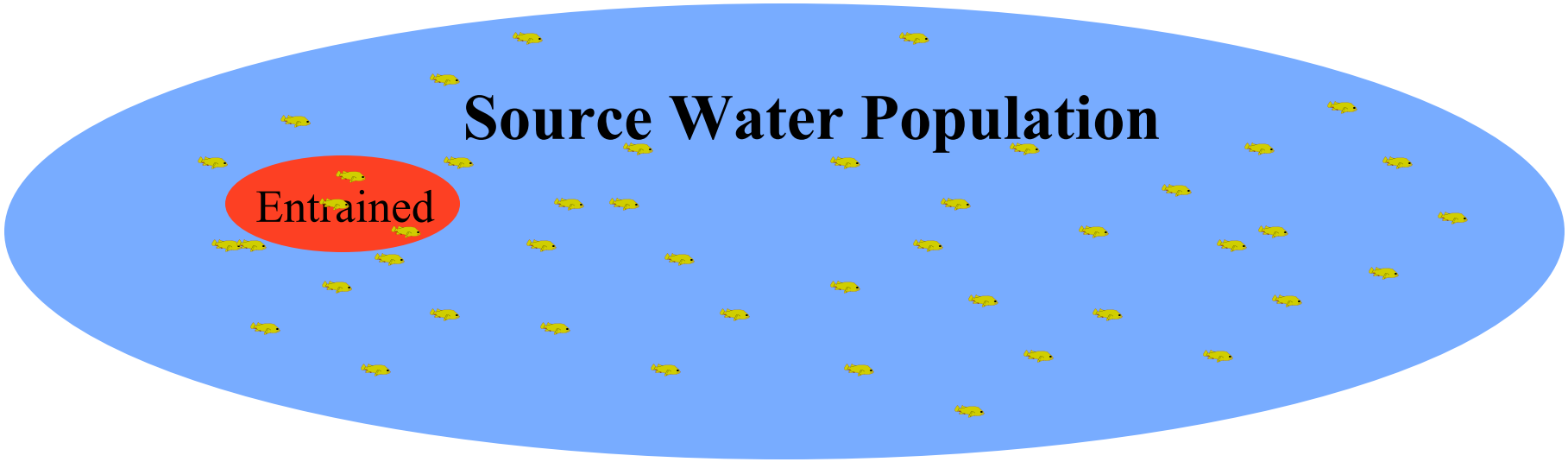
Understanding "Source Water Population" (SWP) and "Proportional Mortality" (P_m)

