

# **CALDESAL Association**

## **1<sup>st</sup> Annual Desalination Conference**

**GOOD SCIENCE**

**GOOD POLICY**

**SUSTAINABILITY**

**Science of Desalination Effects on Marine Life**

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Dave Mayer Tenera Environmental  
Lafayette, CA [dmayer@tenera.com](mailto:dmayer@tenera.com)



# Outline

Intake Screening Science

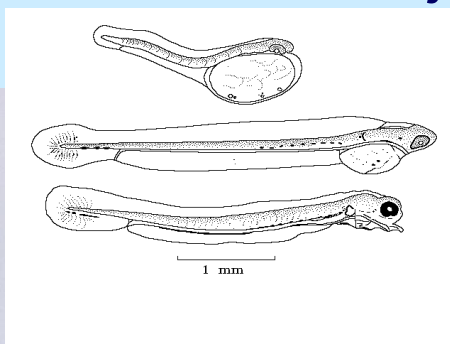
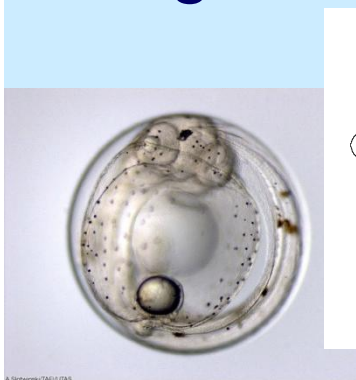
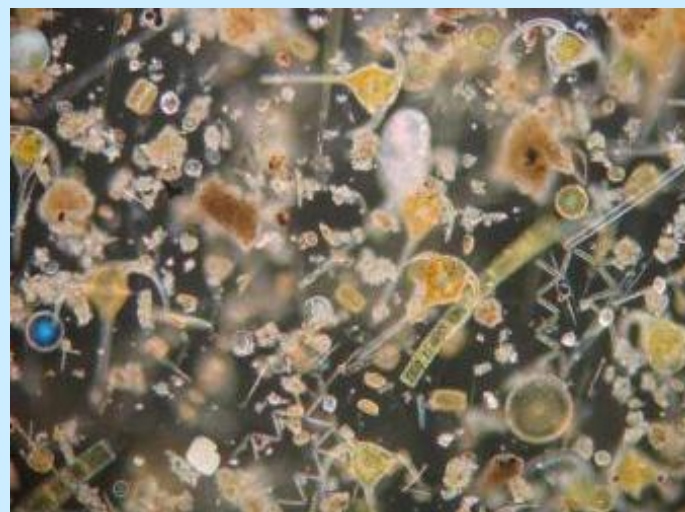
Discharge Diffuser Science

Integration of Science and Policy

# Intake Effects Science

## Entrainment - Plankton

Plankton – “wanderer” – refers to a range of drifting organisms, including plants, animals, and bacteria. Most plankton are microscopic but also include, by definition, large organisms such as jellyfish



# Entrainment Effects are Site-Specific

- Habitat of adult fish also important in assessing entrainment effects – larvae transported out of native habitat have very low likelihood of survival
- Due to variability of marine environment most fishes produce a surplus to account for high levels of mortality

Stage	<u>Northern anchovy</u>		<u>CIQ goby complex</u>		<u>blue rockfish</u>	
	Daily Survival	Duration (days)	Daily Survival	Duration (days)	Daily Survival	Duration (days)
Egg Stage	0.7937	3.0				
Yolksac Stage	0.6935	4.0				
Early Larval Stage	0.7513	12.0	0.9311	60.0	0.8900	15.0
Late Larval Stage	0.9306	45.0			0.9139	26.0
Early Juvenile Stage	0.9860	62.0	0.9949	305.0	0.9418	27.0
Late Juvenile Stage	0.9956	80.0			0.9608	29.0
Adult	0.9969	159.0				
	0.000026 0.003%	365.0	0.002917 0.3%	365.0	0.001041 0.1%	97.0

# Entrainment Effects on Fishes

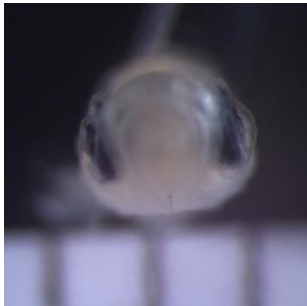
- Over the reproductive life of a female fish only two larvae need to survive to reproductive age to sustain the population
- For example, a single female California halibut may produce millions of eggs per year
- Lifetime fecundity depends on several factors including longevity, age of maturity, and mortality rates of adult females
- These factors contribute to concerns about heavy fishing pressure on late maturing, long-lived fishes, such as rockfishes

