

Appendix D- Summary Tables of Entrainment Studies
Associated with the Draft Staff Report Including the Draft Substitute Environmental
Documentation for the Proposed Desalination Amendment

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Table D. Summary of studies measuring percent reduction in entrainment

Source	Velocity (m/s)	Screen Type	Species (life stage)	Organism length or diameter (mm)	% Reductions Slot Size (mm)				
					0.5	0.75	1	2	3
Bureau of Reclamation, 2007*	0.13	WW	Gizzard shad (eggs)	0.5	NSR				
			Gizzard shad (larvae)	4.2	NSR				
			Fathead minnow (eggs)	1.0	100				
			Smallmouth bass (larvae)	8.5	100				
			Blue catfish (eggs)	3.8	100				
			Blue catfish (larvae)	12.1	100				
ERPI, 2005a	0.15-0.3	WW	Grubby (larvae)	≤3 - ≥10	≥80		≥45		
			Sand lance (larvae)	4-6	≥80		NSR		
			Winter flounder (larvae)	4-6	≥44		NSR		
			Unidentified (eggs)	0.88	≥92		NSR		
ERPI, 2005b	0.15	WW	Shad spp. (larvae)	≤3 - ≥10	NSR		NSR		
			Freshwater drum (larvae)	≤3 - ≥10	NSR		NSR		
			Carp (larvae)	≤3 - ≥10	NSR		NSR		
			Temperate basses (larvae)	≤3 - ≥10	NSR		NSR		
			Eggs, (unidentified)	0.88	≥92		NSR		
	0.3	WW	Shad spp. (larvae)	≤3 - ≥10	NSR		NSR		
			Freshwater drum (larvae)	≤3 - ≥10	NSR		NSR		
			Carp (larvae)	≤3 - ≥10	NSR		54.3		
			Temperate basses (larvae)	≤3 - ≥10	NSR		NSR		
			Unidentified (eggs)	0.88	≥92		NSR		
Foster et al, 2012	NR	WW	Northern anchovies	8-19			74.8		
			Gobies	6-13			39.9		
Hanson, 1981		WW	Yellow perch	<8			NSR		
		WW	Yellow perch	13			100		
Tetratex, 2002	NR	FM	Fish (larvae)	NR	84				
TVA, 1976	NR	FM	Basses (larvae)	5.5-15.5	>99		>75		
Tenera, 2013a	NR	WW/ FM	Kelpfishes (larvae)	2-25		73.3	64.6	24.9	1.4
			Sculpins (larvae)	2-25		85.9	81.1	64.4	49.7
			Flatfishes (larvae)	1-25		78.8	72.8	51.5	33.0
			Monkeyface prickleback (larvae)	3-25		75.7	62.1	12.8	0.5
			Combtooth Blennies (larvae)	2-20		81.9	72.1	32.4	8.4
			Clingfishes (larvae)	2-20		83.0	75.8	48.8	26.9
			Anchovies (larvae)	2-25		55.4	45.1	5.5	0
			Croakers (larvae)	1-20		81.9	74.9	46.1	17.6
			Gobies (larvae)	1-25		74.6	66.5	35.7	8.3
			Silversides (larvae)	2-25		76.0	68.5	34.8	3.0
			Pacific barracuda (larvae)	1-20		68.2	53.1	15.8	4.4
			Rockfishes (larvae)	2-25		77.7	69.7	43.4	22.3
			Cabazon (larvae)	2-25		79.1	70.1	39.3	20.6
			Sea basses (larvae)	1-25		84.8	79.6	59.9	41.0
			Pricklebacks (larvae)	3-25			80.4	58.2	3.9
USEPA, 2011	NR	FM/TS	Fish (larvae)	NR	86				
			Fish (eggs)	NR	95				
USEPA, 2011	0.15	WW	Larvae/eggs	NR	84.7		13.8		
	0.3	WW	Larvae/eggs	NR	25		NSR		
USEPA, 2011	0.15	WW	Larvae/eggs	NR	83.7		14.9		
	0.3	WW	Larvae/eggs	NR	80.8		12.6		
USEPA, 2011	0.15	WW	Larvae	NR			93.6		
USEPA, 2011	NR	WW	Fish (larvae and juveniles)	NR			66	62.4	
Weisberg, 1987	0.2	WW	Bay Anchovy (eggs)	NR			NSR	NSR	NSR
			Bay Anchovy (larvae)	<4			NSR	NSR	NSR
			Bay Anchovy (larvae)	5-7			47.1	55.5	45.3
			Bay Anchovy (larvae)	8-10			87.2	77.8	66.2
			Naked goby (larvae)	<4			NSR	NSR	NSR
Naked goby (larvae)	7-8				97.3	79.3	77.5		