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

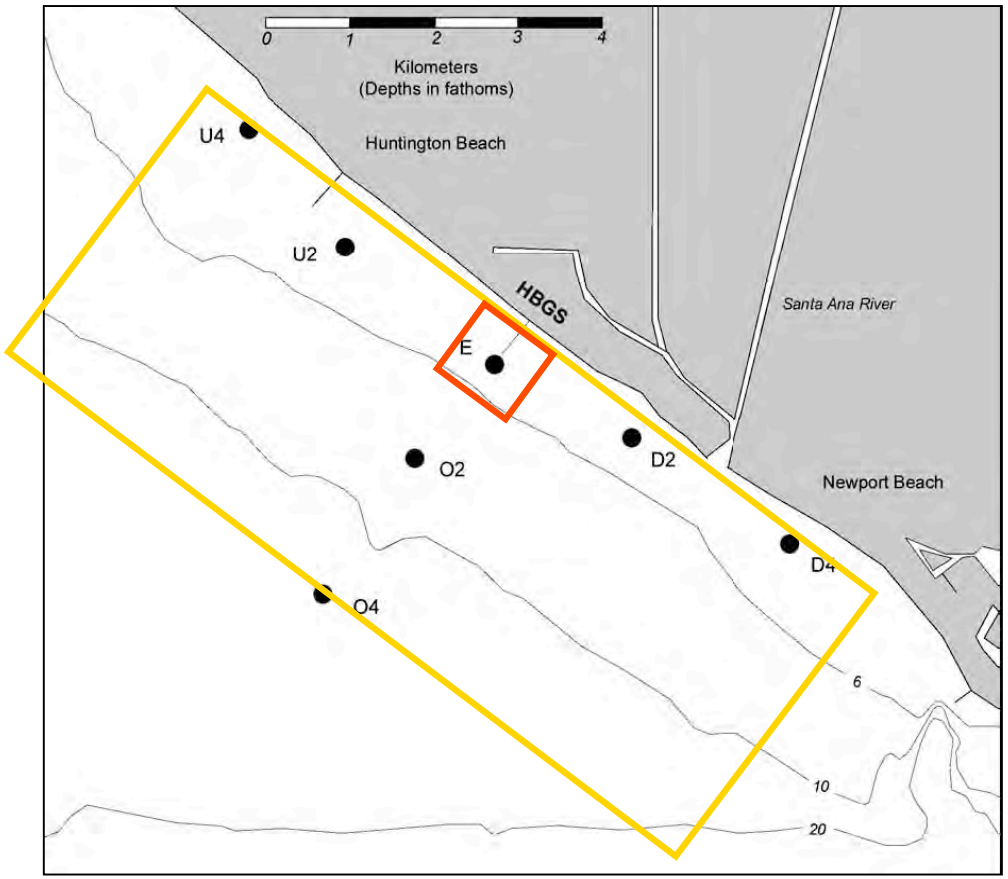


Understanding "Source Water Population" (SWP) and "Proportional Mortality" (P_m)

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



Source Water Sampling at Huntington Beach



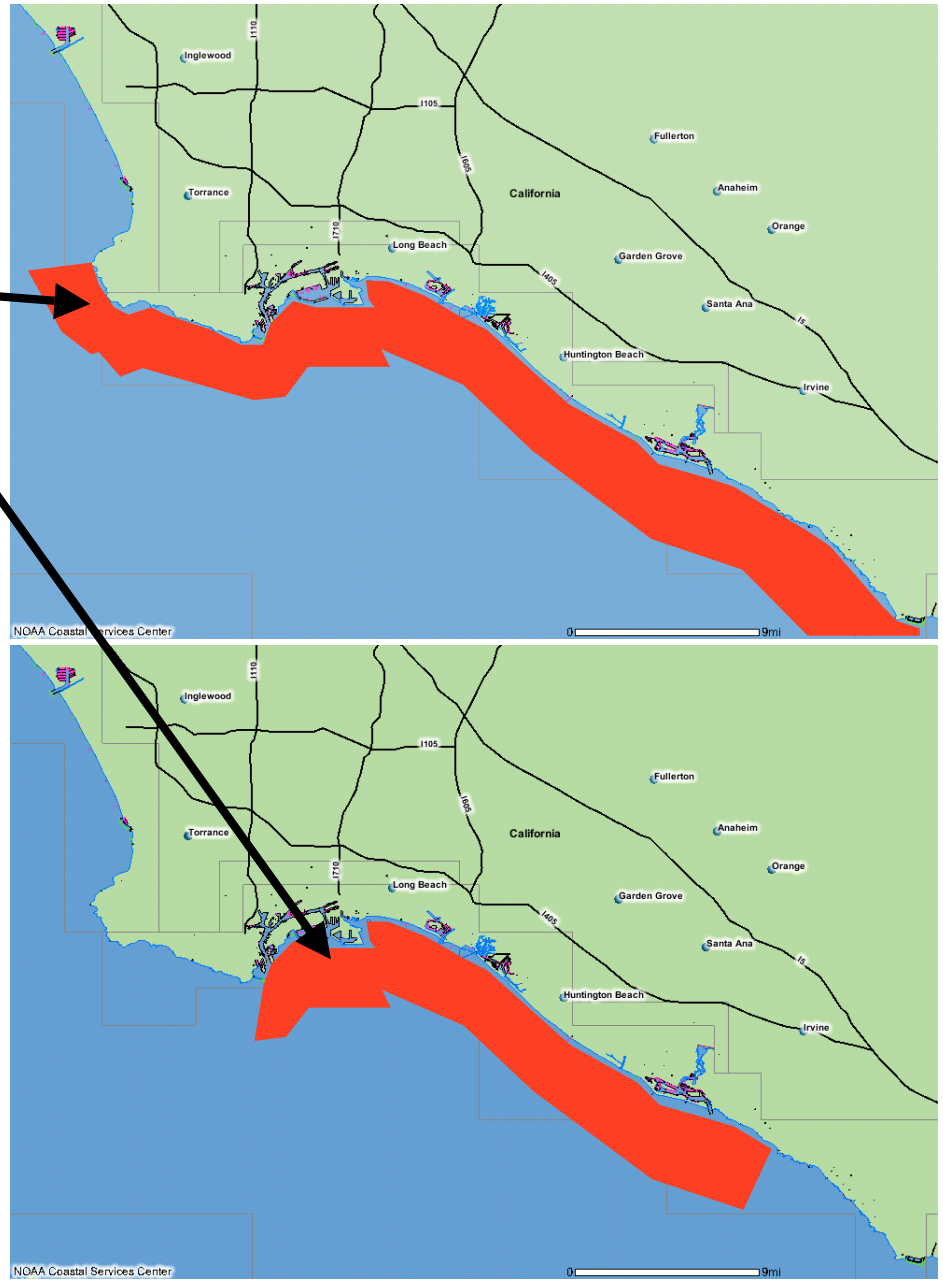
Each species will have a different Source Water Population
Example: Queenfish (50.9 miles along coast)

