Report Supplement: Length-Specific Probabilities of Screen Entrainment of Larval Fishes Based on Head Capsule Measurements

(Incorporating NFPP Site-Specific Estimates)

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Introduction

The State policy on the use of ocean and estuarine waters for power plant cooling requires power plants in California that utilize once-through cooling (OTC) to evaluate and significantly reduce, as achievable, losses of larval fishes and other planktonic organisms due to entrainment.[1] One of the options under consideration at existing facilities is the use of fine-mesh screening systems that either use active 'collect-and-transfer' designs that collect the small organisms from the intake screens and return them alive to the source water body, or passive designs, such as wedgewire screens (WWS) that take advantage of induced currents to move organisms off and away from the screens. Critical to the implementation of any fish protection technology is the need for information that can be used in evaluating the feasibility and/or physical performance of the screens, including estimates of the potential reductions in entrainment for target organisms.

While laboratory (Amaral 2005) and field (Ehrler and Raifsnider 2000, Weisberg et al. 1987) studies have demonstrated that WWS have the potential to reduce entrainment of fish larvae, only preliminary testing has been completed at locations in California using species of fishes found along the west coast. While all of these studies demonstrated reduction in entrainment, Weisberg et al. (1987), in testing WWS with slot sizes of 1, 2, and 3 mm (0.04, 0.08, and 0.12 in.) were unable to detect any reductions in entrainment for smaller fish eggs and larvae, but did detect significant reductions for larger larvae. Modeling studies on the potential effectiveness of WWS at reducing entrainment of target species along the Hudson River have also been conducted (Dey 2005), but the estimated relationships between length and screen exclusion for the four screen slot widths evaluated were based on best professional judgment and not the actual morphology of the larvae. The results from these and other studies have all concluded that the exclusion efficiency of WWS is highly dependent on the size of the organisms being potentially entrained.

This report presents the results of a modeling study on the potential effectiveness of WWS at reducing entrainment of fish larvae for several taxonomic groups of fishes that have been collected in highest abundance during entrainment studies in California over the past 20 years. This study focuses on specific size classes of larvae as recommended by Weisberg et al. (1987) and is unique in using actual measurements of body morphology to estimate proportion of larvae by length that could be susceptible to entrainment. The estimates of the proportion entrained at each length are based on the length of the larvae and the corresponding width and depth of the head capsule. Although most of the body parts of fish larvae are soft and easily compressible at early stages of development when they are susceptible to entrainment, the head capsule has harder cartilage and bone that resists compression. Therefore, the smallest dimension (width or depth) of the head capsule can be used to model the minimum size larva that could pass through rectangular fine-mesh screens or WWS slot openings.

[1] http://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/

It is important to note that survival or viability of larvae that are not entrained, but become impinged on the surface of the screen is not assessed in this report. Our analysis provides estimates of proportional entrainment for WWS slot openings of 0.75, 1.0, 2.0, 3.0, 4.0, and 6.0 mm (0.03, 0.04, 0.08, 0.12, 0.16, and 0.24 in.) for each mm length class for larval fishes that were commonly collected from entrainment studies along the coast of California. The data were from entrainment studies that were included in Appendices E and F of the State Policy Final Substitute Environmental Document (California power plants once-through cooling entrainment and impingement estimates).

The results of the length specific estimates of proportional entrainment are also used to estimate reductions in entrainment for the Diablo Canyon Power Plant (DCPP) near Avila Beach, and the San Onofre Nuclear Generating Station[2] (SONGS) in San Clemente. The estimates for DCCP are more detailed as extensive data were available on both the taxonomic composition and the length distributions of the larvae collected during the entrainment study at the plant.

Background on WWS Testing

Testing of non-conventional screening systems, such as fine-mesh or WWS systems, at coastal intakes in California has been limited to pilot-scale studies related to desalination facilities, and small volume industrial and water system intakes. A list of installed systems for one of the major WWS suppliers, Hendrick Screen Company, provides the range of facilities with WWS intakes.[3] Most of the installations are in freshwater lakes and rivers, although there are intakes operating with WWS in San Francisco Bay.

The only operational coastal (Pacific west coast) intake equipped with WWS at this time is a pilot desalination plant constructed and operated by the West Basin Municipal Water District (WBMWD) in Redondo Beach. The pilot studies on the effectiveness of the WBMWD system expand on earlier pilot studies conducted in Santa Cruz for a planned desalination facility (Tenera 2010). The studies in Santa Cruz used a small WWS module supplied by Hendrick Screen Company with a slot width opening of 2 mm (0.08 in.). The diameter of the screen was 21.9 cm (8-5/8 in.), overall length was 88.9 cm (35 in.), and the outlet flange was 16.8 cm (6-5/8 in.) diameter (**Figure 1**). The size of the module was designed to provide a through-slot velocity of less than 15 cm per second (0.5 feet per second [fps]). The module was attached to pier pilings below the Santa Cruz Wharf at a depth of roughly 4.6–6.1 m (15–20 ft) depending on tidal height.

[2] As of June 2013 SONGS was no longer in operation and will be decommissioned without restarting.

[3] List available at http://www.hendrickscreenco.com/assets/docs/intakeinstall.xls

Figure 1. Wedgewire screen module used for Santa Cruz desalination plant pilot studies testing.

The primary goals of the Santa Cruz studies were to examine the effectiveness of the z-alloy material used in the construction of the screen module at reducing or eliminating fouling, and to examine the potential for small organisms and debris to become impinged on the screen. Although paired sampling from the WWS and an unscreened intake was done to examine the effectiveness of the screen at reducing entrainment, the sampling was only done once per month which resulted in considerable variation in the data due to changes in species composition and the size of larvae throughout the year. As a result, no statistical difference between the WWS and unscreened intake could be detected. Video cameras that were set to monitor the screen surface showed that the WWS was very effective at reducing or even eliminating impingement. The video data showed that any organisms, including fish larvae, or debris that settled or came in contact with the WWS surface were quickly swept from, or moved off, the screen. Results also showed that the z-alloy was very effective at minimizing any corrosion or fouling during the one-year study.

The studies at the WBMWD facility in Redondo Beach were expanded from the Santa Cruz studies to include testing of modules with larger overall dimensions (128 cm [50.4 in.] by 36 cm [14.3 in.] diameter) using both 1-mm (0.04 in.) and 2-mm (0.08 in.) slot openings (**Figures 2a** and **2b**). The screen modules were designed to have through-slot velocities of less than 15 cm per sec (0.5 fps). Similar to the studies at Santa Cruz, an underwater video system was used to quantify impingement on the screens. The video system was set up to capture images from a fixed area of the screen surface, allowing us to actually quantify the levels of impingement by area. The results from an analysis of the video showed that debris and organisms that came into contact with the screen surface were rapidly moved away due to strong ambient currents at the shallow depth (10.2 m [33.5 ft] MLLW) of the intakes. As a result, impingement was not observed on the video footage. There were numerous observations of larval fish recorded by the video showing larvae swimming away from and along the screen surface. Although there were also video data showing small larvae being entrained through the screen slots, there were no data showing larvae trapped against the screen surface. The report on the results from these studies is still being prepared (Tenera *in prep*).

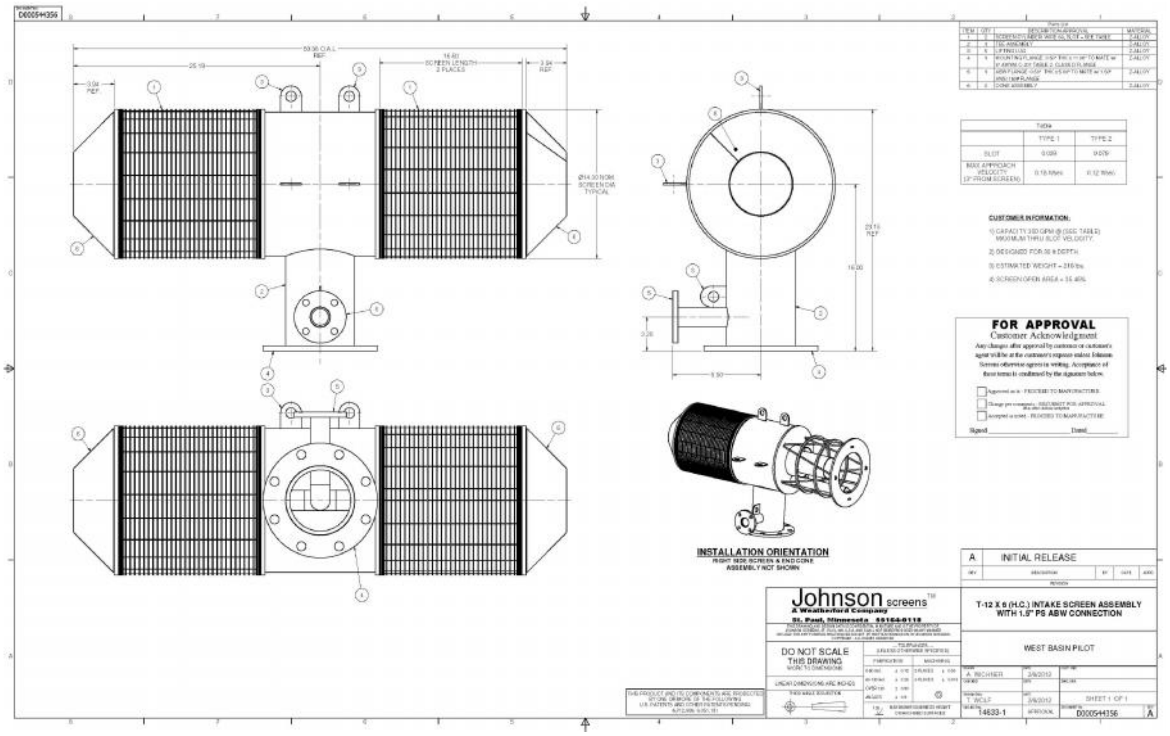
Previous Analyses of Larval Morphology

A study on the relationship between larval fish notochord length (NL) and the head capsule dimensions of depth (height) and width (**Figure 3**) was conducted by Tenera (2011). The larvae used in the study were collected during sampling near the intakes of eight power plants in central and southern California (**Table 1**). Larval NL and head capsule dimension measurements were collected for the 15 taxonomic groups shown in **Table 2**, which included single species such as monkeyface prickleback (*Cebidichthys violaceus*) and cabezon (*Scorpaenichthys marmoratus*), as well as broad taxonomic groups, such as rockfishes, that included several species. The body morphology among the taxonomic groups can vary considerably. For example, the jacksmelt (*Atherinopsis californiensis*) shown in **Figure 3** is relatively long and narrow, whereas the body shape for croakers is more laterally compressed with larger heads. Within each of these taxonomic groups the general morphology of the larvae are very similar and would be expected to have similar relationships between head capsule dimensions and NL. For example, although the hatch lengths of topsmelt (*Aterinops affinis*) (4 to 5 mm [0.16 to 0.20 in.]) and jacksmelt (6 to 9 mm [0.24 to 0.35 in.]) larvae are very different, the shape of the larvae are very similar and sometimes difficult to separate by species.

The number of specimens measured per taxon ranged from a high of 282 for anchovies to a low of 20 for Pacific barracuda (**Table 3**). Although the numbers measured were roughly proportional to the abundances of the target taxa in the selected entrainment samples, the range of lengths shown in **Table 3** does not necessarily correspond to the complete size range collected during the studies. However, the sample lengths chosen attempted to cover the range of lengths for each taxon to the greatest extent possible. For example, some larvae were damaged or contorted and lengths and head dimensions could not be measured for these larvae.

The analysis of the relationship between NL and the head capsule dimensions was done using nonlinear allometric regression analysis where head capsule dimension is a power function of NL. This type of regression model is used to describe proportional changes in body shape with growth (e.g., Fuiman 1983, Gisbert et al. 2002, and Pena and Dumas 2009). In addition to the assumptions that the allometric regressions accounted for any differences in the relationship between NL and head capsule dimensions among species within the taxonomic groupings, the analysis also assumes that any bias due to shrinkage from preservation did not affect the relationship between NL and the head capsule dimensions. Theilacker (1980) showed that shrinkage was relatively constant across the range of lengths of northern anchovy larvae used in his study. It is notable that Theilacker (1980) also used allometric regression in her analysis of changes in larval morphology. The results of the allometric regression analyses from Tenera (2011) are provided in **Appendix A** of this report (**Figures A1–A15**).

a)



b)

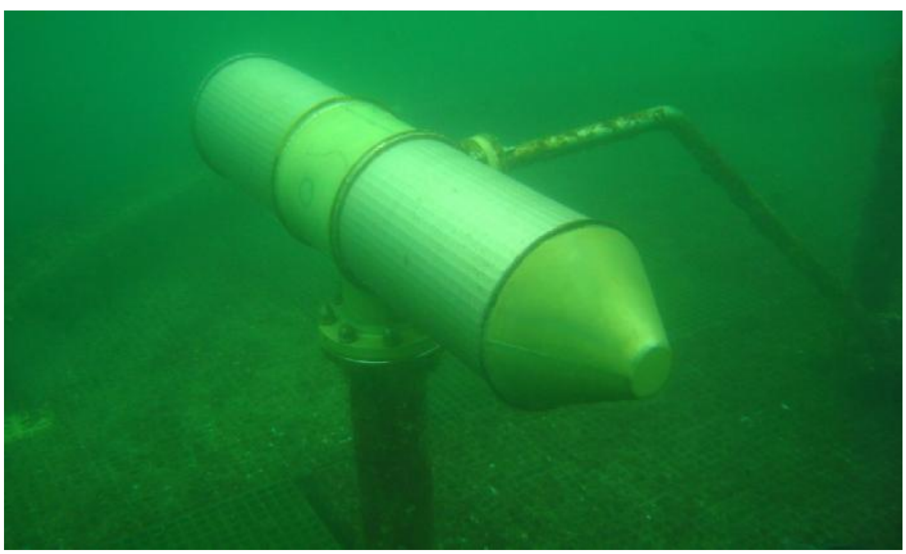


Figure 2. Figures showing a) generalized technical diagram for 1-mm and 2-mm screen modules, and b) underwater photo of wedgewire screen module used during the West Basin Municipal Water District pilot desalination study in Redondo Beach.

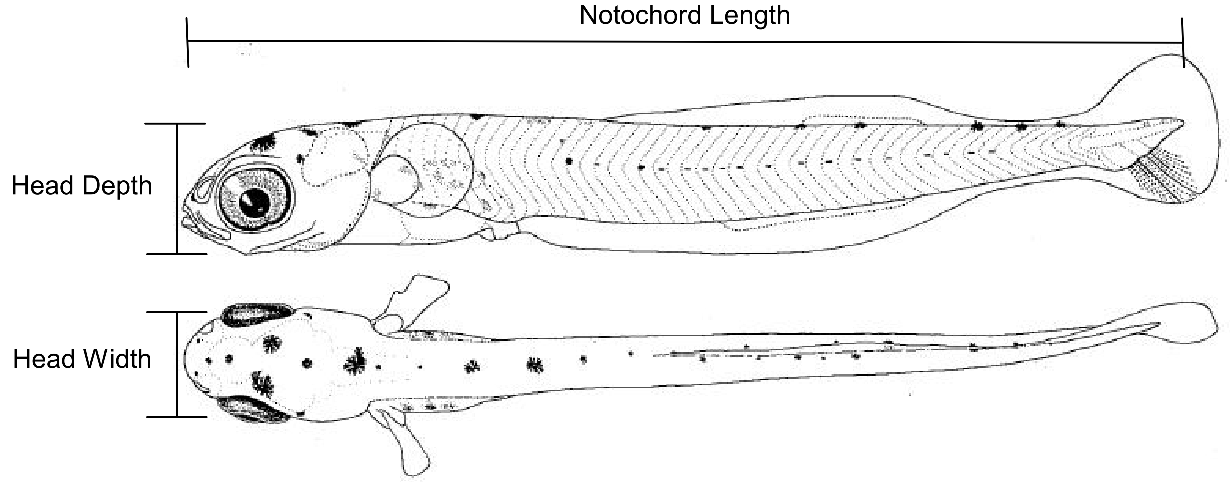


Figure 3. Illustration of the measurement locations for notochord length and head depth (height) and width of a preflexion stage larval fish. Diagram is a 9.9 mm (0.39 in.) notochord length (NL) jacksmelt larva from Moser (1996) and is not necessarily representative of larval morphologies for other taxonomic groups.

Table 1. Location of power plants and the years during which larval fish were collected during entrainment sampling.

Power Plant	Owner (present)	Intake Latitude	Intake Longitude	Sample Period
Moss Landing	Dynegy Inc.	36° 48.292' N	121° 47.130' W	1999–2000
Diablo Canyon	Pacific Gas and Electric Co.	35° 12.456' N	120° 51.407' W	1996–1999
Scattergood	LADWP	33° 54.985' N	118° 26.106' W	2006–2007
El Segundo	El Segundo Power, LLC	33° 54.433' N	118° 26.031' W	2006–2007
Redondo	AES Southland, LLC	33° 50.409' N	118° 23.718' W	2006–2007
Haynes	LADWP	33° 45.121' N	118° 06.556' W	2006–2007
Harbor	LADWP	33° 45.932' N	118° 15.790' W	2006–2007
South Bay	Dynegy Inc.	32° 36.869' N	117° 05.942' W	2001–2003

Table 2. Species and generic taxa included in the 15 taxonomic groupings measured for notochord length (NL) and head capsule dimensions.