# Intake Screening Effectiveness

- Most CA marine fish eggs and young larvae pass through intake screens
- BUT larger, late stage larvae that will become reproductive adults to sustain the species' population can be screened out
- 75% of late-stage northern anchovy larvae can be effectively screened out
- Scientific evaluation of screen effectiveness takes into account the value of each larval stage to natural sustainability

# Intake Screening Effectiveness

## Entrainment with 1.0 mm WWS based on Head Capsule



**northern anchovy**

< 8 mm – 74.5%



**goby species complex**

< 6 mm – 92.2%

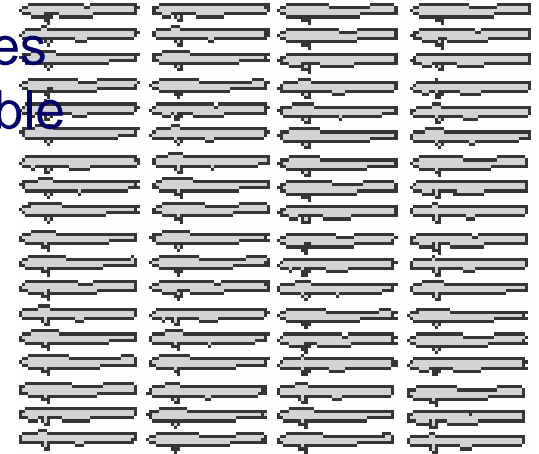
>8 -19 mm – 22.4%

>6 – 13 mm – 7.1%

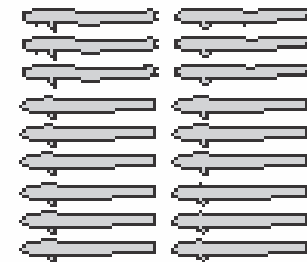
>19 mm – 3.1%

>13 mm – 0.7%

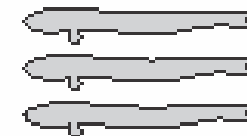
Early Larval Stages – 100 % Entrainable



Mid-Development Stage Larvae – Variable Entrainment



Late Larval Stages – Not Entrainable



\*Estimates based on size-age distribution of larvae from entrainment studies in Santa Monica Bay

# Intake Screening Effectiveness

## Open Ocean Intake Impacts on Age-1 Equivalents

Stage	Northern anchovy			CIQ goby complex		
	Daily Survival	Duration (days)	Cumulative % Survival	Daily Survival	Duration (days)	Cumulative % Survival
Egg Stage	0.7937	3	50.0%			
Yolksac Stage	0.6935	4	11.6%			
Early Larval Stage	0.7513	12	0.374%	0.9311	60.0	1.384%
Late Larval Stage	0.9306	45	0.015%			
Early Juvenile Stage	0.9860	62	0.006%	0.9949	305.0	0.292%
Late Juvenile Stage	0.9956	80	0.004%			
Adult	0.9969	159	0.003%			
	0.000026	365		0.002917	365.0	

**northern anchovy**

1,000,000 larvae



2,391 age-1 fish\*

**goby species complex**

1,000,000 larvae

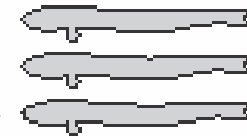
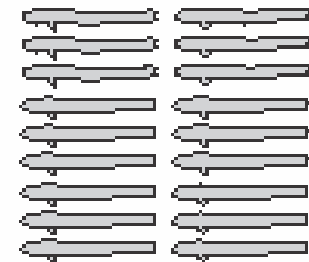
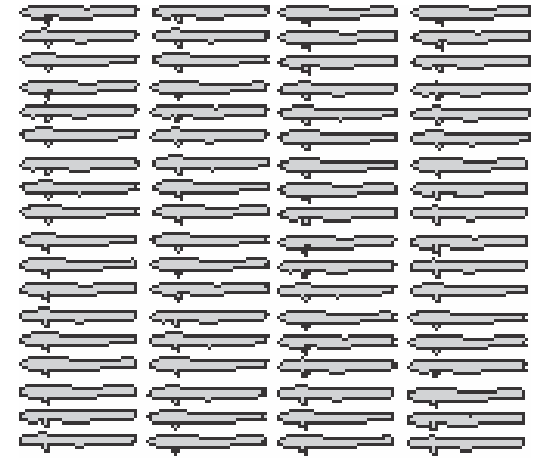