Based on:

- Period of vulnerability to entrainment
- Distance larvae could have come from during the period of vulnerability

Entrainment Study – ETM Model results

Taxon	Estimated Annual Entrainment	Length of Source Water Population (Miles)
spotfin croaker	69,701,589	**10.1**
queenfish	17,809,864	**50.9**
white croaker	17,625,263	**28.7**
black croaker	7,128,127	**11.6**
salema	11,696,960	
blennies	7,165,513	**7.7**
diamond turbot	5,443,118	**10.1**
California halibut	5,021,168	**18.5**
rock crab	6,411,171	**15.9**
AVERAGE		
AVERAGE (acres)		



The ETM Model: Calculation Of Average Mortality due to entrainment

1. Determine target species
2. Determine period when larvae are at risk
3. Calculate rates of mortality (P_m) for target species
4. Assume that target species represent other species that were not targets
5. These values represents the estimated rate of mortality for all species having a larval phase whose PM's were not directly determined

Entrainment Study – ETM Model results based on: (1) "best estimate" and estimate including uncertainty.

Taxon	Estimated Annual Entrainment	P_m Alongshore Extrapolation (Mean)	P_m Alongshore Extrapolation (+1 SE)
spotfin croaker	69,701,589	0.30%	37%
queenfish	17,809,864	0.60%	29%
white croaker	17,625,263	0.70%	24%
black croaker	7,128,127	0.10%	38%
salema	11,696,960	NA**	
blennies	7,165,513	0.80%	28%
diamond turbot	5,443,118	0.60%	28%
California halibut	5,021,168	0.30%	21%
rock crab	6,411,171	1.10%	35%
AVERAGE		**0.56%**	**30.0%**
AVERAGE (acres)			

Interpretation of estimate of LOSS (FH, AEL and PM)

- With FH and AEL we can estimate adult loss
- With PM we can estimate proportional larval loss

  - **Question: what level of loss is environmentally important?**
    - **What counts as important?**
      - **Local**
      - **Regional**
      - **National**