Taxonomic Group	Scientific Names	Common Names
kelpfishes	*Gibbonsia elegans*	spotted kelpfish
	Gibbonsia montereyensis	crevice kelpfish
	Gibbonsia erythra	scarlet kelpfish
sculpins	*Artedius* spp.	artedius sculpins (6 species)
	Orthonopias triacis	snubnbose sculpin
flatfishes	*Paralichthys californicus*	California halibut
	Citharichthys stigmaeus	speckled sanddab
	Citharichthys sordidus	Pacific sanddab
	Platichthys stellatus	starry flounder
monkeyface prickleback	*Cebidichthys violaceus*	monkeyface prickleback
combtooth blennies	*Hypsoblennius gentilis*	bay blenny
	Hypsoblennius gilberti	rockpool blenny
	Hypsoblennius jenkinsi	mussel blenny
clingfish	*Gobiesox* spp.	clingfishes (4 species)
anchovies	*Engraulis mordax*	northern anchovy
	Anchoa spp	bay anchovies (2 species)
croakers	*Seriphus politus*	queenfish
	Genyonemus lineatus	white croaker
gobies	*Lepidogobius lepidus*	bay goby
	Acanthogobius flavimanus	yellowfin goby
	Clevelandia ios *Ilypnus gilberti* *Quietula y-cauda*	CIQ goby complex
silversides	*Leuristhes tenuis*	California grunion
	Atherinopsis californiensis	jacksmelt
	Atherinops affinis	topsmelt
Pacific barracuda	*Sphyraena argentea*	California barracuda
rockfishes	*Sebastes* spp.	scorpionfishes (approximately 57 species)
cabezon	*Scorpaenichthys marmoratus*	cabezon
sea basses	*Paralabrax clathratus*	kelp bass
	Paralabrax nebulifer	sand bass
	Paralabrax maculatofasciatus	spotted sand bass
pricklebacks	Stichaeidae	pricklebacks (approximately 11 species)

Table 3. Summary statistics (mean, maximum, minimum, and median dimensions) and standard deviations describing the sample composition of each taxon used in the analysis.

		Notochord Length (NL) (mm)					Head Depth (mm)					Head Width (mm)				
Common Name	N	Mean	Max	Min	Median	Std. Dev.	Mean	Max	Min	Median	Std. Dev.	Mean	Max	Min	Median	Std. Dev.
kelpfishes	75	10.40	25.91	3.46	10.22	4.927	1.18	4.36	0.47	1.03	0.676	1.09	3.23	0.45	0.98	0.508
sculpins	84	5.77	11.05	2.48	5.33	2.200	1.13	2.78	0.41	0.94	0.577	1.04	2.95	0.43	0.87	0.575
flatfishes	51	4.07	7.51	1.54	4.00	1.516	0.85	2.83	0.18	0.65	0.606	0.51	1.33	0.17	0.49	0.255
monkeyface prickleback	55	10.41	17.65	4.86	10.40	3.120	1.09	2.01	0.65	1.06	0.316	0.97	1.64	0.50	0.93	0.280
combtooth blennies	42	2.54	4.31	1.87	2.25	0.658	0.49	1.10	0.35	0.44	0.144	0.42	0.89	0.32	0.39	0.115
clingfishes	37	4.59	6.76	2.87	4.42	1.090	0.81	1.49	0.51	0.72	0.241	0.82	1.55	0.51	0.70	0.274
anchovies	282	14.10	31.01	1.51	14.23	8.196	1.15	3.49	0.15	0.95	0.815	1.16	3.10	0.19	1.13	0.672
croakers	167	5.18	14.87	1.23	4.18	3.591	1.29	4.31	0.15	0.89	1.034	0.94	3.21	0.20	0.73	0.691
gobies	204	7.88	22.14	1.90	6.46	4.977	1.04	3.44	0.31	0.78	0.688	0.92	3.90	0.25	0.71	0.630
silversides	221	12.28	31.07	3.63	11.01	5.768	1.54	4.37	0.34	1.14	0.953	1.42	3.70	0.35	1.15	0.710
Pacific barracuda	20	2.61	4.22	1.66	2.70	0.618	0.52	1.07	0.24	0.50	0.231	0.42	0.58	0.26	0.41	0.100
rockfishes	25	4.16	6.57	2.71	4.01	0.773	0.69	1.23	0.52	0.68	0.139	0.52	1.02	0.33	0.46	0.148
cabezon	33	5.30	6.40	3.58	5.16	0.854	0.79	1.15	0.55	0.80	0.156	0.70	0.95	0.51	0.73	0.142
sea basses	34	2.34	9.47	1.23	1.77	2.009	0.44	2.29	0.19	0.27	0.535	0.40	1.83	0.20	0.28	0.389
pricklebacks	48	10.08	16.39	5.83	9.55	2.989	1.02	1.85	0.58	0.98	0.241	0.99	1.59	0.62	1.00	0.196

Methods

Entrainment Reduction Estimates

The parameter estimates and their standard errors from the allometric regressions in Tenera (2011) representing the relationship between head capsule dimensions and NL for the 15 taxonomic groups in **Table 2** were used to estimate the proportion of larvae potentially subject to entrainment at each mm NL increment. This approach assumes that individuals with head capsules larger than a specific screen mesh size would be excluded from entrainment, even if the approach vector was perpendicular (head-on) to the screen. It is likely that larvae do not contact the WWS surface head on and therefore the proportions excluded from entrainment are likely to be much greater than the estimated proportions, but this approach provides an estimate of the largest proportion potentially entrained at each mm NL increment. This assumption requires that the WWS be properly designed to maintain a through-slot velocity of 0.15 m per sec (0.5 fps) or less to ensure that larvae are not pulled through the screen slots.

This approach also assumes that any bias due to shrinkage from preservation did not affect the relationship between head capsule dimensions and NL. The relative constant ratio of shrinkage in larval length across the range of lengths used in a study by Theilacker (1980) indicates that any effects of shrinkage would not affect the results of the allometric regressions. Theilacker (1980) also measured shrinkage in head lengths which was similar to the reductions in body length, further indicating that this should not affect the results of the analysis based on measurements of head depth and width. Length-specific entrainment for the taxa shown in **Table 2** was calculated for WWS slot openings of 0.75, 1.0, 2.0, 3.0, 4.0, and 6.0 mm (0.03, 0.04, 0.08, 0.12, 0.16, and 0.24 in.). The results could also be used in determining the theoretical performance of screens with rectangular screen mesh, but would need to be adjusted to provide estimates for screens with square mesh openings.

The proportion of larvae entrained at each mm NL increment for the six slot widths were estimated using the variability (standard errors) around the estimated head capsule width and depth at each mm NL using the allometric regressions from the analysis in Tenera (2011) (**Table 4**). To account for the effects of variation on head capsule dimension at each length, 10,000 estimates of head width and head depth for each mm NL (from a minimum up to a maximum NL determined for the taxon) were computer-generated using the estimated standard errors for each regression parameter. Errors were assumed to be normally distributed. For each mm NL, the proportion of larvae potentially subject to entrainment was determined as the proportion of the 10,000 values that were less than the selected WWS slot size, with the final estimate being the larger value of either the head width or the head depth. The 10,000 estimates were calculated 1,000 times using randomly selected values within ±0.5 mm of each length. Although the summary statistics on the head capsule dimensions show that the average head depth is greater than head width for all 15 taxa groups (**Table 3**), the multiple randomizations provided estimates that covered the wide range of variation in the regressions for some of the taxa. For example, although the average head depth is slightly greater than the head width for sculpins (**Table 3**), the multiple randomizations accounted for the wide range of variation and overlap among the values for head depth and width shown in the regression (**Figure A2**). The average proportion and standard error were calculated from the 1,000 estimates calculated for each mm NL increment.

The proportions were calculated over a range of larval lengths that approximately corresponded to the range that would be potentially entrainable. The minimum lengths for the taxa were based on the smallest larvae measured from the studies (**Table 3**). The maximum was set at either 20 or 25 mm NL depending on the fish taxon. While a few larvae larger than 20–25 mm were collected during the sampling, larger larvae have characteristics (e.g., presence of head and opercular spines) that would likely bias entrainment probabilities based only on larval head capsule measurements. Fishes at this size also have swimming abilities that may allow them to avoid entrainment, especially at reduced intake velocities that could be used at plants retrofitting with fine-mesh screens or WWS.

The proportional entrainment across the size range of entrainable larvae for a taxon can be used to assess the effects on population mortality for a particular WWS slot dimension using the following two simple assumptions: 1) linear growth over time, and 2) constant exponential natural mortality. These assumptions are reasonable because the time period being evaluated is likely to be very short. The time period may only be a few days for fishes that are only subject to entrainment over a narrow size range, but would likely never extend beyond one or two months. By assuming linear growth during this narrow time period, length becomes directly proportional to age. As a larval cohort subsequently progresses through consecutive length classes it continues to decrease in numbers over time due to natural mortality. Under these assumptions, each length class (or age class), including the larvae susceptible to entrainment, results in an identical number of fishes at a later time and size where they are not subject to entrainment. This is because the numbers at each length (or age) class G that survive are directly proportional to the reduced population size at some later time, N_t, where:

$$N_t = N_0 S_{0\to G} S_G S_{G\to t}$$

where S is survival over indicated time period, $N_0 S_{0\to G} S_G$ are the numbers of length (age) class G surviving entrainment and N_0 is the initial cohort size.

For example, assuming a constant daily survival rate of 93 percent, and a constant growth rate of 0.33 mm (0.01 in.) per day, 100 million zero age larvae with a hatch length of 1.2 mm (0.05 in.) would produce approximately 1.6 million 20 mm NL larvae, the same number of 20 mm larvae produced by every mm length increment up to that length. Therefore, the proportional losses due to entrainment at each NL increment have an equivalent effect on the losses to the population. The total percentage reduction for each screen mesh dimension can be made by summing the proportional entrainment estimates at each mm NL increment, and dividing by the number of estimates. The subtraction of this value from one is an estimate of the reduction in mortality for the total cohort of larvae that would survive to the length or age when they are no longer subject to entrainment. The average reduction in mortality would need to be adjusted for the composition and size structure of the fish larvae for a specific location and sample year, but otherwise provides an estimate of population-level mortality extrapolated to the length or age at which the fish are no longer subject to entrainment (estimated to be 20–25 mm [0.79–0.98 in.] for this analysis).

Table 4. Allometric regression parameter statistics ($y = ax^b$) and standard errors describing the sample composition of each taxon used in the analysis, where x = notochord length (mm).

	Y Variable: Head Depth (Height)				Y Variable: Head Width			
Taxon	**a**	**SE(a)**	**b**	**SE(b)**	**a**	**SE(a)**	**b**	**SE(b)**
kelpfishes	0.0541	0.0079	1.2856	0.0533	0.0998	0.0091	1.0137	0.0344
sculpins	0.1237	0.0178	1.2479	0.0713	0.0877	0.0158	1.3810	0.0881
flatfishes	0.0502	0.0146	1.9182	0.1669	0.0824	0.0125	1.2811	0.0912
monkeyface prickleback	0.1422	0.0214	0.8724	0.0610	0.1199	0.0156	0.8927	0.0529
combtooth blennies	0.1833	0.0160	1.0427	0.0814	0.1777	0.0166	0.9231	0.0884
clingfishes	0.1475	0.0266	1.1139	0.1105	0.1281	0.0293	1.2111	0.1398
anchovies	0.0215	0.0023	1.4524	0.0342	0.0776	0.0046	1.0167	0.0195
croakers	0.2094	0.0129	1.0979	0.0276	0.1894	0.0148	0.9783	0.0356
gobies	0.1100	0.0073	1.0735	0.0258	0.0890	0.0068	1.1123	0.0297
silversides	0.0588	0.0035	1.2880	0.0206	0.1006	0.0038	1.0531	0.0135
Pacific barracuda	0.1216	0.0347	1.5004	0.2581	0.2057	0.0330	0.7505	0.1545
rockfishes	0.1867	0.0359	0.9164	0.1298	0.0936	0.0271	1.1971	0.1929
cabezon	0.1615	0.0417	0.9504	0.1511	0.1085	0.0231	1.1183	0.1240
sea basses	0.1468	0.0094	1.2305	0.0317	0.1516	0.0054	1.0968	0.0184
pricklebacks	0.2809	0.0561	0.5623	0.0839	0.3506	0.0599	0.4534	0.0723

Calculation of Site-Specific Estimates for DCPP and SONGS

The differences in the sampling frequency at DCPP and SONGS required that different approaches be taken when estimating the potential entrainment reductions resulting from different mesh or WWS slot openings at the two plants. The data for the analyses previously described were derived from larvae sampled from several sites over several years. This was done to ensure that the estimates covered the full length range of entrainable larvae, since most studies, including the study at SONGS, only sampled monthly or biweekly. An exception was the sampling for the entrainment studies at DCPP which started in October 1996 and continued through June 1999 was conducted weekly at four stations in front of the intake structure. The sampling also occurred every three hours resulting in the collection of over 4,600 plankton samples. Many of the larvae collected from the entrainment samples were measured, resulting in a large number of NL measurements for certain taxa that are likely representative of the complete size ranges of larvae entrained at the plant. At DCPP, the large amount of data allows for a site-specific approach for calculating screening efficiency, whereas the estimates for SONGS should be based on the database derived from multiple sites. This difference in approaches is also appropriate since the taxonomic composition of the data collected at SONGS was similar to the data from other plants in southern California, whereas the composition at DCPP was different due to its location north of Point Conception in central California.

Even with the large sample sizes at DCPP, only the most abundant larvae were measured, therefore, detailed length-specific entrainment adjustments were only calculated for seven of the entrained taxonomic categories of fishes. For these seven taxa, the percentages of larvae at each mm NL from the length frequency distribution of the larvae collected at DCPP were used with the annual entrainment estimates for the same taxon to estimate the numbers entrained by length category. The estimates of the proportional entrainment for the six mesh or slot openings were then used to determine the reductions in entrainment for each taxon. The estimated population-level reductions for these taxa, assuming constant growth and survival rates to the length or age at which the fish are no longer subject to entrainment were adjusted for the range of sizes of larvae collected.

Results

Individual Taxa

The statistics and parameters resulting from the allometric regressions of head capsule dimensions as a function of NL from Tenera (2011) shown in **Table 4** (dispersion plots of the data for each taxon from Tenera [2011] are shown in **Appendix A**) were used to calculate the proportional entrainment estimates through six WWS slot openings for the 15 larval taxa shown in **Appendix B**. The data used in the regressions (**Table 3** and **Figures A1–A15**) encompassed the entire length range of the estimates in **Appendix B** for taxa such as kelpfishes (**Figure A1** and **Table B1**), monkeyface pricklebacks (**Figure A4** and **Table B4**), anchovies (**Figure A7** and **Table B7**), croakers (**Figure A8** and **Table B8**), and gobies (**Figure A9** and **Table B9**), but covered only a limited range of the estimates for other taxa such as combtooth blennies (**Figure A5** and **Table B5**), clingfishes (**Figure A6** and **Table B6**), rockfishes (**Figure A12** and **Table B12**), and cabezon (**Figure A13** and **Table B13**). The NL range measured for fishes such as combtooth blennies does reflect actual entrainment results from several studies showing that the larvae for this taxonomic group are only collected when they are small, typically less than 5 mm (0.20 in.). Therefore, any use of the estimated proportions entrained for larvae larger than the maximum value shown in **Table 3** should consider the level of uncertainty associated with these extrapolated values. This should not normally be a problem as the length ranges in **Table 3** are reflective of the length range of larvae collected from studies in California. Also, in practice, the estimated proportional entrainment at each mm NL increment would be applied to a set of site-specific data to obtain estimates for a particular plant as is done below for DCPP.

Extrapolated Population-Level Efficiency

The estimates of proportional entrainment at each mm NL increment for the six WWS slot openings in **Appendix B** were used to estimate the reductions in mortality for the population surviving past the size when the larvae would be subject to entrainment (**Table 5**). The estimates were extrapolated to the total population when the larvae are at a NL of 20 or 25 mm (0.79 or 0.98 in); a size when the larvae are likely to not be susceptible to entrainment due to maturing musculature and increased swimming ability. Although, population-level reductions in mortality were estimated based on a NL of 20 or 25 mm (0.79 or 0.98 in), the summary of the length data on larvae from the entrainment studies indicates that larvae for many of the taxonomic groups are not entrained at larger sizes (**Table 3**). As a result, the entrainment for larger larvae is essentially zero for these taxa. For example, if the results for combtooth blennies (**Table B5**) were adjusted based on the length distribution of the entrained larvae, the estimate of the population-level effects of the smaller 0.75 and 1 mm (0.03 and 0.04 in.) WWS slot openings would increase since all of the proportions past a size of 5 or 6 mm (0.20 or 0.24 in.) would not be included in the calculations. Conversely, there would be no population-level benefits to the other larger slot openings as all of the larvae smaller than 6 mm (0.24 in.) are entrained. As a result, it is important to adjust estimates of proportional entrainment based on the composition and size structure of the fish larvae for a specific location and sample year to provide estimates of population-level reductions in mortality, as is done for DCPP below.