8,942 age-1 fish\*



Open Intake – 100% Entrainment

1,000,000 larvae



\* based on size-age distribution of larvae from entrainment studies in Santa Monica Bay



# Intake Screening Effectiveness

## 1.0 mm WWS Intake Effects for Northern Anchovy

Theoretical Entrainment of one million northern anchovy larvae based on head capsule dimensions\*

Age-1 Production      Larvae Protected

1,113 ←

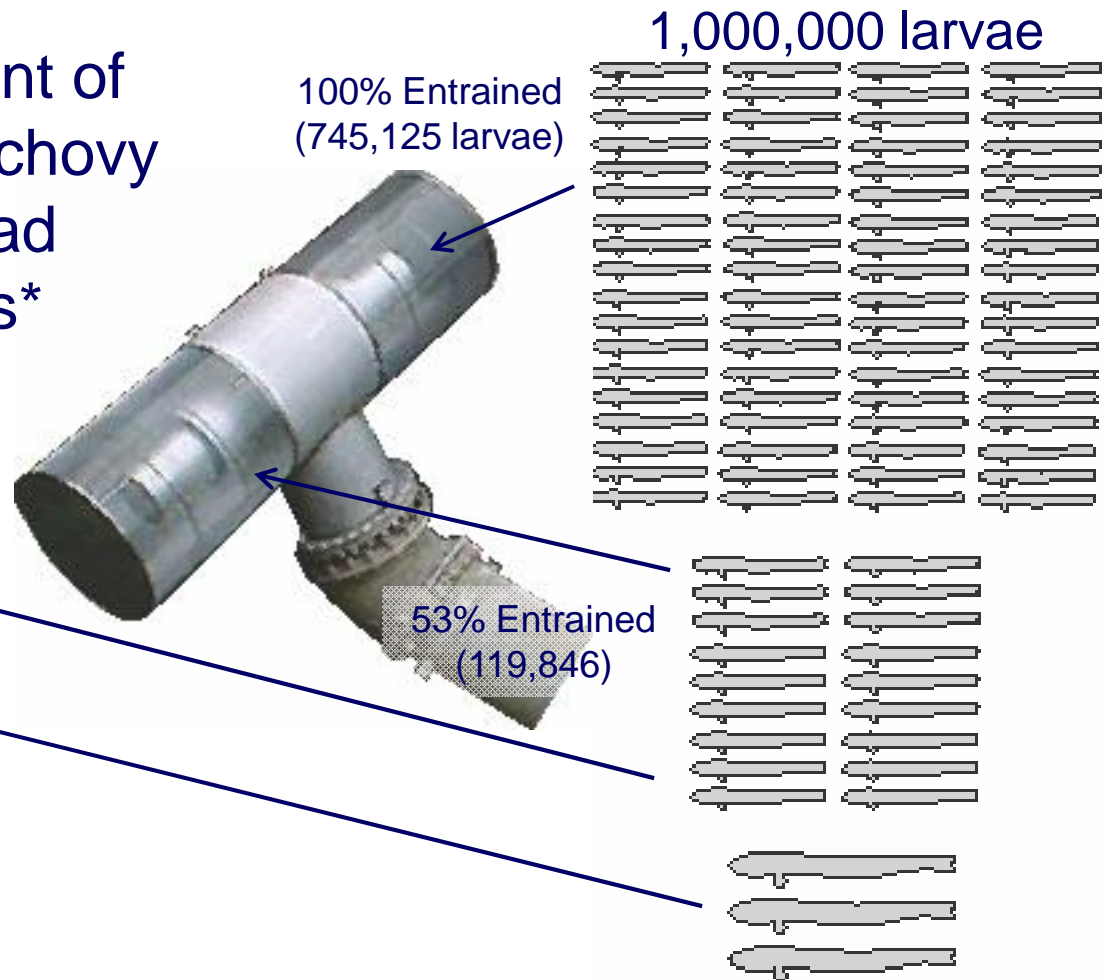
47% Not Entrained  
(104,388)

676 ←

100% Not Entrained  
(30,641)