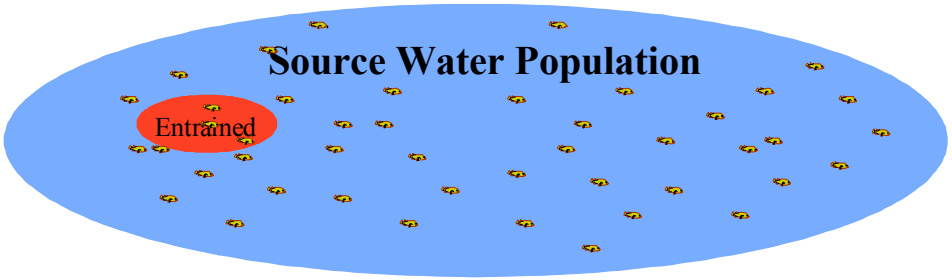
Area of Production Foregone – a way to interpret loss

- Method allows for conversion of organismal loss to habitat
- Can work for any source of loss
  - Impingement or entrainment
- Can work for any estimate of loss (e.g.)
  - Fecundity Hindcast
  - Adult Equivalent Loss
  - Proportional Mortality

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

You cannot interpret P_m without knowing the size of the SWP

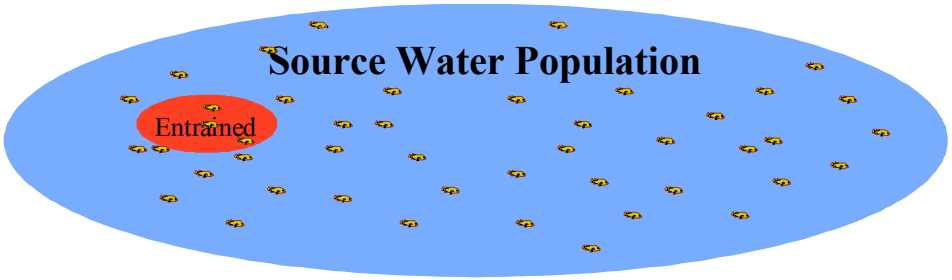
	Scenario 1	Scenario 2
P_m	10%	1%
SWP		



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

You cannot interpret P_m without knowing the size of the SWP

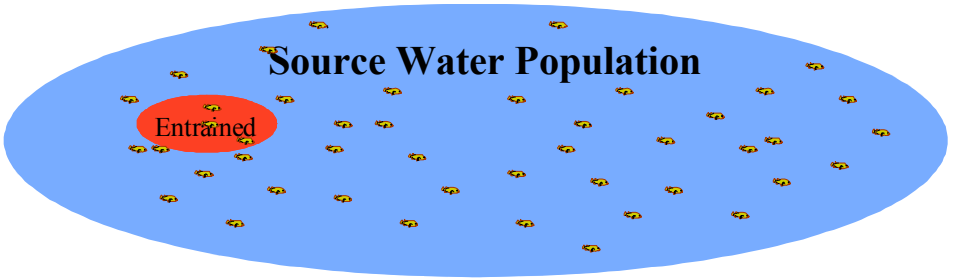
	Scenario 1	Scenario 2
P_m	10%	1%
SWP	1 acre	640 acres



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

You cannot interpret P_m without knowing the size of the SWP. The product of P_m and SWP is the Area of Production forgone (APF), which is the best way to understand the impact

	Scenario 1	Scenario 2
P_m	10%	1%
SWP	1 acre	640 acres
APF	**0.1 acre**	**6.4 acres**