Estimated Effectiveness at DCPP and SONGS

The results for the individual taxa in **Appendix B** were used to estimate reductions in entrainment for the six WWS slot sizes for each of the 15 taxa that were collected during sampling at DCPP and SONGS, the two nuclear-fueled facilities in California. As mentioned previously, the methods used to estimate the reductions for the two facilities are different due to the taxonomic composition and data available from the studies, and, therefore, are presented separately.

DCPP

Entrainment sampling at DCPP was conducted from October 1996 through June 1999. Results for the fishes analyzed for this study are from two consecutive 12-month periods, and emphasizes the considerable annual variation that can occur in composition and abundance between periods (**Table 6**). The difference between periods was likely attributable to the occurrence of a major El Niño that started developing in late 1997 and extended into 1998, which affected reproduction and larval survival during the 1998 spawning season. The fishes analyzed for this study accounted for approximately 72 and 69 percent, respectively, of the total estimated larvae from the two periods (**Table 6)**.

Table 5. Estimated percentage reductions (two standard errors in parentheses) in mortality (relative to an open intake) to the population surviving past the size when 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.

Taxon	Size Range	Percentage Reduction in Mortality by Slot Opening Width [1]					
		0.75 mm	1 mm	2 mm	3 mm	4 mm	6 mm
kelpfishes	2–25 mm	73.3 (2.4)	64.6 (2.4)	24.9 (2.4)	1.4 (0.5)	0.0 (0.0)	0.0 (0.0)
sculpins	2–25 mm	85.9 (2.5)	81.1 (2.4)	64.4 (2.4)	49.7 (2.4)	36.0 (2.4)	14.1 (1.7)
flatfishes	1–25 mm	78.8 (2.3)	72.8 (2.3)	51.5 (2.3)	33.0 (2.2)	18.8 (1.8)	4.6 (0.8)
monkeyface prickleback	3–25 mm	75.7 (2.6)	62.1 (2.5)	12.8 (1.6)	0.5 (0.2)	0.0 (0.0)	0.0 (0.0)
combtooth blenny	2–20 mm	81.9 (3.1)	72.1 (3.1)	32.4 (2.8)	8.4 (1.4)	1.5 (0.4)	0.0 (0.0)
clingfishes	2–20 mm	83.0 (3.1)	75.8 (3.1)	48.8 (3.0)	26.9 (2.5)	13.1 (1.7)	2.6 (0.6)
anchovies	2–25 mm	55.4 (2.3)	45.1 (2.3)	5.5 (1.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
croakers	1–20 mm	81.9 (3.0)	74.9 (3.0)	46.1 (2.9)	17.6 (2.7)	1.7 (0.7)	0.0 (0.0)
gobies	1–25 mm	74.6 (2.3)	66.5 (2.3)	35.7 (2.3)	8.3 (1.7)	0.2 (0.1)	0.0 (0.0)
silversides	2–25 mm	76.0 (2.5)	68.5 (2.5)	34.8 (2.4)	3.0 (1.5)	0.0 (0.0)	0.0 (0.0)
Pacific barracuda	1–20 mm	68.2 (2.9)	53.1 (2.8)	15.8 (1.5)	4.4 (0.6)	1.3 (0.2)	0.1 (0.0)
rockfishes	2–25 mm	77.7 (2.5)	69.7 (2.5)	43.4 (2.2)	22.3 (1.7)	10.6 (1.0)	2.4 (0.4)
cabezon	2–25 mm	79.1 (2.5)	70.1 (2.5)	39.3 (2.1)	20.6 (1.5)	10.6 (1.0)	2.9 (0.4)
sea basses	1–25 mm	84.8 (2.4)	79.6 (2.2)	59.9 (2.4)	41.0 (2.3)	22.7 (2.3)	0.1 (0.1)
pricklebacks	3–25 mm	80.4 (2.6)	58.2 (2.5)	3.9 (0.5)	0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Average % Reduction		**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).

Sculpins were the most abundant fish larvae collected during the July 1997 through June 1998 period, comprising 18.3 percent of the total by concentration, while rockfishes were the most abundant during the July 1998 through June 1999 period, comprising 22.6 percent of the total by concentration. The fishes analyzed for this report comprised 72 and 69 percent of the total by concentration for the two periods, respectively.

Length measurements for several of the most abundant taxa of fish larvae were recorded during the DCPP studies. The data for several of the taxa were combined across taxonomic categories to match the taxa groups analyzed for this study. For example, the data for flatfishes combine length measurements on species and generic groupings of sanddabs with California halibut, English sole, and family-level groups such as Pleuronectidae, and the data for rockfishes are combined across species and species groupings that are distinguished based on larval morphology. The summary of the data in **Table 7** shows that for all of the taxa except anchovies, almost all of the larvae (99th percentile) were much smaller than the range of lengths shown in Appendix **Tables B1–B15**. For example, the largest rockfish and cabezon larvae measured were only 10.2 (0.40 in.) and 8.4 mm (0.33 in.), respectively. The length frequency distribution of the larvae for these taxa show that for sculpins, rockfishes, cabezon, and flatfishes, over 90% of the larvae were 6 mm (0.24 in.) or less (**Table 7**).

Table 6. Average concentrations of fish larvae collected during entrainment sampling and annual entrainment estimates at DCPP for two year-long study periods: **July 1997–June 1998** and **July 1998–June 1999**. The annual entrainment estimates were based on actual plant cooling water volumes during the periods.

	1997–1998			1998–1999		
Common Name	Average Concentration (# / 1,000 m^3)	Percent of Total Concentration	Total Annual Entrainment Estimate	Average Concentration (# / 1,000 m^3)	Percent of Total Concentration	Total Annual Entrainment Estimate
sculpins	80.57	18.3%	281,090,063	55.17	18.9%	276,345,912
rockfishes	65.27	14.8%	216,878,458	66.06	22.6%	374,596,029
kelpfishes	36.88	8.4%	121,977,076	23.36	8.0%	90,774,143
monkeyface prickleback	32.61	7.4%	118,960,221	24.30	8.3%	127,721,405
northern anchovy	31.02	7.0%	106,375,289	1.27	0.4%	3,209,133
gobies	22.45	5.1%	77,134,182	6.77	2.3%	22,413,173
croakers	18.03	4.1%	67,033,233	4.89	1.7%	21,431,357
flatfishes	12.11	2.8%	45,128,059	5.22	1.8%	19,245,735
pricklebacks	9.52	2.2%	35,579,099	5.76	2.0%	33,382,111
cabezon	3.90	0.9%	14,707,340	1.83	0.6%	9,189,686
clingfishes	0.28	0.1%	989,753	1.13	0.4%	4,728,863
combtooth blennies	2.03	0.5%	7,154,897	4.43	1.5%	10,673,514
silversides	0.18	0.0%	482,917	0.08	0.0%	97,072
sea basses	0.02	0.0%	64,552	0.00	0.0%	-
Subtotal	**314.87**	**71.6%**	**1,093,555,139**	**200.24**	**68.6%**	**993,808,134**
Other Taxa (54 and 40)	125.19	28.4%	422,730,243	91.86	31.4%	292,431,756
Total	**440.06**		**1,516,285,382**	**292.10**		**1,286,239,890**

Table 7. Summary of notochord length (NL) measurements for seven taxa of larval fishes collected during entrainment sampling at DCPP from October 1996 through June 1999.Only fishes up to 25 mm (0.98 in) NL length were included in the analysis.

Taxon	N	Mean Length (mm)	Standard Deviation	Upper 95% Confidence Interval (mm)	Minimum Length (mm)	Maximum Length (mm)	Median Length (mm)	99th Percentile Length (mm)
sculpins	10,173	3.5	0.7	3.5	1.6	11.8	3.3	6.1
rockfishes	13,105	4.1	0.5	4.1	1.7	10.2	4.1	5.3
kelpfishes	7,331	6.4	1.7	6.4	2.4	23.4	6.0	12.0
monkeyface prickleback	5,909	7.3	1.2	7.4	2.8	24.6	7.0	12.0
anchovies	2,527	6.0	4.9	6.1	1.6	25.4	3.7	23.4
cabezon	1,537	4.8	0.5	4.8	2.3	8.4	4.7	6.1
flatfishes	394	3.0	1.3	3.1	1.3	8.0	2.7	7.7

The estimated percentages of larvae for each mm NL increment (**Table 8**) were used to calculate the entrainment for each length based on the total annual entrainment estimates for the two periods shown in **Table 9**. The estimates of proportional entrainment for the corresponding mm NL increments provided for the seven taxa in **Appendix B** were then used to calculate estimates of entrainment for the six WWS slot openings, also shown in **Table 9**. The results show that based on the number of larvae excluded across all length categories there would be very little reduction in total entrainment for all but the smallest slot widths relative to the total estimated entrainment for the two periods.

The estimated entrainment reductions in **Table 9** for total larvae across all size classes, incorporates the length frequency distribution of the larvae at DCPP. The estimated population-level reductions in entrainment mortality in **Table 4** were calculated across all the NL increments up to the maximum lengths of 20 or 25 mm (0.79 or 0.98 in), and therefore, does not incorporate the DCPP length frequency data showing that some fishes are not subject to entrainment at larger sizes (**Table 7**). As a result, the effective population-level reductions for the six slot openings based on the length range of the larvae in **Table 6** were used to recalculate the population-level reductions shown in **Table 10**. While these estimates are larger than the reductions based on the actual reductions in entrainment by slot width in **Table 9**, they are less than the estimates in **Table 4**, which assumed entrainment occurred up to a NL of 20 or 25 mm (0.79 or 0.98 in). The results show very little benefit of screen or slot openings larger than 2 mm (0.08 in) for these fishes. The results in **Table 10** for anchovies are identical to the estimates in **Table 4** because, as shown in **Table 8**, the larvae for that taxon were entrained across the same range of lengths used in the generalized analysis.

Table 8. Distribution of notochord length (NL) measurements by number and percentage (in parentheses) for seven taxa of larval fishes collected during entrainment sampling at DCPP from October 1996 through June 1999. Only fishes up to 25 mm (0.98 in) NL were included in the analysis.

Notochord Length (mm)	sculpins	rockfishes	kelpfishes	monkeyface prickleback	anchovies	cabezon	flatfishes
1	-	-	-	-	-	-	4 (1.0%)
2	128 (1.3%)	13 (0.1%)	1 (0.0%)	-	97 (3.8%)	1 (0.1%)	124 (31.5%)
3	6,134 (60.3%)	1,085 (8.3%)	7 (0.1%)	3 (0.1%)	914 (36.2%)	5 (0.3%)	204 (51.8%)
4	2,993 (29.4%)	10,101 (77.1%)	285 (3.9%)	5 (0.1%)	665 (26.3%)	394 (25.6%)	26 (6.6%)
5	692 (6.8%)	1,791 (13.7%)	1,938 (26.4%)	27 (0.5%)	162 (6.4%)	946 (61.5%)	6 (1.5%)
6	164 (1.6%)	91 (0.7%)	2,332 (31.8%)	591 (10.0%)	53 (2.1%)	188 (12.2%)	6 (1.5%)
7	40 (0.4%)	21 (0.2%)	1,499 (20.4%)	3,560 (60.2%)	38 (1.5%)	2 (0.1%)	17 (4.3%)
8	16 (0.2%)	1 (0.0%)	664 (9.1%)	1,056 (17.9%)	56 (2.2%)	1 (0.1%)	7 (1.8%)
9	5 (0.0%)	1 (0.0%)	307 (4.2%)	352 (6.0%)	73 (2.9%)	-	-
10	-	1 (0.0%)	125 (1.7%)	150 (2.5%)	69 (2.7%)	-	-
11	-	-	72 (1.0%)	76 (1.3%)	66 (2.6%)	-	-
12	1 (0.0%)	-	40 (0.5%)	48 (0.8%)	53 (2.1%)	-	-
13	-	-	13 (0.2%)	20 (0.3%)	37 (1.5%)	-	-
14	-	-	17 (0.2%)	10 (0.2%)	29 (1.1%)	-	-
15	-	-	2 (0.0%)	5 (0.1%)	27 (1.1%)	-	-
16	-	-	2 (0.0%)	4 (0.1%)	31 (1.2%)	-	-
17	-	-	4 (0.1%)	1 (0.0%)	27 (1.1%)	-	-
18	-	-	-	-	21 (0.8%)	-	-
19	-	-	5 (0.1%)	-	19 (0.8%)	-	-
20	-	-	6 (0.1%)	-	23 (0.9%)	-	-
21	-	-	5 (0.1%)	-	18 (0.7%)	-	-
22	-	-	6 (0.1%)	-	12 (0.5%)	-	-
23	-	-	1 (0.0%)	-	12 (0.5%)	-	-
24	-	-	-	-	12 (0.5%)	-	-
25	-	-	-	1 (0.0%)	13 (0.5%)	-	-
Totals	**10,173 (100%)**	**13,105 (100%)**	**7,331 (100%)**	**5,909 (100%)**	**2,527 (100%)**	**1,537 (100%)**	**394 (100%)**

Table 9. Estimated total entrainment for seven taxonomic categories of fishes at DCPP for two year-long time periods: **July 1997–June 1998** and **July 1998–June 1999,** and estimated annual entrainment and percentage reductions in entrainment for six WWS slot widths.

Taxon	Year	Annual Entrainment Estimate	Entrainment with 0.75 mm Slot	Entrainment with 1.0 mm Slot	Entrainment with 2.0 mm Slot	Entrainment with 3.0 mm Slot	Entrainment with 4.0 mm Slot	Entrainment with 6.0 mm Slot
sculpins	97-98	281,090,063	250,963,525	272,928,200	280,905,488	281,077,740	281,088,820	281,090,063
	98-99	276,345,912	246,727,840	268,321,802	276,164,452	276,333,797	276,344,690	276,345,912
	Percent Reduction		**10.7**	**2.9**	**0.1**	**<0.1**	**<0.1**	**0.0**
rockfishes	97-98	216,878,458	184,049,464	207,640,578	216,852,906	216,877,448	216,878,392	216,878,458
	98-99	374,596,029	317,893,252	358,640,210	374,551,895	374,594,285	374,595,915	374,596,029
	Percent Reduction		**15.1**	**4.3**	**<0.1**	**<0.1**	**<0.1**	**0.1**
kelpfishes	97-98	121,977,076	99,498,869	116,388,842	121,704,903	121,972,683	121,977,076	121,977,076
	98-99	90,774,143	74,046,082	86,615,434	90,571,594	90,770,874	90,774,143	90,774,143
	Percent Reduction		**18.4**	**4.6**	**0.2**	**<0.1**	**0.0**	**0.0**
monkeyface prickleback	97-98	118,960,221	75,512,079	112,810,990	118,940,270	118,959,255	118,960,201	118,960,221
	98-99	127,721,405	81,073,394	121,119,296	127,699,985	127,720,367	127,721,383	127,721,405
	Percent Reduction		**36.5**	**5.2**	**<0.1**	**<0.1**	**<0.1**	**0.0**
anchovies	97-98	106,375,289	92,329,457	96,839,651	105,639,334	106,375,289	106,375,289	106,375,289
	98-99	3,209,133	2,785,398	2,921,462	3,186,931	3,209,133	3,209,133	3,209,133
	Percent Reduction		**13.2**	**9.0**	**0.7**	**0.0**	**0.0**	**0.0**
cabezon	97-98	14,707,340	10,576,147	13,674,113	14,705,082	14,707,330	14,707,340	14,707,340
	98-99	9,189,686	6,608,365	8,544,088	9,188,275	9,189,680	9,189,686	9,189,686
	Percent Reduction		**28.1**	**7.0**	**<0.1**	**<0.1**	**0.0**	**0.0**
flatfishes	97-98	45,128,059	42,009,412	43,464,849	45,114,887	45,128,059	45,128,059	45,128,059
	98-99	19,245,735	17,915,728	18,536,427	19,240,118	19,245,735	19,245,735	19,245,735
	Percent Reduction		**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 10. Estimated percentage reductions (standard errors in parentheses) in mortality (relative to an open intake) to the population surviving past the size when they would be subject to entrainment,[1] based on probabilities of screen entrainment for larvae from seven taxonomic categories of fishes measured during DCPP entrainment studies conducted October 1996 through June 1999. The mortality adjusted from the estimates in **Table 4** was based on the length range of larvae measured from the studies, except for anchovies and monkeyface pricklebacks.

	Percentage Reduction in Mortality by Slot Opening Width [1]					
Taxon	**0.75 mm**	**1 mm**	**2 mm**	**3 mm**	**4 mm**	**6 mm**
sculpins	69.2 (5.4)	58.7 (5.3)	24.3 (4.6)	5.5 (2.2)	0.5 (0.4)	0.0 (0.0)
rockfishes	46.2 (5.7)	32.0 (5.0)	5.2 (1.7)	0.5 (0.2)	0.0 (0.0)	0.0 (0.0)
kelpfishes	72.1 (2.5)	63.0 (2.5)	21.8 (2.4)	0.8 (0.3)	0.0 (0.0)	0.0 (0.0)
monkeyface prickleback [2]	62.8 (3.9)	42.2 (3.8)	0.9 (0.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
anchovies *	55.4 (2.3)	45.1 (2.3)	5.5 (1.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
cabezon	36.3 (7.2)	19.0 (5.5)	0.6 (0.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
flatfishes	34.1 (7.1)	17.7 (6.0)	0.2 (0.2)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Average % Reduction	**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).

[2] – 25-mm monkeyface prickleback in Table 7 not included as the length distribution shows the data point as an outlier.