**Protection of 75% of Age-1 Production**

13% of 1,000,000 Not Entrained

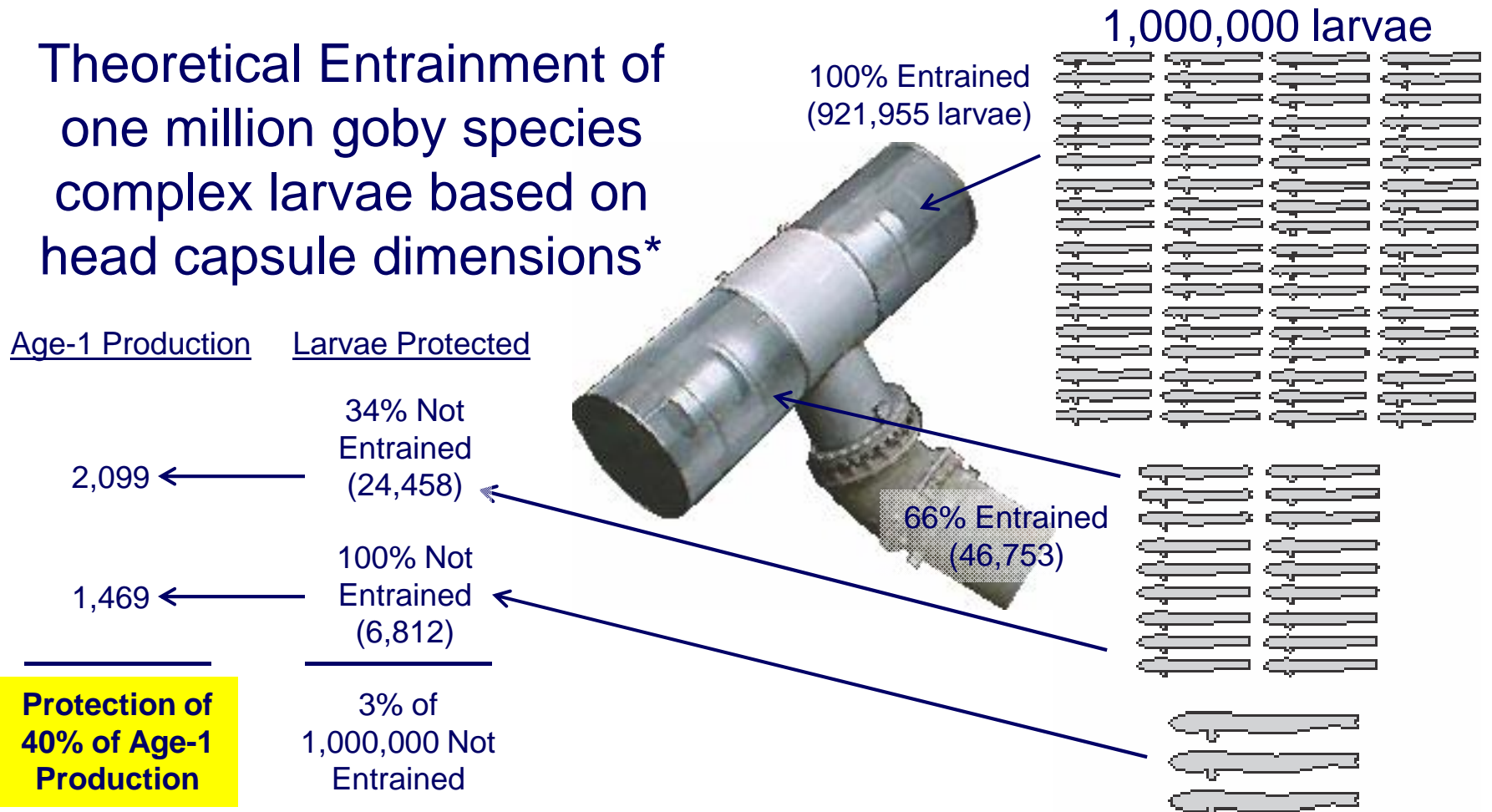


\*Estimates based on size-age distribution of larvae from entrainment studies in Santa Monica Bay

# Intake Screening Effectiveness

## 1.0 mm WWS Intake Effects for Goby Species Complex

Theoretical Entrainment of one million goby species complex larvae based on head capsule dimensions\*



\*Estimates based on size-age distribution of larvae from entrainment studies in Santa Monica Bay

# State of Science

## Intake Impacts

- Good to excellent temporal and spatial inventory of Southern California ichthyoplankton
- Completed and in-progress intake screen tests
- Proven models to assess entrainment effects on population sustainability and effectiveness of screens and operations to minimize effects

# Desalination Policy Development

First Principle: Choose Best Location, Design and Capacity

Feedwater Intake Policy

- Zero Impingement Effects

- Lowest Practicable Effects on Reproductive Adults

Brine Discharge Policy

- Site-specific narrative standard (e.g. protection of BIC, including ichthyoplankton)

- Low discharge plume turbulence

- Low Induced Turbidity

# Questions?

Dave Mayer  
Tenera Environmental  
dmayer@tenera.com  
(925) 962-9769