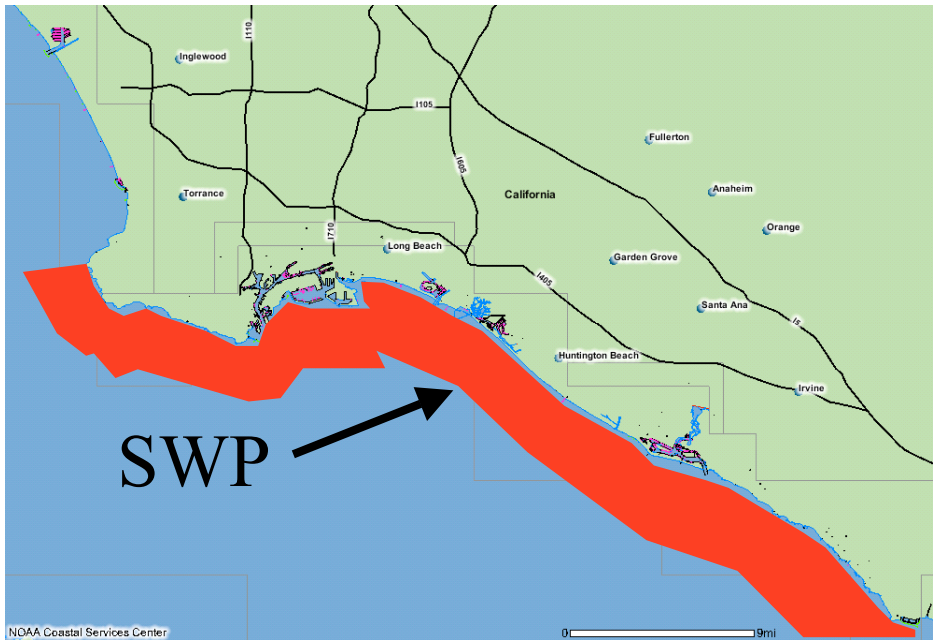
Example: Proportional mortality for Queenfish (average) = 0.60%

1. Calculate area of Source water Population (SWP)
2. Then the habitat required to compensate for larval losses =

SWP x 0.006

SWP = 89,920 acres (140.5 sq. miles)

89,920 x 0.006 = 539 **acres** (0.84 sq. miles) of new bay habitat would be needed to produce larvae equivalent to losses



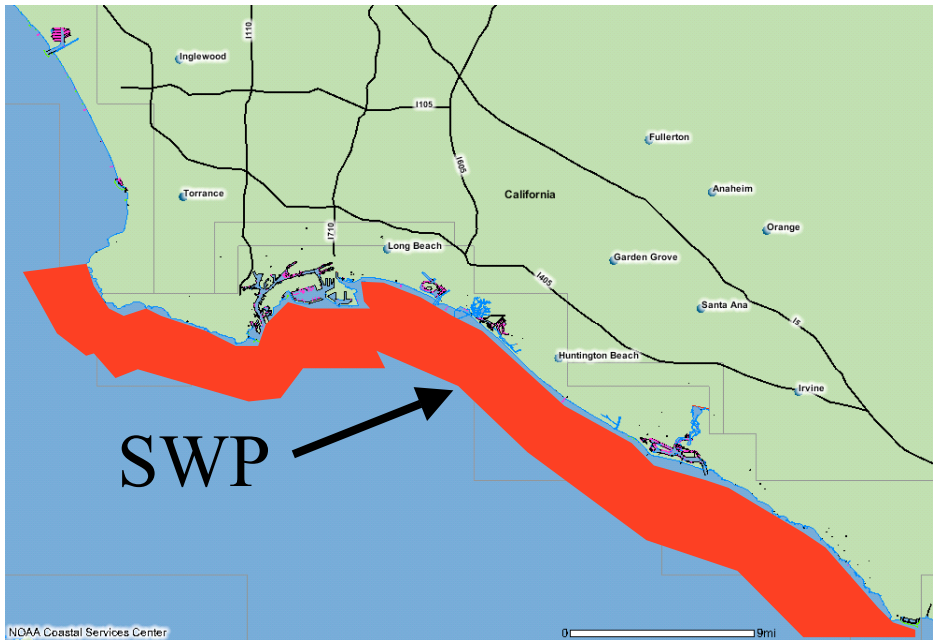
Example: Proportional mortality for Queenfish (+1 SE) = 29%