* - percentage reductions are the same as the values in Table 4.

SONGS

Entrainment sampling at SONGS occurred approximately monthly from March 2006 through April 2007. Although entrainment sampling was also done inside the plant, the results presented here were from samples collected at a location in the vicinity of the offshore intake. The taxa that were measured for length and head capsule dimensions comprised over 83 percent of the total larvae collected from the offshore entrainment station (**Table 11**). Anchovies were the most abundant fish larvae collected, comprising over 65 percent of the total. Since detailed data on the length frequency distribution for each of the taxa were not available from the study, the estimated percentage reductions for the six WWS slot openings from **Table 4** provide the best estimates of potential screen effectiveness at SONGS.

Table 11. Concentrations of fish larvae collected during entrainment sampling at SONGS from March 2006 through April 2007 for the fishes analyzed for this report.

Common Name	Entrainment Concentration (#/1,000 m^3)	Percent of Total
anchovies	1,285.37	65.4
croakers	157.70	8.0
combtooth blenny	108.78	5.5
flatfishes	23.26	1.2
Pacific barracuda	22.05	1.1
sea basses	15.68	0.8
silversides	11.32	0.6
kelpfishes	9.98	0.5
gobies	3.74	0.2
clingfishes	0.67	0.0
sculpins	0.45	0.0
Total for analyzed taxa	**1,638.80**	**83.4**
Minimum of 27 other taxa	243.73	16.6
Total	**1,882.53**	**100.0**

Conclusions

The results from the head capsule analysis indicate that rectangular mesh or WWS slot openings larger than about 3 mm (0.12 in.) will result in very little reduction in population-level mortality, especially for fishes that have been entrained in large numbers in southern California such as anchovies, croakers, and gobies. The results also show that the performance of screens will vary by location and also between years due to differences in the composition of entrained larvae and changes to their abundances and proportions over time. For example, due to the generally smaller size of the larvae entrained at DCPP, the estimated reductions in entrainment for any mesh or WWS slot openings larger than about 1 mm (0.04 in.) was very small. Overall, the methodology presented provides an initial means to evaluate, based on the morphology of the larvae, the potential for screen technologies to reduce larval fish entrainment through exclusion.

The results of the generalized analysis of the fishes commonly subject to entrainment summarized in **Table 5** provide estimates that could be used in a first order assessment of the potential effectiveness of different rectangular mesh or WWS slot openings for plants such as SONGS where only limited data on the length frequency of entrainable larvae are available. The analysis of the DCPP data demonstrate the importance of having detailed site-specific data. The DCPP results showed that the assumption that the screen would be effective across all length classes up to the maximum lengths of 20 or 25 mm (0.79 or 0.98 in.), which was used in calculating the estimated population-level reductions in entrainment mortality presented in **Table 5,** was not valid for some of the most abundant fishes collected during entrainment sampling. The absence of larger larvae for the fishes collected during entrainment sampling was likely due to behavioral differences among species that likely occur following transformation of the larvae when they begin taking on adult morphological characteristics and, as a result, develop increased swimming abilities that allow them to better avoid entrainment. Results from a study by Beldade et al. (2006) on the vertical distribution of fish larvae in a marine reserve area in Portugal showed that only small larvae occurred at the surface while the whole range of sizes was present at the bottom. These results support the role of behavior and indicate that larvae for some fishes may be completing the entire pelagic phase near the adult habitat. Although it is tempting to generalize regarding behaviors of nearshore rocky reef fishes that result in the larvae moving to the bottom at early stages of development to avoid transport long distances away from their natal habitat, kelpfishes, which are part of the rocky reef fish assemblage were collected during entrainment sampling at DCPP across a large range of sizes (**Table 8**). Also flatfishes, which are associated with soft bottom habitat, had a length frequency distribution (**Table 8**) similar overall to fishes, other than kelpfishes, that form the rocky reef fish assemblage. Screening technologies using only smaller slot sizes would be effective at reducing entrainment for these fishes, but a shorter time of susceptibility likely results in very low population level effects of entrainment as larger larvae, which have a disproportionately greater contribution to population sustainability appear to have low risk of entrainment.

The results from DCPP indicate that the low numbers of larger larvae for some fishes would need to be taken into account during the design of any further pilot studies to determine the effectiveness of screening technologies at reducing entrainment. Studies would need to be designed to collect an adequate number of samples to account for the expected small numbers of large larvae. Such analysis, as applicable, should also focus on specific size classes as recommended by Weisberg et al. (1987). In testing of WWS in Chesapeake Bay with slot sizes of 1, 2, and 3 mm (0.04, 0.08, and 0.12 in.) Weisberg et al. (1987) were unable to detect any reductions in entrainment for smaller fish eggs and larvae, but did detect significant reductions for larger larvae. Even though the concentrations of the larger larvae were very low in that study, the analysis was able to detect statistically significant differences, which was at least partially due to the large differences in abundance for the larger larvae between the open and screened intakes for the larger larvae. The results from the studies along the California coast indicate that large larvae may only be present from a limited number of taxa and in low numbers complicating any field testing of WWS effectiveness.

In addition to the assumptions associated with the modeling presented in this study, the estimates of screen effectiveness do not attempt to account for the potential effects of field flow (currents) around specific WWS module designs, which may increase the effectiveness of offshore screen modules at reducing larval entrainment. Additionally, the viability of larvae initially impinged on inshore fine-mesh screens and then released to the source water body was not evaluated. Larval survival following impingement will be highly variable depending on the screen type and fish return systems employed, as well as the types of organisms susceptible to entrainment at a given location. The results presented would also not be directly applicable to fine-mesh screens using square mesh configurations due to differences in larval head dimensions, specifically variation in head width versus depth. The smallest dimension (width or depth) of the head capsule is a reasonable approach for estimating the minimum sizes of larvae that could be entrained through rectangular mesh or WWS slot openings. The dimensions of the head capsule, as well as the overall length and body shape, are all likely to contribute to the size of fish larvae that could be entrained through screens with square mesh openings. Therefore, the results of this study are best applied to WWS or fine-mesh screens with rectangular openings.

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Appendix A

Regression Plots from Intake Screening Technology Support Studies: Morphology of Larval Fish Head Capsules (Tenera 2011)

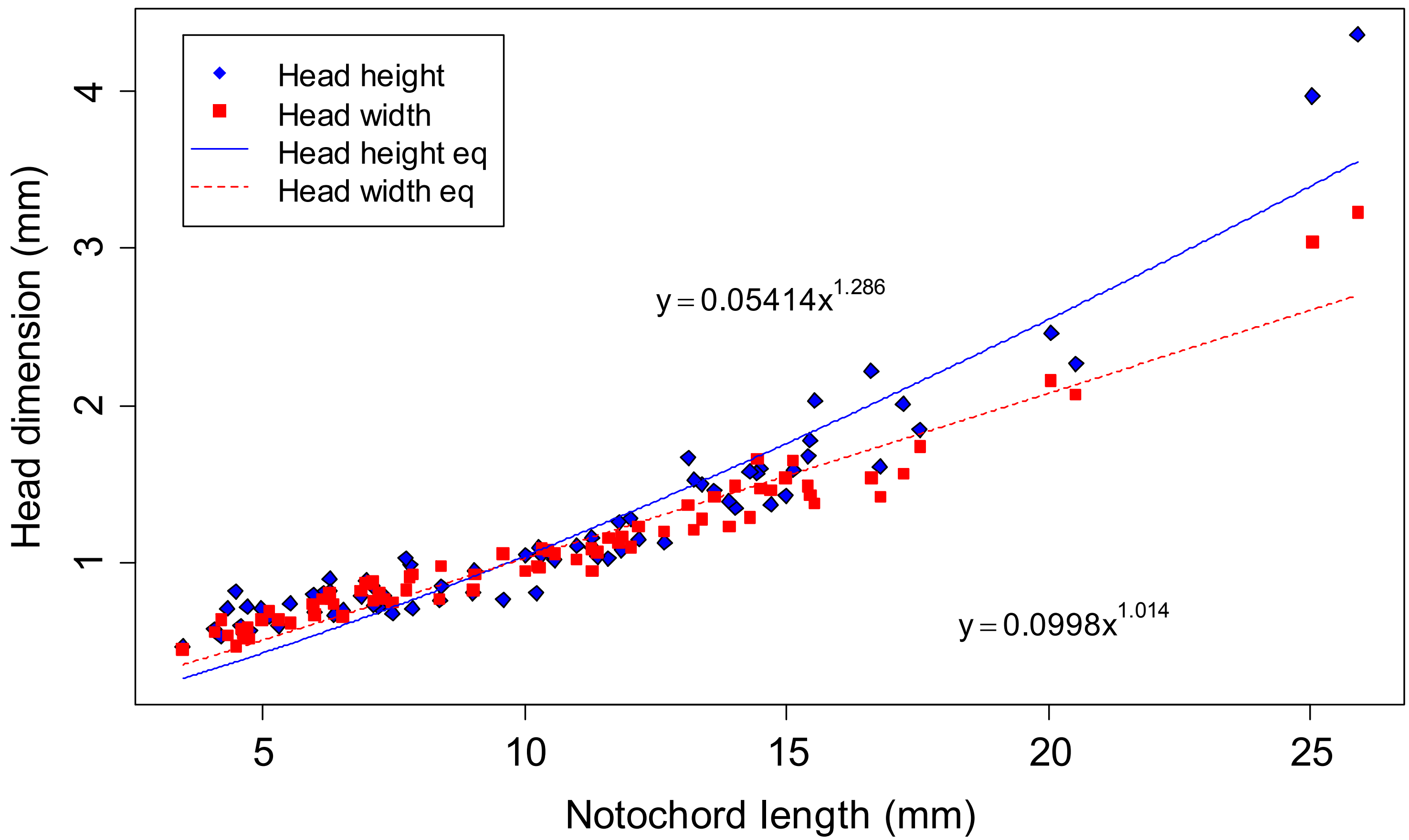

Figure A1. Kelpfishes (*Gibbonsia* spp.) allometric regression plots.

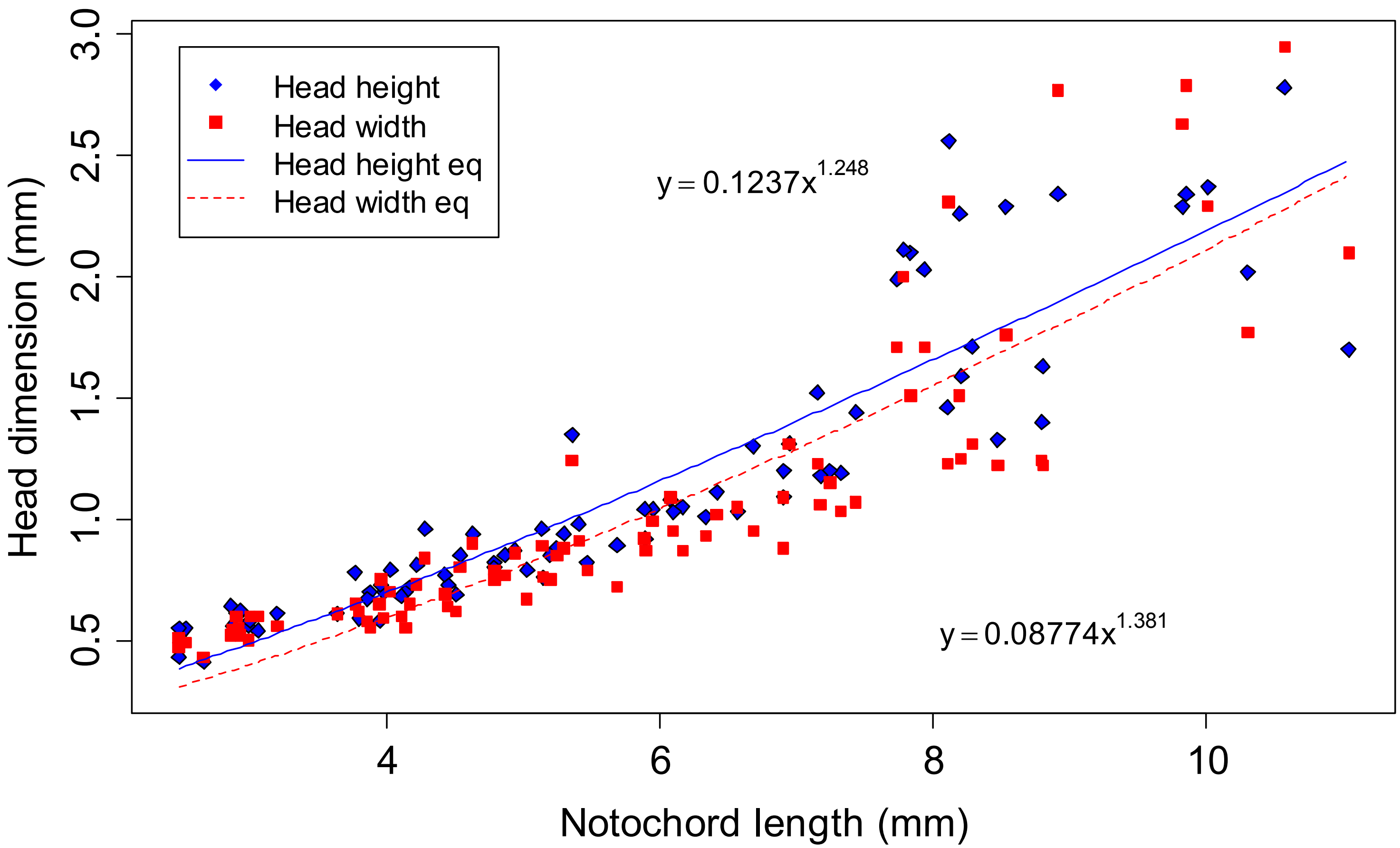

Figure A2. Sculpins (Cottidae) allometric regression plots.

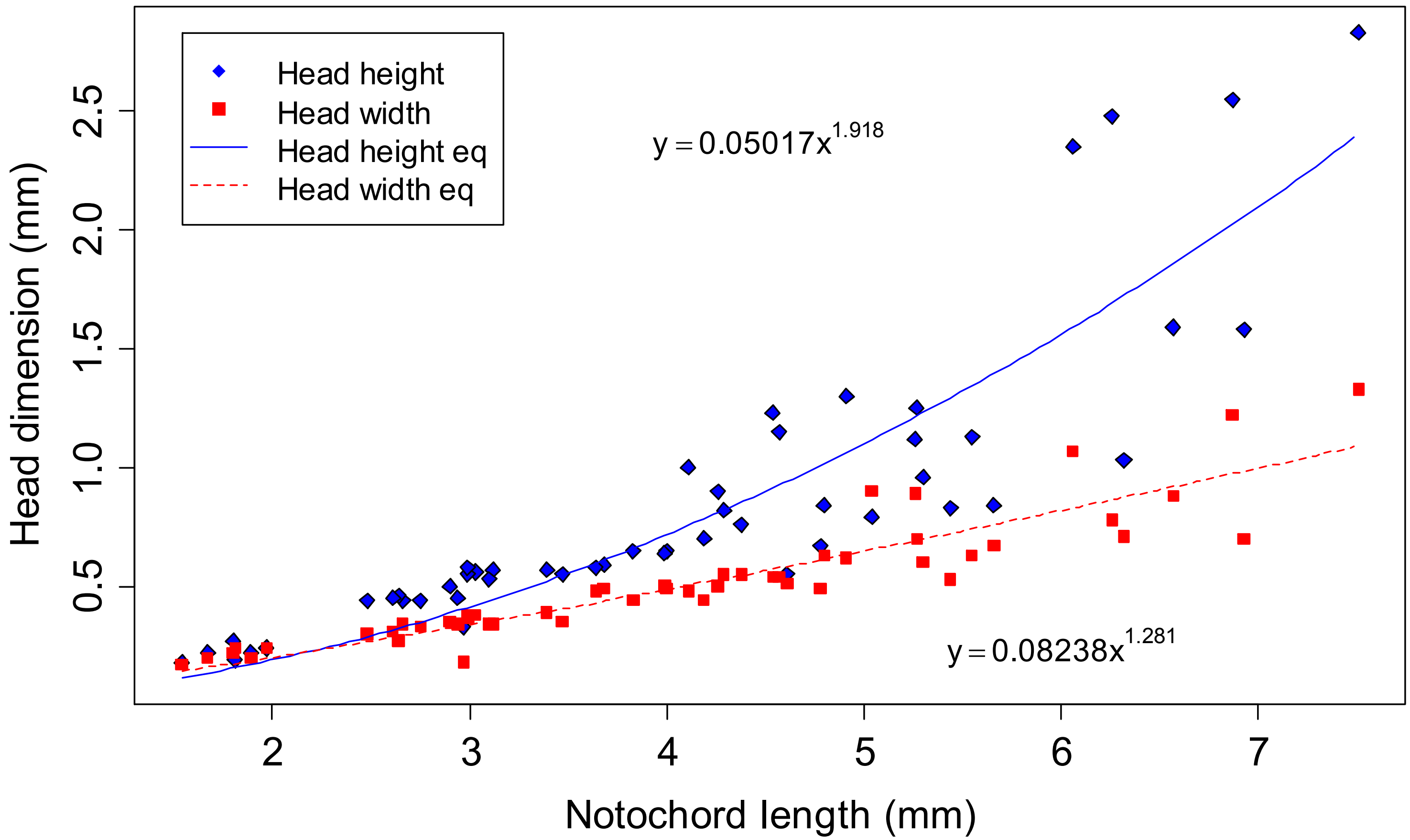

Figure A3. Flatfishes (Pleuronectiformes) allometric regression plots.