* Screen size is actually 0.6 mm NR – Not Recorded NSR – No Significant Reduction WW – Wedgewire screen s
 FM– Fine Mesh TS – Traveling Screen

Table D-2. Estimated percentage reductions in mortality (relative to an open intake) to the population surviving past the size where they would be subject to entrainment,¹ based on probabilities of screen entrainment for larvae from 15 taxonomic categories of fishes for six WWS slot widths. (Modified Table 4 from Tenera 2013)

Taxon	Size Range (mm)	Percentage Reduction in Entrainment ¹					
		0.75 mm	1 mm	2 mm	3 mm	4 mm	6 mm
kelpfishes	2–25	73.3	64.6	24.9	1.4	0.0	0.0
sculpins	2–25	85.9	81.1	64.4	49.7	36.0	14.1
flatfishes	1–25	78.8	72.8	51.5	33.0	18.8	4.6
monkeyface prickleback	3–25	75.7	62.1	12.8	0.5	0.0	0.0
combtooth blenny	2–20	81.9	72.1	32.4	8.4	1.5	0.0
clingfishes	2–20	83.0	75.8	48.8	26.9	13.1	2.6
anchovies	2–25	55.4	45.1	5.5	0.0	0.0	0.0
croakers	1–20	81.9	74.9	46.1	17.6	1.7	0.0
gobies	1–25	74.6	66.5	35.7	8.3	0.2	0.0
silversides	2–25	76.0	68.5	34.8	3.0	0.0	0.0
Pacific barracuda	1–20	68.2	53.1	15.8	4.4	1.3	0.1
rockfishes	2–25	77.7	69.7	43.4	22.3	10.6	2.4
cabezon	2–25	79.1	70.1	39.3	20.6	10.6	2.9
sea basses	1–25	84.8	79.6	59.9	41.0	22.7	0.1
pricklebacks	3–25	80.4	58.2	3.9	0.1	0.0	0.0
Average % Reduction in Entrainment		77.1	67.6	34.6	15.8	7.8	1.8

¹ - Extrapolated to the size at which the larvae are no longer susceptible to entrainment (estimated to be 20–25 mm [0.98 in] for this analysis).

Table D-3. Estimated total entrainment for seven taxonomic categories of fishes at DCPD for two year-long time periods: July 1997–June 1998 and July 1998–June 1999, and estimated entrainment and percentage reductions in entrainment for six WWS slot widths. (Modified Table 8 from Tenera 2013)

Taxon	Percent Reduction in Entrainment ¹					
	0.75 mm	1 mm	2 mm	3 mm	4 mm	6 mm
scuplins	10.7	2.9	0.1	<0.1	<0.1	0.0
rockfishes	15.1	4.3	<0.1	<0.1	<0.1	0.1
kelpfishes	18.4	4.6	0.2	<0.1	0.0	0.0
monkeyface prickleback	36.5	5.2	<0.1	<0.1	<0.1	0.0
anchovies	13.2	9.0	0.7	0.0	0.0	0.0
cabezón	28.1	7.0	<0.1	<0.1	0.0	0.0
flatfishes	6.9	3.7	<0.1	0.0	0.0	0.0
Average Percent Reduction in Entrainment	18.4	5.2	0.2	<0.1	<0.1	0.0

Table D-4. Estimated percentage reductions in mortality (relative to an open intake) to the population surviving past the size where they would be subject to entrainment,¹ based on probabilities of screen entrainment for larvae from seven taxonomic categories of fishes measured during DCPD entrainment studies conducted October 1996 through June 1999. Mortality adjusted from estimates in Table D-2 based on length range of larvae measured from the studies, except for anchovies. (Modified Table 9 from Tenera 2013)

Taxon	Percent Reduction in Entrainment ¹					
	0.75 mm	1 mm	2 mm	3 mm	4 mm	6 mm
scuplins	69.2	58.7	24.3	5.5	0.5	0.0
rockfishes	46.2	32.0	5.2	0.5	0.0	0.0
kelpfishes	72.1	63.0	21.8	0.8	0.0	0.0
monkeyface prickleback	62.8	42.2	0.9	0.0	0.0	0.0
anchovies ³	55.4	45.1	5.5	0.0	0.0	0.0
cabezón	36.3	19.0	0.6	0.0	0.0	0.0
flatfishes	34.1	17.7	0.2	0.0	0.0	0.0
Average Percent Reduction in Entrainment	53.7	39.7	8.4	1.0	0.1	0.0

¹ - Extrapolated to the size at which the larvae are no longer susceptible to entrainment (estimated to be 20–25 mm [0.98 in] for this analysis). Not the reduction in adult equivalents.

² - percentage reductions are the same as the values in Table D-2.