1. Calculate area of Source water Population (SWP)
2. Then the habitat required to compensate for larval losses =

SWP x 0.29

SWB = 89,920 acres (140.5 sq. miles)

89,920 x 0.29 = 26,077 **acres** (40.74 sq. miles) of new bay habitat would be needed to produce larvae equivalent to losses



Entrainment Study – ETM Model results

Taxon	Estimated Annual Entrainment	P_m Alongshore Extrapolation (Mean)	Pm Alongshore Extrapolation (+ 1 SE)	Length of Source Water Population (Miles)	Area (mi^2) of Production Foregone (Mean)	Area (mi^2) of Production Foregone (+1 SE)
spotfin croaker	69,701,589	0.30%	37%	10.1	0.085	10.3141
queenfish	17,809,864	0.60%	29%	50.9	0.911	40.7404
white croaker	17,625,263	0.70%	24%	28.7	0.583	19.0109
black croaker	7,128,127	0.10%	38%	11.6	0.039	12.1661
salema	11,696,960	NA**				
blennies	7,165,513	0.80%	28%	7.7	0.170	5.9506
diamond turbot	5,443,118	0.60%	28%	10.1	0.170	7.8053
California halibut	5,021,168	0.30%	21%	18.5	0.131	10.7226
rock crab	6,411,171	1.10%	35%	15.9	0.486	15.3594
AVERAGE (sq. miles)					0.325	15.26
AVERAGE (acres)					**208**	**9765**
Based on Units 3 & 4 (acres)					**104**	**4882.5**

What does this mean

- If 104 (4882.5) acres of new bay habitat were added to the system (in general area of source water body) then (for Units 3 & 4):
  - Direct impacts to sampled fish and invertebrates would be mitigated for
  - Direct impact to other entrained species would probably be mitigated for (assuming the P_m values were proxies for all species)
  - Indirect impacts would also probably be mitigated for

Assuming that new bay habitat was a comparable mixture of habitats to that in source water body

THRESHOLDS OF SIGNIFICANCE

An impact is significant:

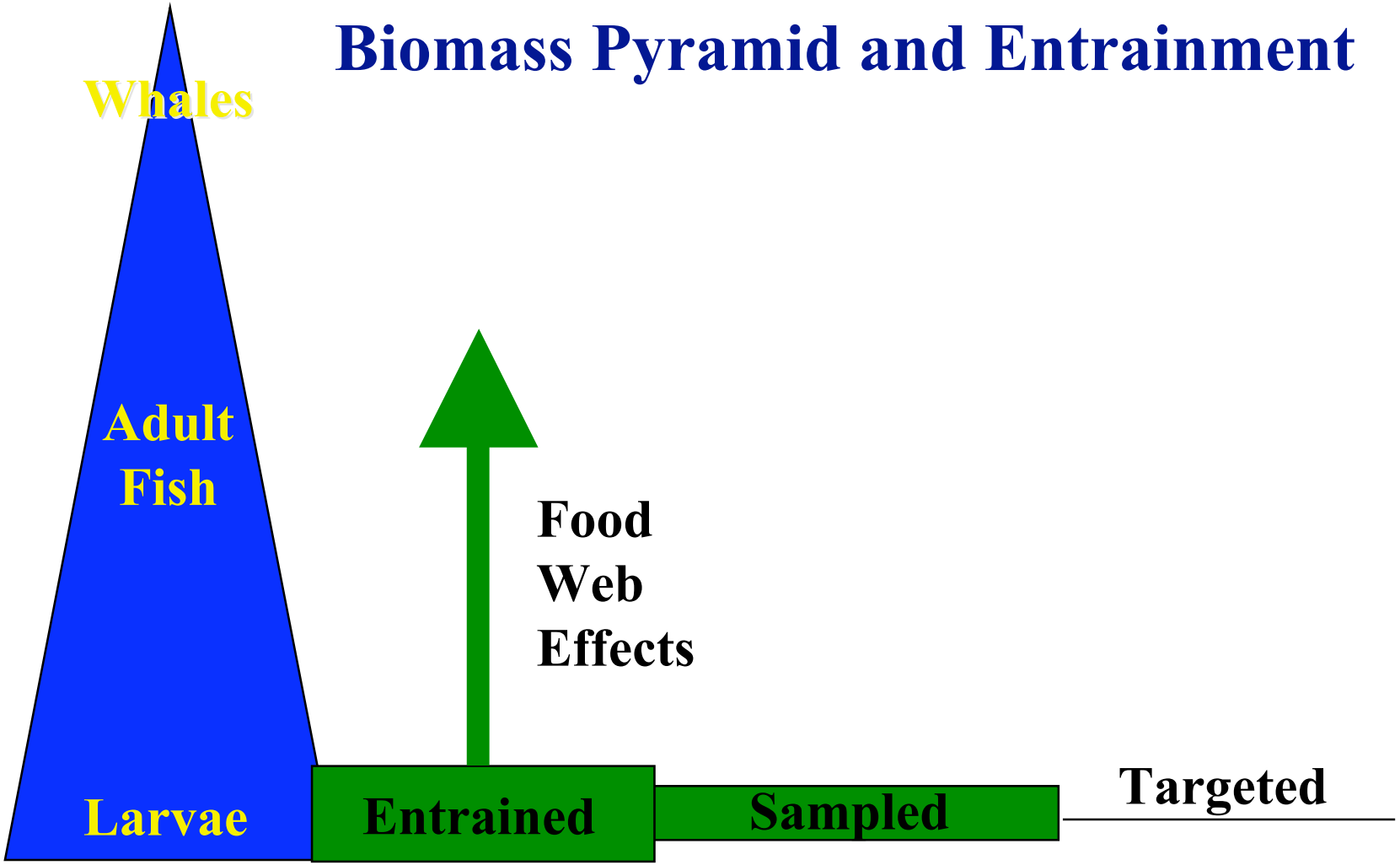
- if state- or federal-listed species, state Fully Protected species, candidates for state or federal listing and/or Species of Concern are
- impacted;
- if migration of a species is interrupted;
- if there is a reduction of native fish, wildlife and plant habitat;
- if a fish or wildlife population is caused to drop below self-sustaining
- levels;

  if a wetlands, marsh, riparian area or other wildlife habitat is disturbed;

  if there is substantial degradation in the quality of the environment.

In addition, CEQA Guidelines specify a Mandatory Finding of Significance if the project has possible environmental effects that are individually limited but cumulatively considerable (CEQA Guidelines Section