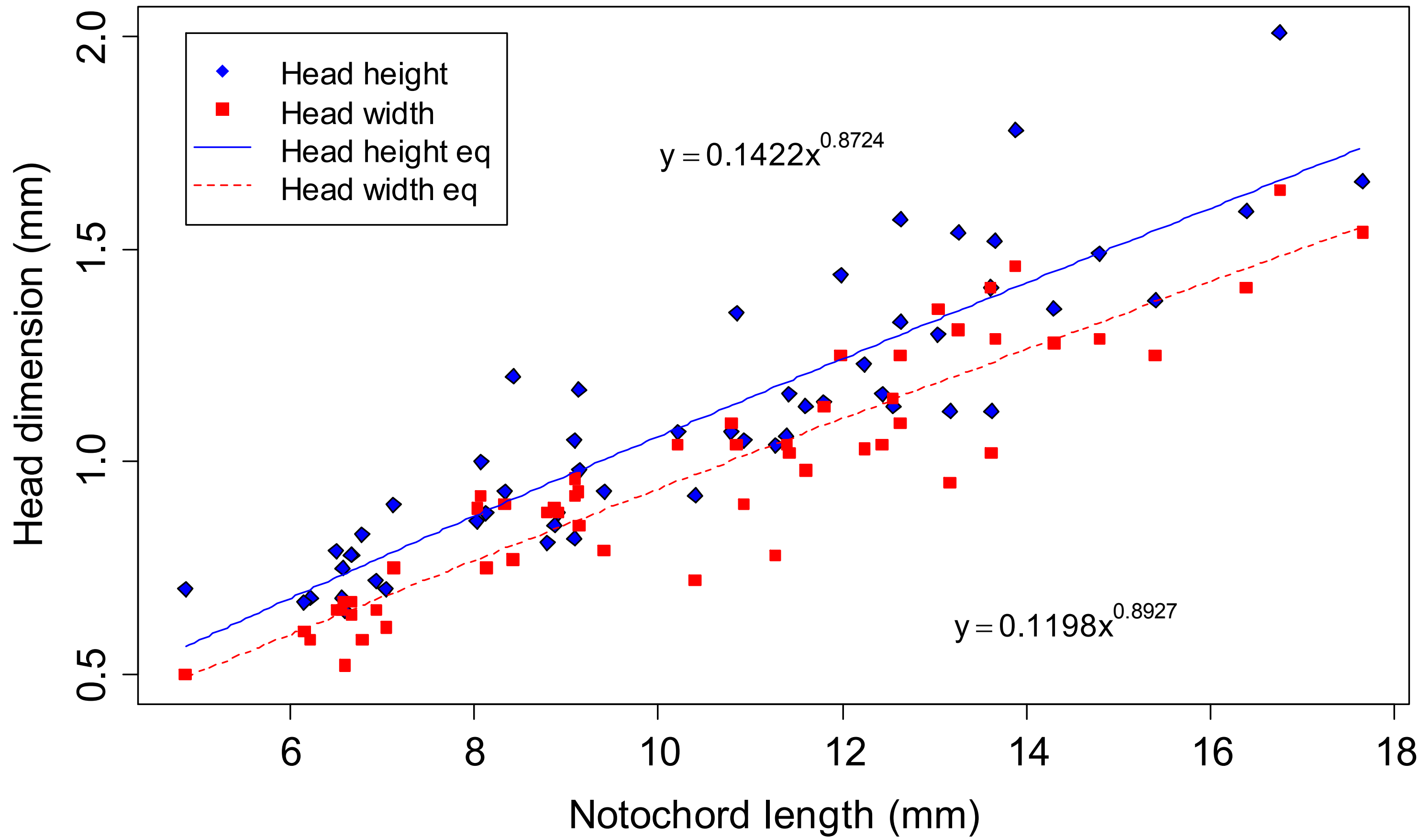

Figure A4. Monkeyface prickleback (*Cebidichthys violaceus*) allometric regression plots.

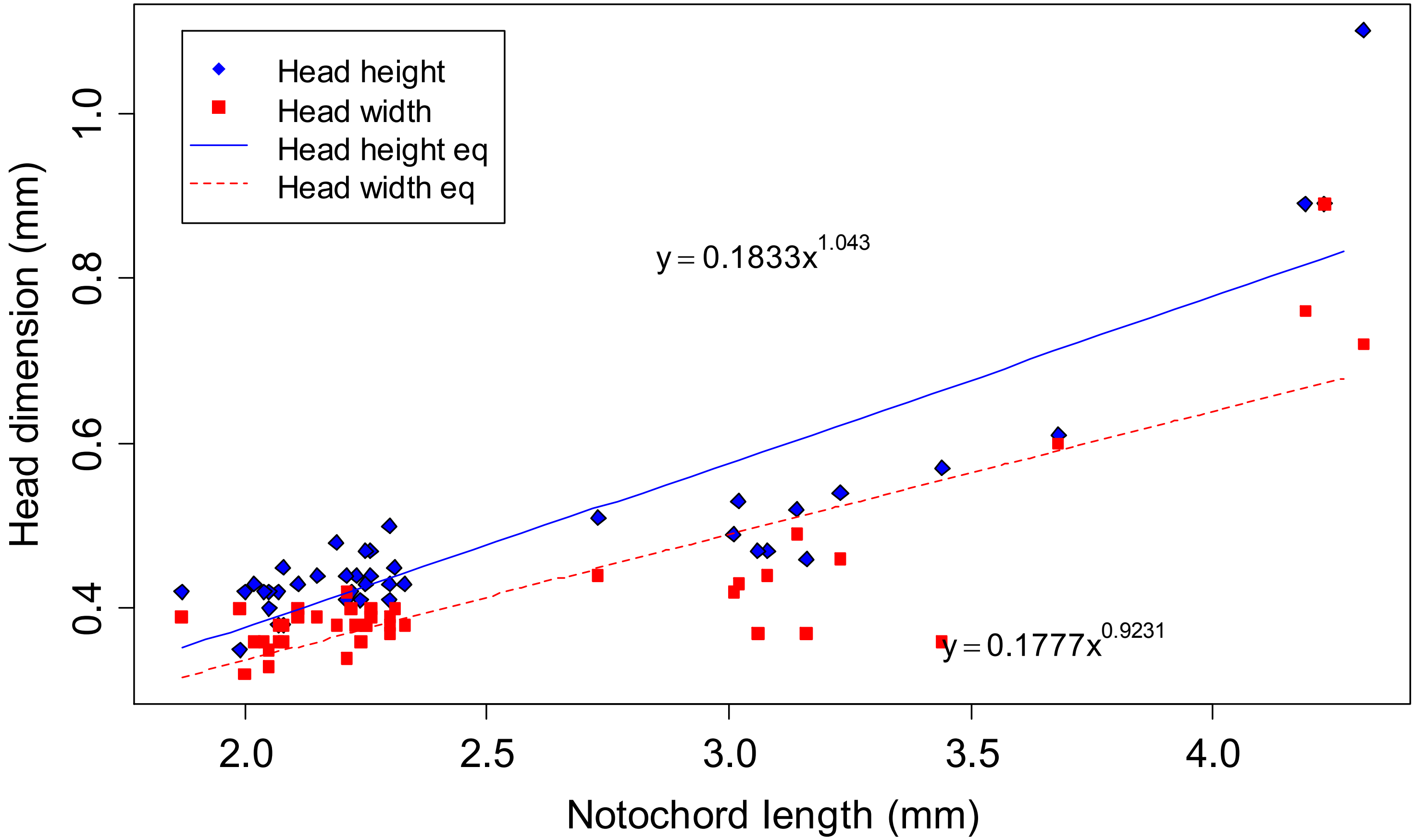

Figure A5. Combtooth blennies (*Hypsoblennius* spp.) allometric regression plots.

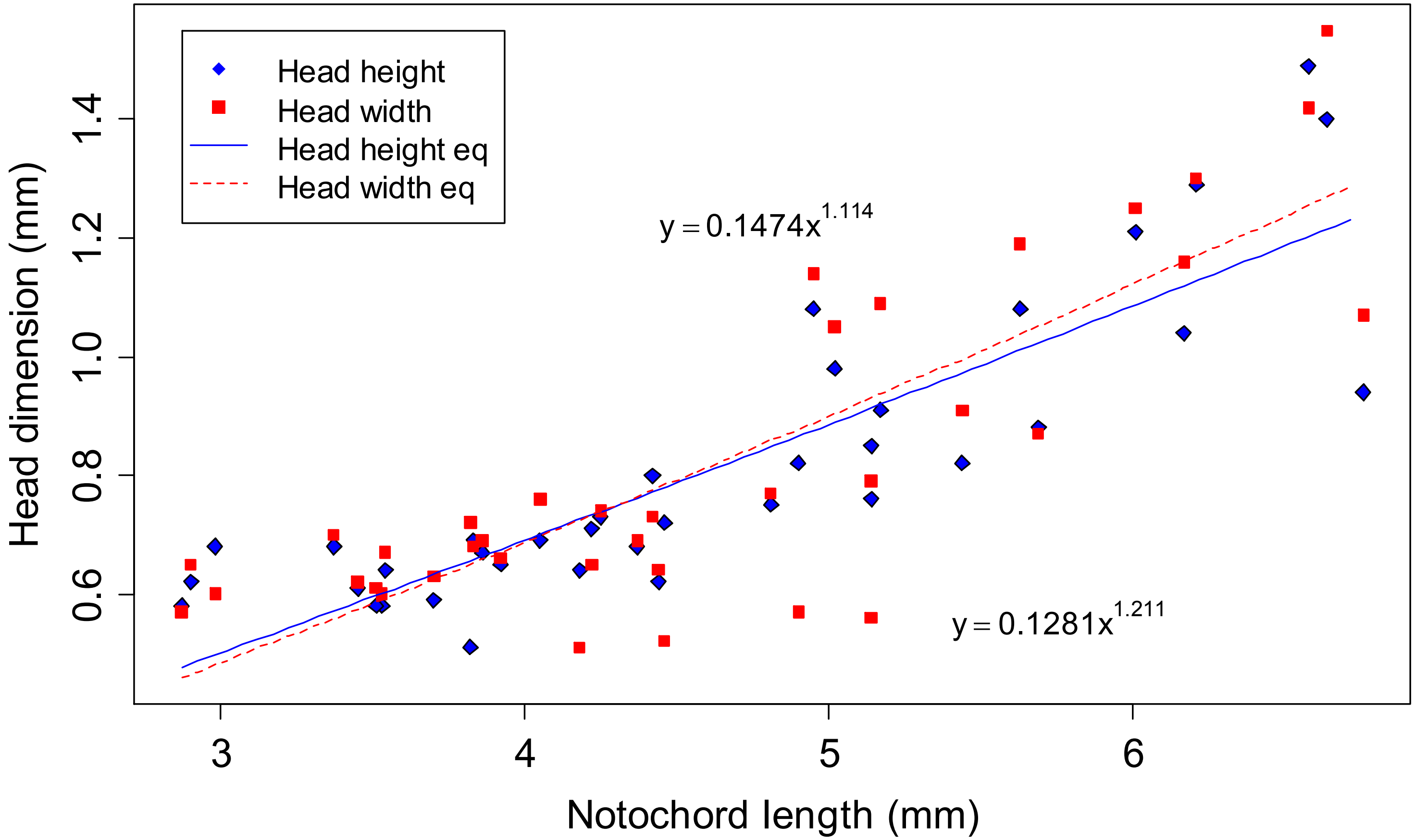

Figure A6. Clingfishes (*Gobiesox* spp.) allometric regression plots.

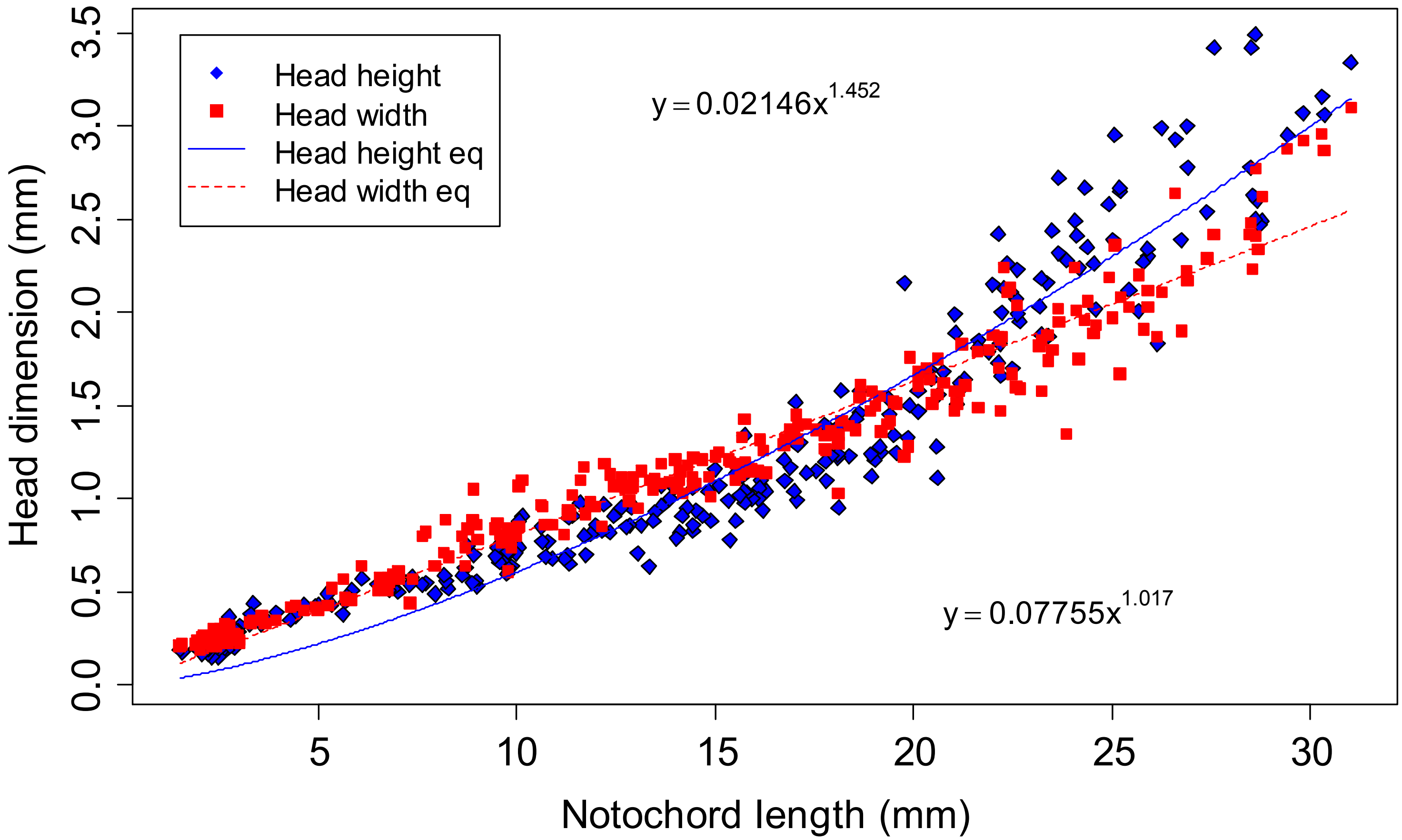

Figure A7. Anchovies (Engraulidae and *Engraulis mordax*) allometric regression plots.