Biomass Pyramid and Entrainment



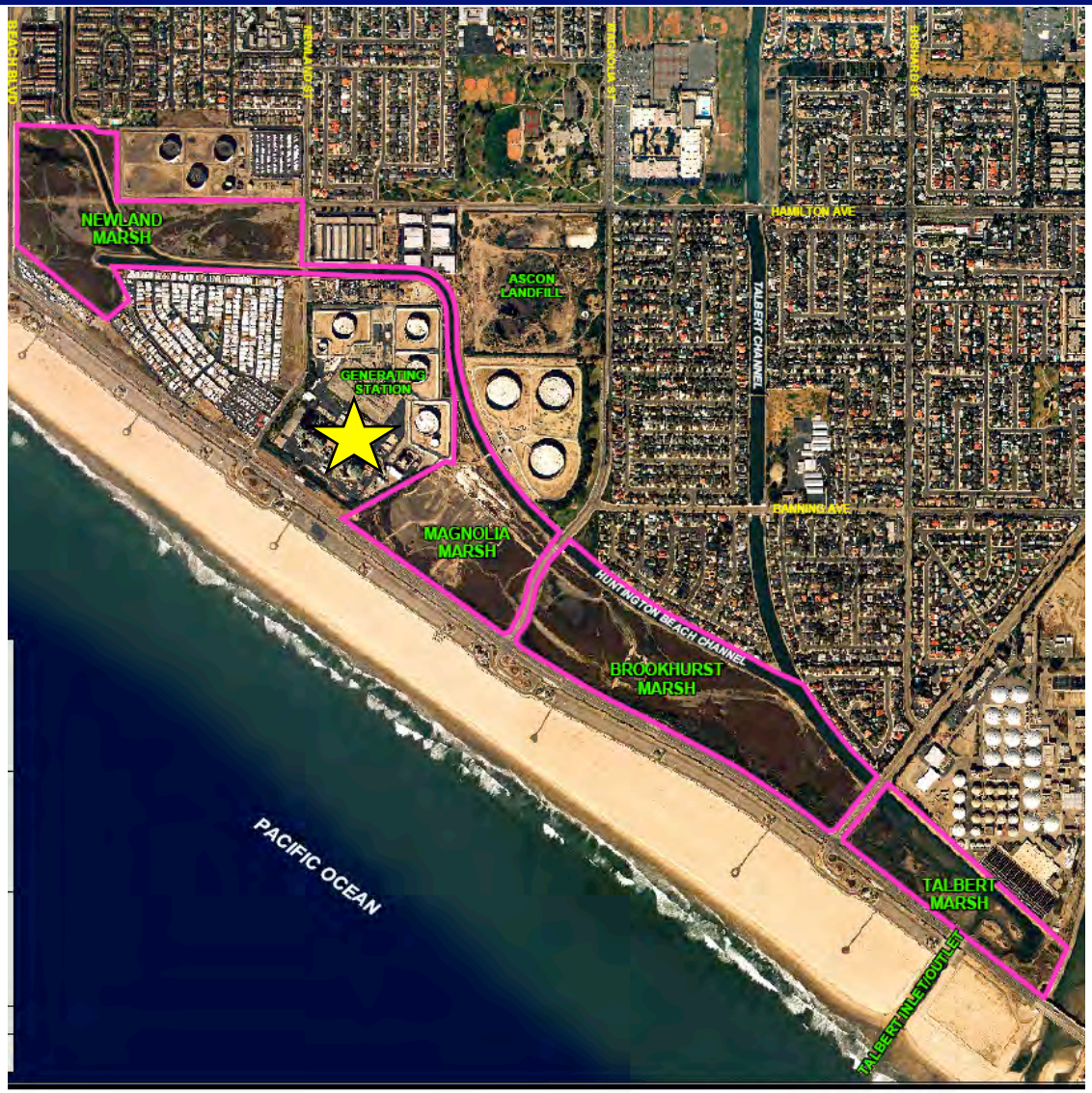
AGENCY CONCURRENCE WITH STAFF FINDING OF SIGNIFICANT IMPACT

- National Marine Fisheries Service
- California Department of Fish and Game
- Santa Ana Regional Water Quality Control Board
- California Coastal Commission

MITIGATION OPPORTUNITIES

- Reduce Cooling Water Flows
- Huntington Beach Wetlands
- Santa Ana River Marsh
- Artificial Reefs

California Energy Commission



Huntington Beach Wetlands

HUNTINGTON BEACH WETLANDS RESTORATION

Phase 1 - 27-acre Talbert Marsh and 43 acre Magnolia Marsh - $5.46 million

Phase 2 - 67 acre Brookhurst Marsh - $6.05 million

Phase 3 - 54 acre Newland Marshes - $2.75 million

Total $14.26 million for construction

$149,767 per year for maintenance and monitoring

RECOMMENDED MITIGATION

- 1:1 Mitigation Ratio
- Contribute money sufficient to restore 104 acres of the Huntington Beach Wetlands and maintain them for 10 years - $7,956,000
- If flow to Units 3 and 4 can be reduced to an annual average of 126.7 mgd (equivalent to an Area of Production Foregone of 74.7 acres) restore 74.7 acres of the Huntington Beach wetlands and maintain them for 10 years - $6,162,750