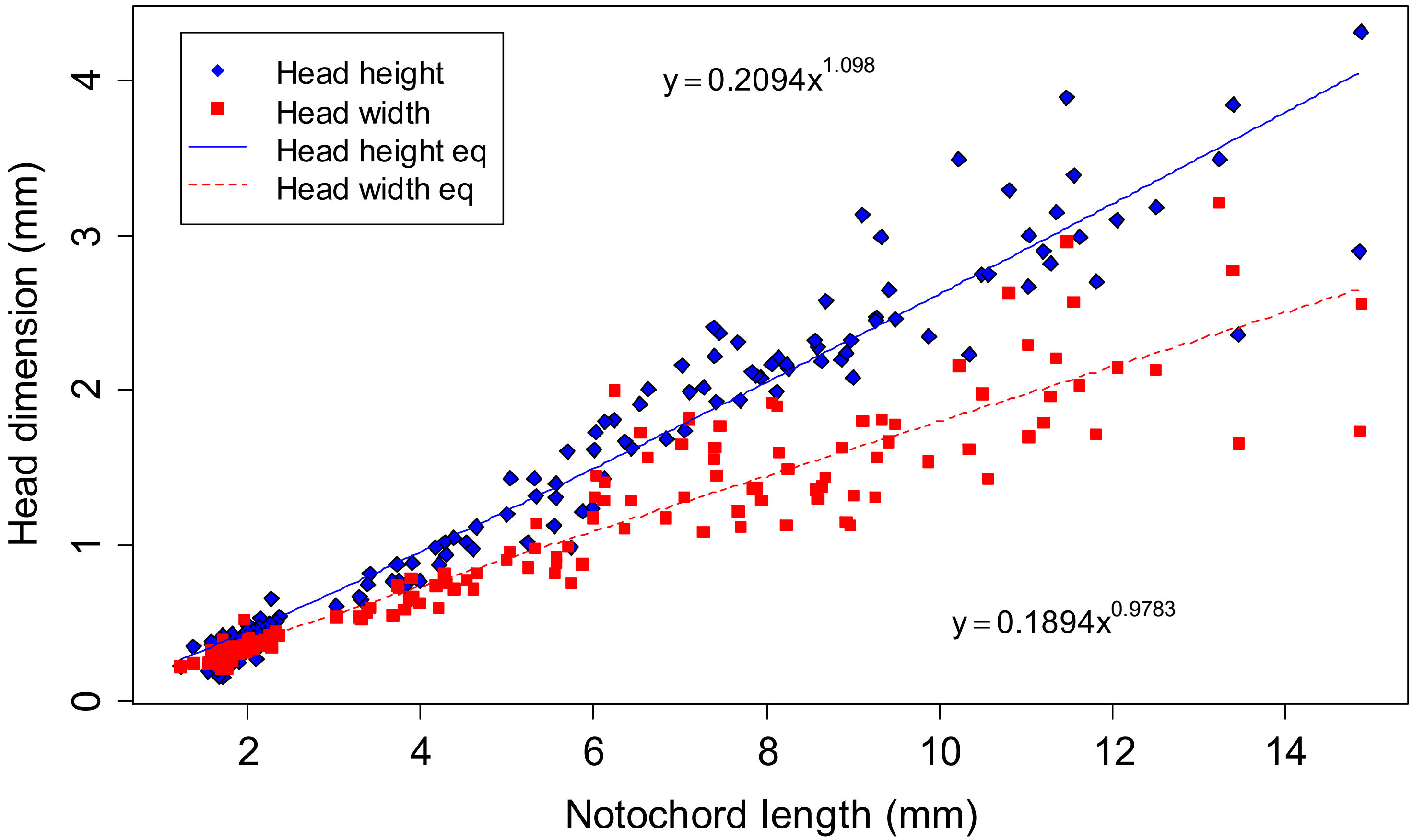

Figure A8. Croakers (*Seriphus politus* and *Genyonemus lineatus*) allometric regression plots.

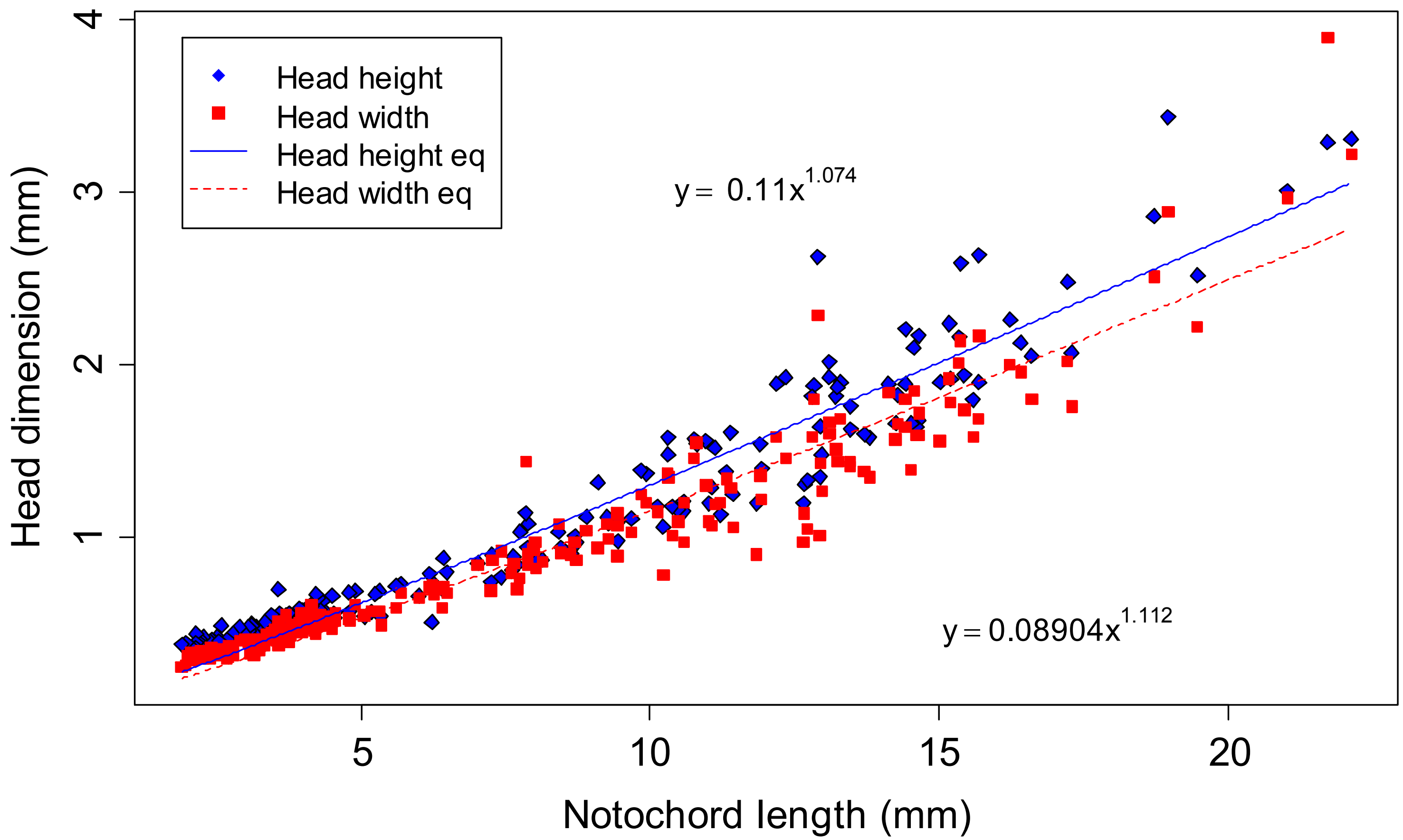

Figure A9. Gobies (*Acanthogobius flavimanus, Lepidogobius lepidus* and CIQ [*Clevelandia, Ilypnus, Quietula]* goby complex) allometric regression plots.

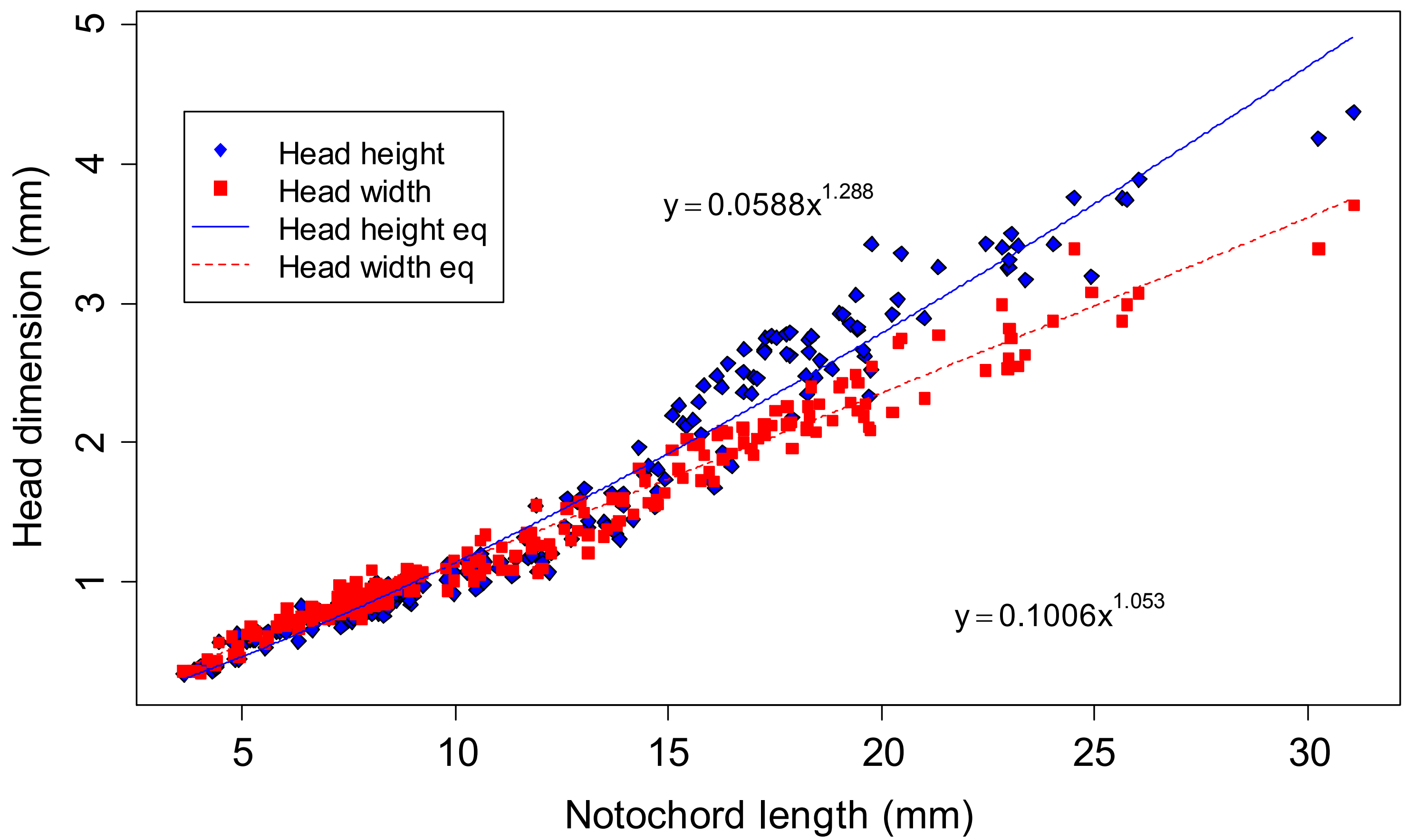

Figure A10. Silversides (Atherinopsidae, *Atherinopsis californiensis, Atherinops affinis,* and *Leuresthes tenuis*) allometric regression plots.

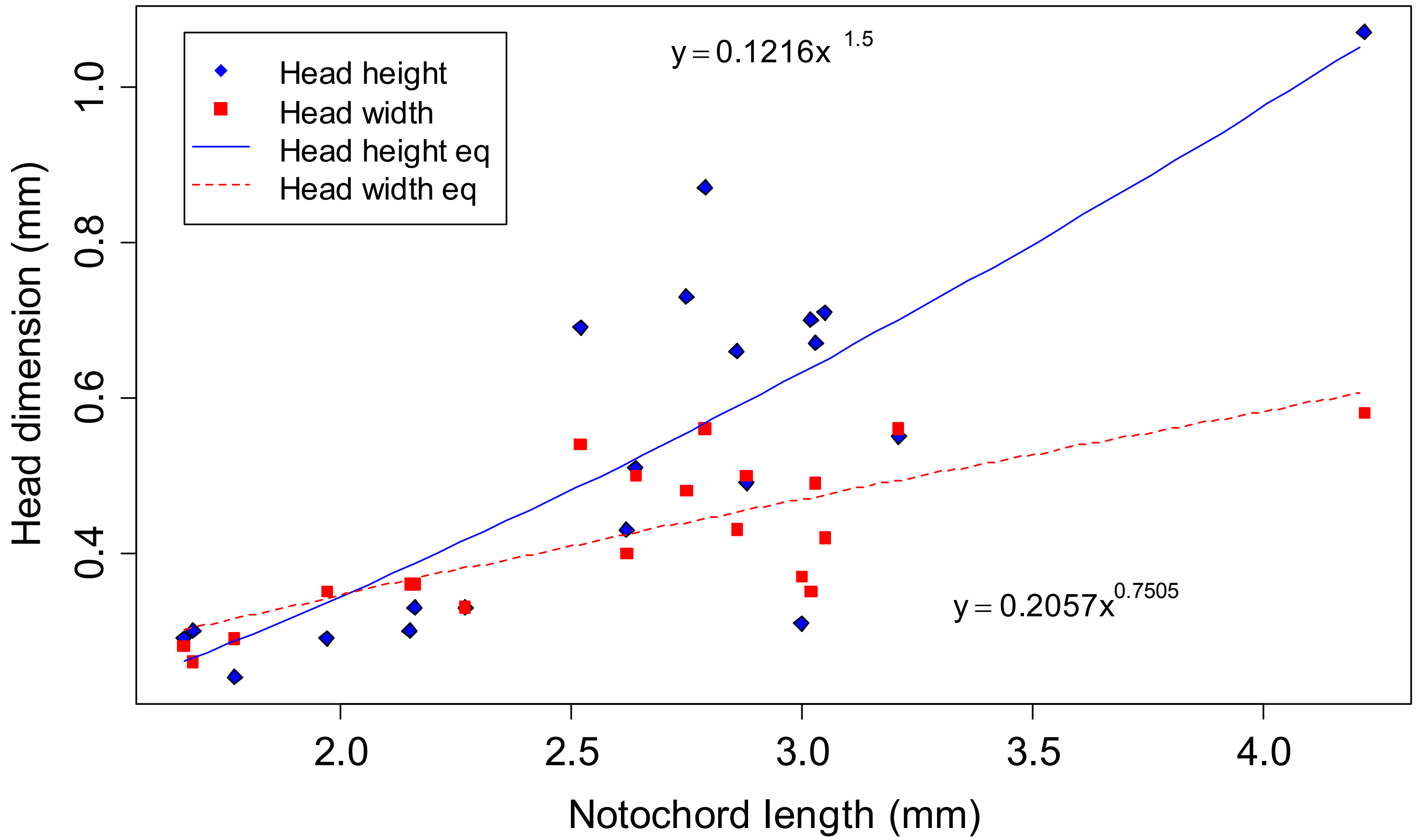

Figure A11. Pacific barracuda (*Sphyraena argentea*) allometric regression plots.

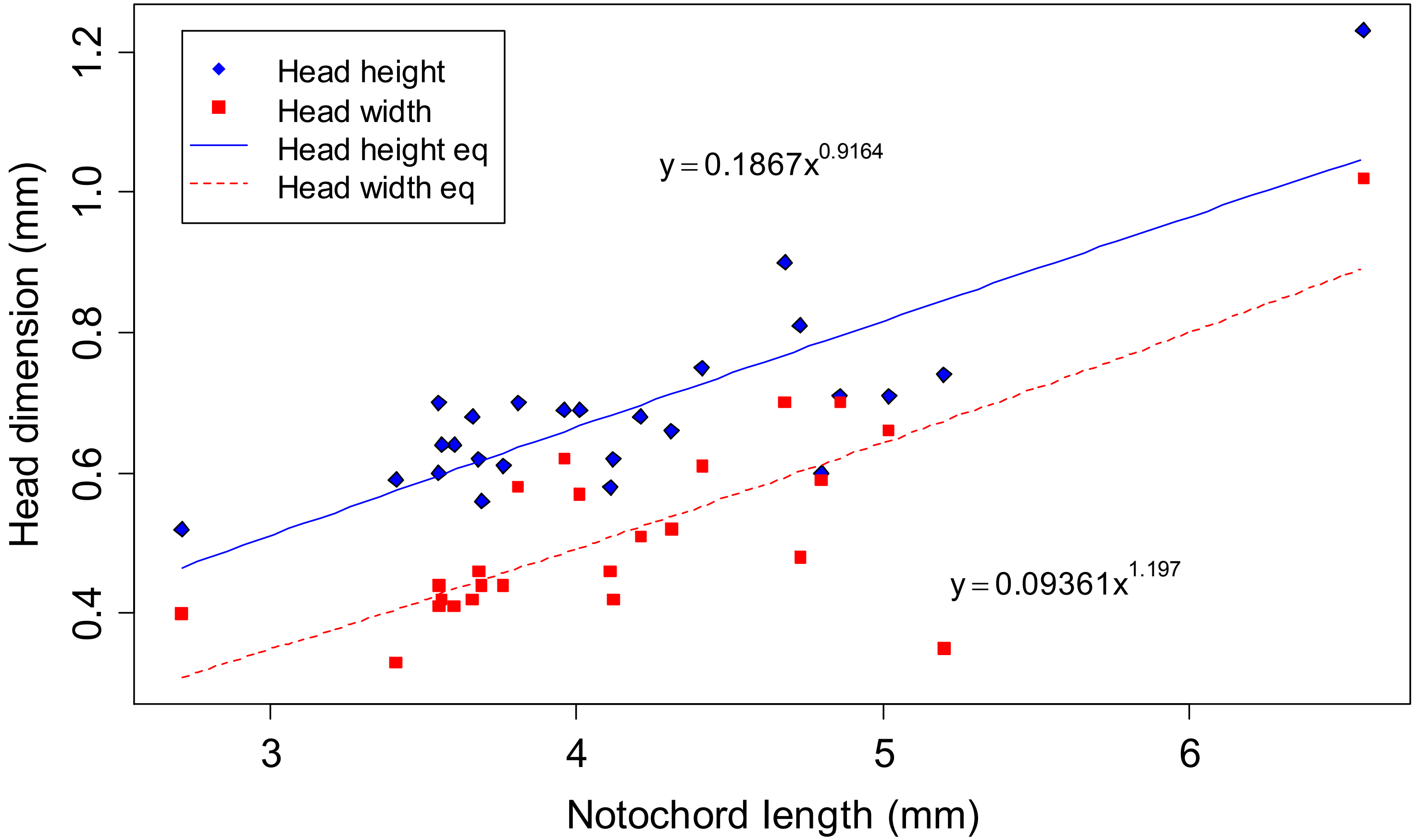

Figure A12. Rockfishes (*Sebastes* spp.) allometric regression plots.

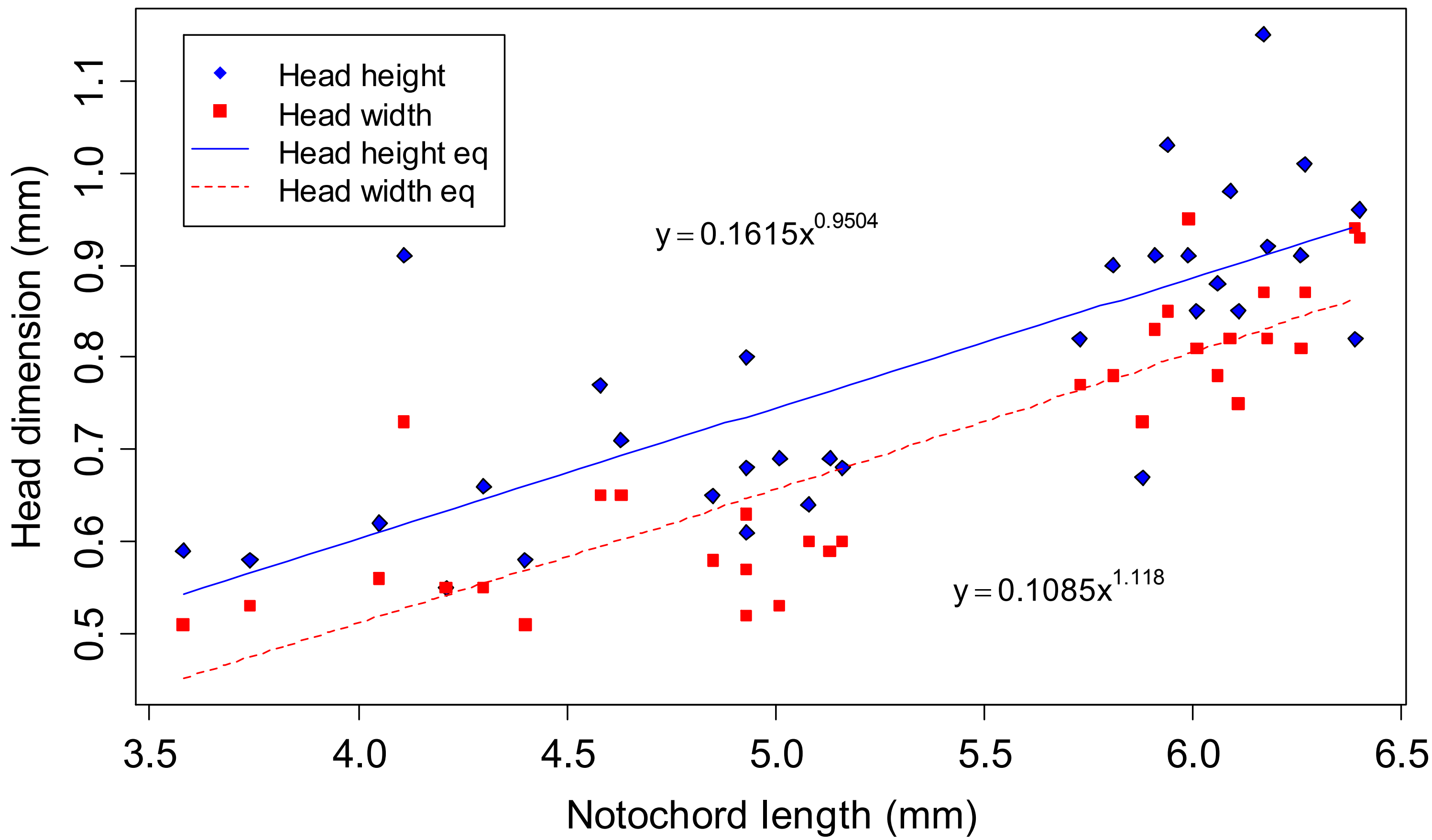

Figure A13. Cabezon (*Scorpaenichthys marmoratus*) allometric regression plots.

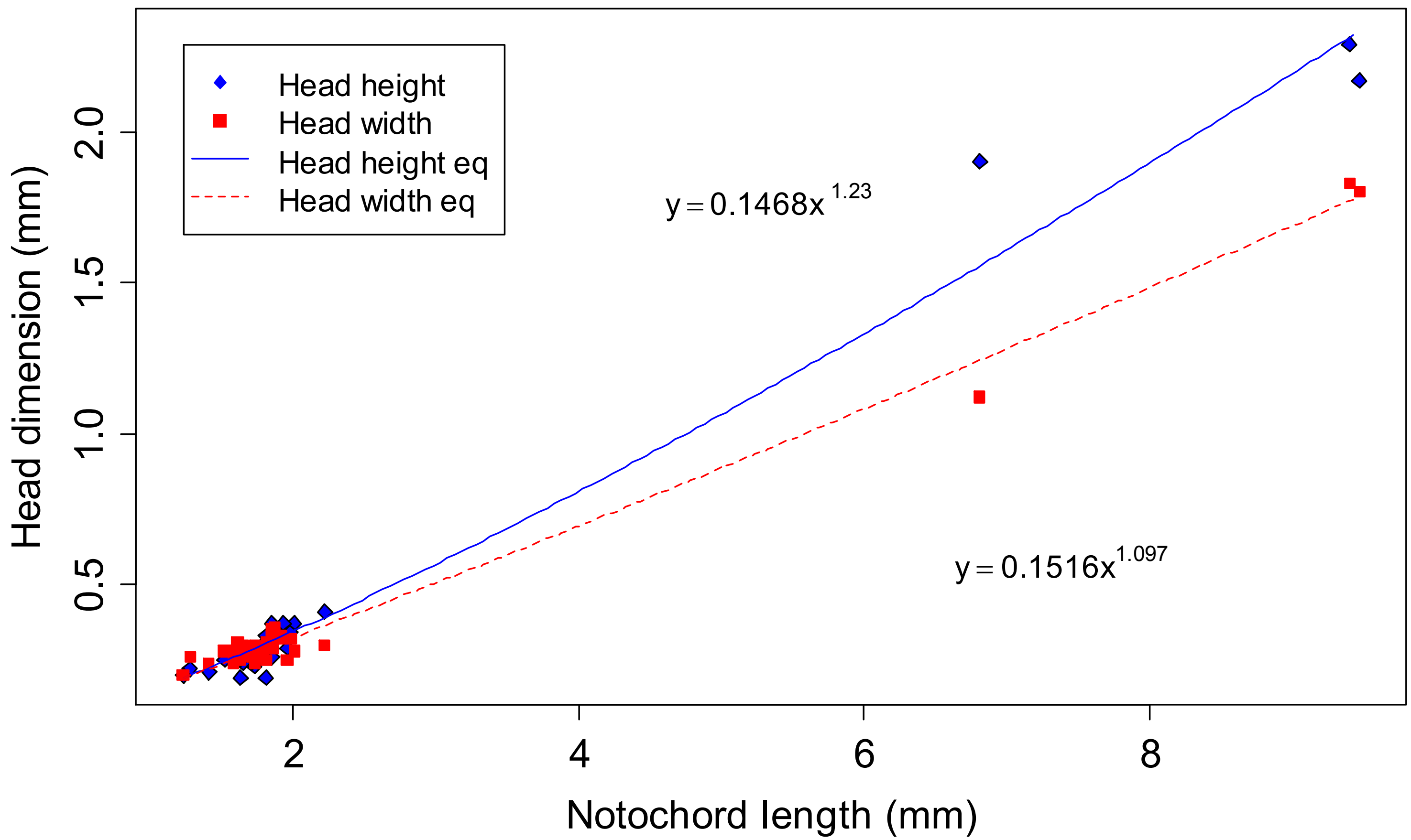

Figure A14. Sea basses (*Paralabrax* spp.) allometric regression plots.

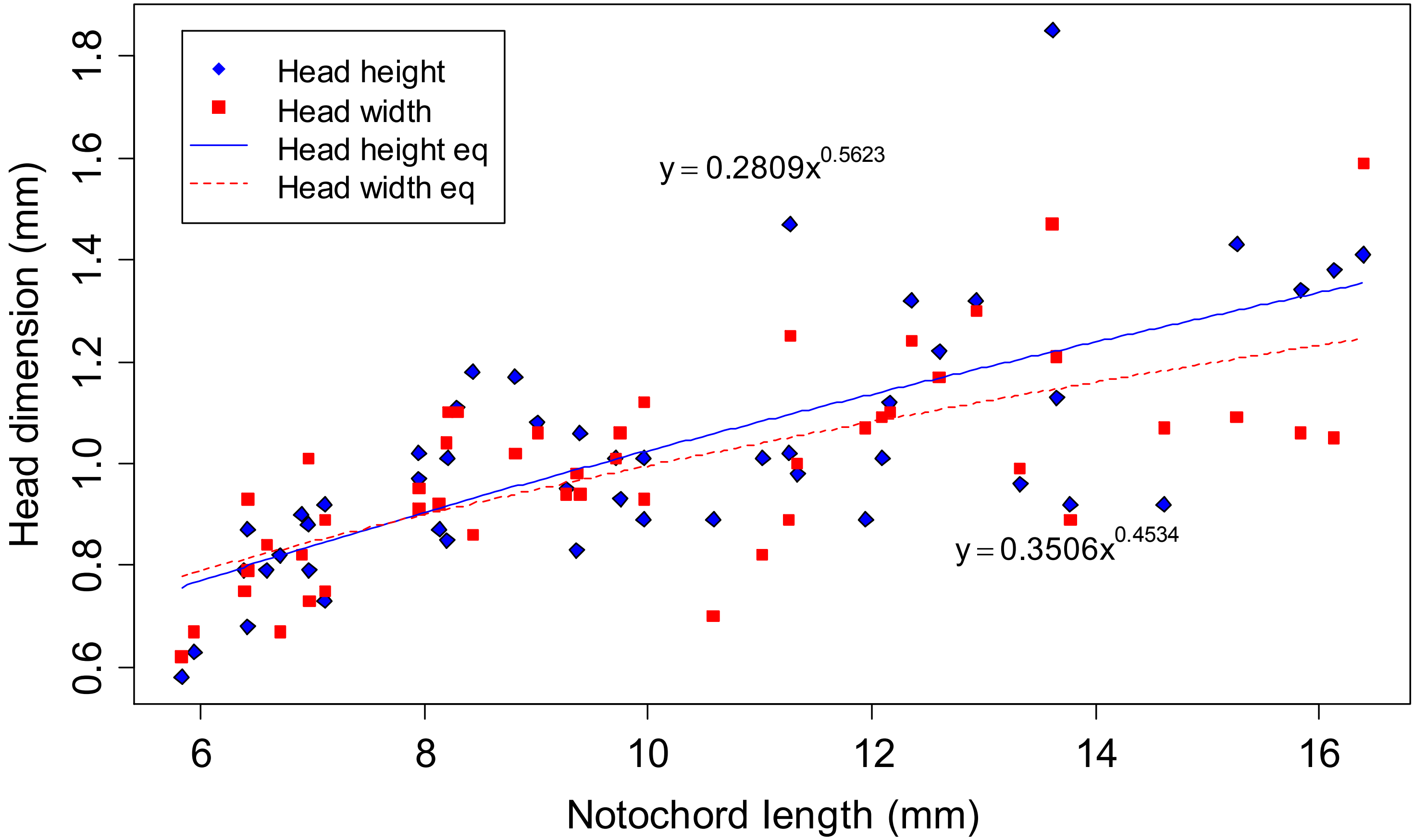

Figure A15. Pricklebacks (Stichaeidae) allometric regression plots.

Appendix B

Estimated Proportions and Standard Errors of Larval Fish Taxa Entrained Through Various Screen Slot Openings Based on Head Capsule Allometric Regressions on Notochord Lengths

Table B1. Estimated proportions (standard error) of **kelpfish** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	**1**	**2**	**3**	**4**	**6**
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.970 (0.026)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.766 (0.091)	0.998 (0.002)	1 (0)	1 (0)	1 (0)	1 (0)
8	0.418 (0.092)	0.954 (0.030)	1 (0)	1 (0)	1 (0)	1 (0)
9	0.171 (0.049)	0.747 (0.087)	1 (0)	1 (0)	1 (0)	1 (0)
10	0.057 (0.019)	0.426 (0.081)	1 (0)	1 (0)	1 (0)	1 (0)
11	0.018 (0.006)	0.213 (0.046)	1 (0)	1 (0)	1 (0)	1 (0)
12	0.006 (0.002)	0.098 (0.024)	1 (0)	1 (0)	1 (0)	1 (0)
13	0.002 (0.001)	0.041 (0.010)	0.999 (<.001)	1 (0)	1 (0)	1 (0)
14	0.001 (<.001)	0.017 (0.004)	0.995 (0.003)	1 (0)	1 (0)	1 (0)
15	0 (0)	0.007 (0.002)	0.976 (0.009)	1 (0)	1 (0)	1 (0)
16	0 (0)	0.003 (0.001)	0.927 (0.021)	1 (0)	1 (0)	1 (0)
17	0 (0)	0.001 (<.001)	0.831 (0.034)	1 (0)	1 (0)	1 (0)
18	0 (0)	0.001 (<.001)	0.698 (0.043)	1 (0)	1 (0)	1 (0)
19	0 (0)	0 (0)	0.543 (0.046)	0.999 (<.001)	1 (0)	1 (0)
20	0 (0)	0 (0)	0.397 (0.040)	0.997 (0.001)	1 (0)	1 (0)
21	0 (0)	0 (0)	0.271 (0.032)	0.991 (0.003)	1 (0)	1 (0)
22	0 (0)	0 (0)	0.175 (0.023)	0.976 (0.006)	1 (0)	1 (0)
23	0 (0)	0 (0)	0.108 (0.016)	0.948 (0.011)	1 (0)	1 (0)
24	0 (0)	0 (0)	0.065 (0.010)	0.905 (0.015)	1 (0)	1 (0)
25	0 (0)	0 (0)	0.037 (0.006)	0.842 (0.021)	0.999 (<.001)	1 (0)

Table B2. Estimated proportions (standard error) of **sculpin** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	**1**	**2**	**3**	**4**	**6**
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.998 (0.003)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.849 (0.108)	0.990 (0.012)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.393 (0.128)	0.823 (0.095)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.114 (0.044)	0.456 (0.104)	0.998 (0.002)	1 (0)	1 (0)	1 (0)
7	0.028 (0.011)	0.179 (0.053)	0.967 (0.020)	1 (0)	1 (0)	1 (0)
8	0.007 (0.003)	0.061 (0.019)	0.848 (0.049)	0.998 (0.001)	1 (0)	1 (0)
9	0.002 (0.001)	0.021 (0.006)	0.648 (0.062)	0.985 (0.008)	1 (0)	1 (0)
10	0.001 (<.001)	0.008 (0.002)	0.436 (0.057)	0.930 (0.024)	0.998 (0.001)	1 (0)
11	0 (0)	0.003 (0.001)	0.271 (0.040)	0.819 (0.041)	0.987 (0.006)	1 (0)
12	0 (0)	0.001 (<.001)	0.160 (0.025)	0.661 (0.048)	0.955 (0.014)	1 (0)
13	0 (0)	0.001 (<.001)	0.091 (0.015)	0.503 (0.043)	0.890 (0.024)	0.999 (<.001)
14	0 (0)	0 (0)	0.051 (0.009)	0.368 (0.035)	0.789 (0.033)	0.995 (0.002)
15	0 (0)	0 (0)	0.029 (0.005)	0.260 (0.027)	0.666 (0.036)	0.984 (0.005)
16	0 (0)	0 (0)	0.017 (0.003)	0.181 (0.020)	0.539 (0.037)	0.963 (0.009)
17	0 (0)	0 (0)	0.010 (0.002)	0.122 (0.014)	0.415 (0.033)	0.924 (0.013)
18	0 (0)	0 (0)	0.006 (0.001)	0.083 (0.010)	0.314 (0.027)	0.870 (0.018)
19	0 (0)	0 (0)	0.003 (0.001)	0.057 (0.007)	0.235 (0.020)	0.801 (0.022)
20	0 (0)	0 (0)	0.002 (<.001)	0.038 (0.005)	0.176 (0.015)	0.722 (0.025)
21	0 (0)	0 (0)	0.001 (<.001)	0.026 (0.003)	0.131 (0.012)	0.634 (0.026)
22	0 (0)	0 (0)	0.001 (<.001)	0.018 (0.002)	0.097 (0.009)	0.547 (0.025)
23	0 (0)	0 (0)	0.001 (<.001)	0.012 (0.002)	0.073 (0.007)	0.466 (0.023)
24	0 (0)	0 (0)	0 (0)	0.008 (0.001)	0.053 (0.005)	0.388 (0.022)
25	0 (0)	0 (0)	0 (0)	0.006 (0.001)	0.040 (0.004)	0.320 (0.019)

Table B3. Estimated proportions (standard error) of **flatfish** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.982 (0.020)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.753 (0.112)	0.978 (0.019)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.368 (0.097)	0.820 (0.074)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.131 (0.041)	0.521 (0.087)	0.999 (0.001)	1 (0)	1 (0)	1 (0)
8	0.041 (0.014)	0.262 (0.058)	0.986 (0.008)	1 (0)	1 (0)	1 (0)
9	0.013 (0.004)	0.118 (0.029)	0.937 (0.023)	0.999 (<.001)	1 (0)	1 (0)
10	0.005 (0.001)	0.049 (0.013)	0.828 (0.039)	0.994 (0.003)	1 (0)	1 (0)
11	0.003 (<.001)	0.021 (0.005)	0.683 (0.047)	0.978 (0.008)	0.999 (<.001)	1 (0)
12	0.002 (<.001)	0.009 (0.002)	0.521 (0.045)	0.939 (0.015)	0.996 (0.002)	1 (0)
13	0.002 (<.001)	0.004 (0.001)	0.379 (0.038)	0.874 (0.023)	0.986 (0.004)	1 (0)
14	0.001 (<.001)	0.002 (<.001)	0.263 (0.029)	0.782 (0.029)	0.965 (0.008)	0.999 (<.001)
15	0.001 (<.001)	0.002 (<.001)	0.180 (0.021)	0.678 (0.032)	0.929 (0.013)	0.998 (0.001)
16	0.001 (<.001)	0.001 (<.001)	0.121 (0.014)	0.571 (0.032)	0.877 (0.018)	0.995 (0.002)
17	0.001 (<.001)	0.001 (<.001)	0.080 (0.010)	0.466 (0.029)	0.809 (0.021)	0.988 (0.003)
18	0.001 (<.001)	0.001 (<.001)	0.053 (0.007)	0.372 (0.025)	0.731 (0.024)	0.975 (0.005)
19	0.001 (<.001)	0.001 (<.001)	0.035 (0.004)	0.296 (0.021)	0.651 (0.024)	0.957 (0.007)
20	0.001 (<.001)	0.001 (<.001)	0.023 (0.003)	0.230 (0.017)	0.568 (0.023)	0.930 (0.009)
21	0.001 (<.001)	0.001 (<.001)	0.016 (0.002)	0.178 (0.014)	0.489 (0.023)	0.896 (0.011)
22	0.001 (<.001)	0.001 (<.001)	0.011 (0.001)	0.137 (0.011)	0.416 (0.021)	0.854 (0.013)
23	0.001 (<.001)	0.001 (<.001)	0.007 (0.001)	0.105 (0.009)	0.351 (0.018)	0.807 (0.015)
24	0 (0)	0.001 (<.001)	0.005 (0.001)	0.080 (0.007)	0.293 (0.016)	0.755 (0.016)
25	0 (0)	0.001 (<.001)	0.003 (<.001)	0.061 (0.005)	0.243 (0.014)	0.700 (0.017)

Table B4. Estimated proportions (standard error) of **monkeyface prickleback** larvae entrained through six different size screen slot openings based on head capsule regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.995 (0.005)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.932 (0.038)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.722 (0.079)	0.992 (0.006)	1 (0)	1 (0)	1 (0)	1 (0)
8	0.457 (0.073)	0.946 (0.023)	1 (0)	1 (0)	1 (0)	1 (0)
9	0.250 (0.049)	0.831 (0.045)	1 (0)	1 (0)	1 (0)	1 (0)
10	0.122 (0.025)	0.655 (0.053)	1 (0)	1 (0)	1 (0)	1 (0)
11	0.057 (0.013)	0.468 (0.050)	1 (0)	1 (0)	1 (0)	1 (0)
12	0.027 (0.006)	0.312 (0.039)	1 (0)	1 (0)	1 (0)	1 (0)
13	0.012 (0.003)	0.198 (0.028)	0.998 (0.001)	1 (0)	1 (0)	1 (0)
14	0.006 (0.001)	0.122 (0.018)	0.994 (0.002)	1 (0)	1 (0)	1 (0)
15	0.003 (0.001)	0.074 (0.011)	0.984 (0.004)	1 (0)	1 (0)	1 (0)
16	0.002 (<.001)	0.044 (0.007)	0.964 (0.008)	1 (0)	1 (0)	1 (0)
17	0.001 (<.001)	0.026 (0.004)	0.931 (0.012)	1 (0)	1 (0)	1 (0)
18	0.001 (<.001)	0.016 (0.002)	0.886 (0.015)	1 (0)	1 (0)	1 (0)
19	0 (0)	0.010 (0.002)	0.829 (0.018)	0.999 (<.001)	1 (0)	1 (0)
20	0 (0)	0.006 (0.001)	0.762 (0.021)	0.997 (0.001)	1 (0)	1 (0)
21	0 (0)	0.004 (0.001)	0.689 (0.023)	0.994 (0.001)	1 (0)	1 (0)
22	0 (0)	0.003 (<.001)	0.613 (0.022)	0.989 (0.002)	1 (0)	1 (0)
23	0 (0)	0.002 (<.001)	0.539 (0.022)	0.981 (0.003)	1 (0)	1 (0)
24	0 (0)	0.001 (<.001)	0.468 (0.020)	0.969 (0.004)	0.999 (<.001)	1 (0)
25	0 (0)	0.001 (<.001)	0.402 (0.019)	0.952 (0.006)	0.999 (<.001)	1 (0)

Table B5. Estimated proportions (standard error) of **combtooth blenny** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 20 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.997 (0.005)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.842 (0.102)	0.997 (0.004)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.411 (0.117)	0.917 (0.050)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.134 (0.046)	0.659 (0.088)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.041 (0.014)	0.381 (0.071)	0.999 (<.001)	1 (0)	1 (0)	1 (0)
8	0.012 (0.004)	0.183 (0.040)	0.992 (0.004)	1 (0)	1 (0)	1 (0)
9	0.004 (0.001)	0.087 (0.020)	0.966 (0.012)	1 (0)	1 (0)	1 (0)
10	0.001 (<.001)	0.041 (0.009)	0.908 (0.022)	0.999 (<.001)	1 (0)	1 (0)
11	0.001 (<.001)	0.020 (0.004)	0.817 (0.029)	0.996 (0.002)	1 (0)	1 (0)
12	0 (0)	0.010 (0.002)	0.707 (0.034)	0.988 (0.004)	1 (0)	1 (0)
13	0 (0)	0.005 (0.001)	0.593 (0.033)	0.970 (0.007)	0.999 (<.001)	1 (0)
14	0 (0)	0.003 (<.001)	0.481 (0.031)	0.941 (0.011)	0.997 (0.001)	1 (0)
15	0 (0)	0.002 (<.001)	0.385 (0.026)	0.900 (0.014)	0.992 (0.002)	1 (0)
16	0 (0)	0.001 (<.001)	0.304 (0.022)	0.849 (0.017)	0.983 (0.003)	1 (0)
17	0 (0)	0.001 (<.001)	0.239 (0.017)	0.789 (0.018)	0.970 (0.005)	1 (0)
18	0 (0)	0 (0)	0.186 (0.014)	0.724 (0.020)	0.951 (0.007)	0.999 (<.001)
19	0 (0)	0 (0)	0.145 (0.011)	0.657 (0.020)	0.926 (0.008)	0.998 (<.001)
20	0 (0)	0 (0)	0.113 (0.009)	0.591 (0.019)	0.895 (0.010)	0.997 (0.001)

Table B6. Estimated proportions (standard error) of **clingfish** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 20 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.963 (0.040)	0.999 (0.001)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.652 (0.126)	0.943 (0.043)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.313 (0.070)	0.696 (0.092)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.141 (0.032)	0.396 (0.072)	0.990 (0.006)	1 (0)	1 (0)	1 (0)
7	0.068 (0.014)	0.221 (0.036)	0.947 (0.020)	0.999 (<.001)	1 (0)	1 (0)
8	0.035 (0.007)	0.127 (0.021)	0.850 (0.036)	0.993 (0.003)	1 (0)	1 (0)
9	0.019 (0.003)	0.074 (0.011)	0.712 (0.043)	0.973 (0.009)	0.998 (0.001)	1 (0)
10	0.011 (0.002)	0.046 (0.007)	0.568 (0.041)	0.932 (0.016)	0.993 (0.003)	1 (0)
11	0.007 (0.001)	0.029 (0.004)	0.436 (0.035)	0.866 (0.022)	0.979 (0.006)	1 (0)
12	0.004 (0.001)	0.019 (0.003)	0.328 (0.028)	0.783 (0.026)	0.953 (0.010)	0.998 (<.001)
13	0.003 (<.001)	0.013 (0.002)	0.243 (0.021)	0.689 (0.028)	0.913 (0.014)	0.995 (0.001)
14	0.002 (<.001)	0.009 (0.001)	0.181 (0.016)	0.598 (0.027)	0.863 (0.017)	0.990 (0.002)
15	0.002 (<.001)	0.006 (0.001)	0.135 (0.011)	0.509 (0.024)	0.802 (0.019)	0.979 (0.004)
16	0.001 (<.001)	0.005 (0.001)	0.104 (0.008)	0.429 (0.022)	0.735 (0.021)	0.963 (0.006)
17	0.001 (<.001)	0.004 (<.001)	0.082 (0.006)	0.360 (0.020)	0.667 (0.021)	0.942 (0.008)
18	0.001 (<.001)	0.003 (<.001)	0.065 (0.005)	0.301 (0.017)	0.600 (0.020)	0.915 (0.009)
19	0.001 (<.001)	0.002 (<.001)	0.053 (0.004)	0.250 (0.014)	0.535 (0.019)	0.882 (0.011)
20	0 (0)	0.002 (<.001)	0.043 (0.003)	0.208 (0.012)	0.475 (0.017)	0.845 (0.012)

Table B7. Estimated proportions (standard error) of **anchovy** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	**1**	**2**	**3**	**4**	**6**
1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
6	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
7	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
8	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
9	0.997 (0.003)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
10	0.943 (0.037)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
11	0.699 (0.099)	0.997 (0.003)	1 (0)	1 (0)	1 (0)	1 (0)
12	0.350 (0.089)	0.956 (0.024)	1 (0)	1 (0)	1 (0)	1 (0)
13	0.125 (0.044)	0.803 (0.067)	1 (0)	1 (0)	1 (0)	1 (0)
14	0.033 (0.013)	0.530 (0.084)	1 (0)	1 (0)	1 (0)	1 (0)
15	0.007 (0.003)	0.268 (0.061)	1 (0)	1 (0)	1 (0)	1 (0)
16	0.001 (0.001)	0.109 (0.031)	1 (0)	1 (0)	1 (0)	1 (0)
17	0 (0)	0.037 (0.012)	1 (0)	1 (0)	1 (0)	1 (0)
18	0 (0)	0.011 (0.004)	1 (0)	1 (0)	1 (0)	1 (0)
19	0 (0)	0.003 (0.001)	0.999 (<.001)	1 (0)	1 (0)	1 (0)
20	0 (0)	0.001 (<.001)	0.993 (0.004)	1 (0)	1 (0)	1 (0)
21	0 (0)	0 (0)	0.968 (0.012)	1 (0)	1 (0)	1 (0)
22	0 (0)	0 (0)	0.900 (0.028)	1 (0)	1 (0)	1 (0)
23	0 (0)	0 (0)	0.765 (0.047)	1 (0)	1 (0)	1 (0)
24	0 (0)	0 (0)	0.590 (0.057)	1 (0)	1 (0)	1 (0)
25	0 (0)	0 (0)	0.401 (0.052)	1 (0)	1 (0)	1 (0)

Table B8. Estimated proportions (standard error) of **croaker** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 20 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.996 (0.009)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.575 (0.252)	0.998 (0.004)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.041 (0.043)	0.780 (0.155)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.001 (0.001)	0.224 (0.123)	1 (0)	1 (0)	1 (0)	1 (0)
7	0 (0)	0.019 (0.015)	1 (0)	1 (0)	1 (0)	1 (0)
8	0 (0)	0.001 (0.001)	0.998 (0.002)	1 (0)	1 (0)	1 (0)
9	0 (0)	0 (0)	0.969 (0.020)	1 (0)	1 (0)	1 (0)
10	0 (0)	0 (0)	0.826 (0.067)	1 (0)	1 (0)	1 (0)
11	0 (0)	0 (0)	0.546 (0.086)	1 (0)	1 (0)	1 (0)
12	0 (0)	0 (0)	0.280 (0.064)	0.998 (0.002)	1 (0)	1 (0)
13	0 (0)	0 (0)	0.113 (0.032)	0.983 (0.008)	1 (0)	1 (0)
14	0 (0)	0 (0)	0.039 (0.013)	0.932 (0.024)	1 (0)	1 (0)
15	0 (0)	0 (0)	0.012 (0.004)	0.823 (0.041)	0.999 (<.001)	1 (0)
16	0 (0)	0 (0)	0.003 (0.001)	0.657 (0.051)	0.997 (0.001)	1 (0)
17	0 (0)	0 (0)	0.001 (<.001)	0.478 (0.052)	0.987 (0.005)	1 (0)
18	0 (0)	0 (0)	0 (0)	0.315 (0.042)	0.960 (0.011)	1 (0)
19	0 (0)	0 (0)	0 (0)	0.191 (0.030)	0.906 (0.020)	1 (0)
20	0 (0)	0 (0)	0 (0)	0.108 (0.018)	0.821 (0.029)	1 (0)

Table B9. Estimated proportions (standard error) of **goby** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.907 (0.086)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.379 (0.167)	0.994 (0.008)	1 (0)	1 (0)	1 (0)	1 (0)
8	0.051 (0.037)	0.851 (0.093)	1 (0)	1 (0)	1 (0)	1 (0)
9	0.003 (0.002)	0.420 (0.131)	1 (0)	1 (0)	1 (0)	1 (0)
10	0 (0)	0.100 (0.049)	1 (0)	1 (0)	1 (0)	1 (0)
11	0 (0)	0.014 (0.009)	1 (0)	1 (0)	1 (0)	1 (0)
12	0 (0)	0.001 (0.001)	1 (0)	1 (0)	1 (0)	1 (0)
13	0 (0)	0 (0)	0.992 (0.005)	1 (0)	1 (0)	1 (0)
14	0 (0)	0 (0)	0.947 (0.023)	1 (0)	1 (0)	1 (0)
15	0 (0)	0 (0)	0.817 (0.052)	1 (0)	1 (0)	1 (0)
16	0 (0)	0 (0)	0.603 (0.069)	1 (0)	1 (0)	1 (0)
17	0 (0)	0 (0)	0.375 (0.061)	1 (0)	1 (0)	1 (0)
18	0 (0)	0 (0)	0.194 (0.042)	0.996 (0.002)	1 (0)	1 (0)
19	0 (0)	0 (0)	0.089 (0.022)	0.983 (0.006)	1 (0)	1 (0)
20	0 (0)	0 (0)	0.036 (0.010)	0.946 (0.016)	1 (0)	1 (0)
21	0 (0)	0 (0)	0.013 (0.004)	0.872 (0.029)	1 (0)	1 (0)
22	0 (0)	0 (0)	0.004 (0.001)	0.750 (0.039)	0.999 (<.001)	1 (0)
23	0 (0)	0 (0)	0.001 (<.001)	0.604 (0.045)	0.996 (0.001)	1 (0)
24	0 (0)	0 (0)	0 (0)	0.454 (0.043)	0.989 (0.004)	1 (0)
25	0 (0)	0 (0)	0 (0)	0.313 (0.037)	0.970 (0.008)	1 (0)

Table B10. Estimated proportions (standard error) of **silverside** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.997 (0.005)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.687 (0.225)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
8	0.068 (0.068)	0.969 (0.040)	1 (0)	1 (0)	1 (0)	1 (0)
9	0.001 (0.001)	0.528 (0.202)	1 (0)	1 (0)	1 (0)	1 (0)
10	0 (0)	0.065 (0.055)	1 (0)	1 (0)	1 (0)	1 (0)
11	0 (0)	0.002 (0.002)	1 (0)	1 (0)	1 (0)	1 (0)
12	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)	1 (0)
13	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)	1 (0)
14	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)	1 (0)
15	0 (0)	0 (0)	0.994 (0.006)	1 (0)	1 (0)	1 (0)
16	0 (0)	0 (0)	0.896 (0.062)	1 (0)	1 (0)	1 (0)
17	0 (0)	0 (0)	0.545 (0.127)	1 (0)	1 (0)	1 (0)
18	0 (0)	0 (0)	0.175 (0.076)	1 (0)	1 (0)	1 (0)
19	0 (0)	0 (0)	0.027 (0.017)	1 (0)	1 (0)	1 (0)
20	0 (0)	0 (0)	0.002 (0.002)	1 (0)	1 (0)	1 (0)
21	0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)
22	0 (0)	0 (0)	0 (0)	0.993 (0.005)	1 (0)	1 (0)
23	0 (0)	0 (0)	0 (0)	0.949 (0.025)	1 (0)	1 (0)
24	0 (0)	0 (0)	0 (0)	0.799 (0.062)	1 (0)	1 (0)
25	0 (0)	0 (0)	0 (0)	0.537 (0.082)	1 (0)	1 (0)

Table B11. Estimated proportions (standard error) of **Pacific barracuda** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 20 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.976 (0.020)	0.999 (0.001)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.836 (0.058)	0.980 (0.013)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.628 (0.058)	0.903 (0.031)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.452 (0.044)	0.781 (0.038)	0.998 (0.001)	1 (0)	1 (0)	1 (0)
7	0.326 (0.029)	0.650 (0.036)	0.992 (0.003)	1 (0)	1 (0)	1 (0)
8	0.241 (0.021)	0.536 (0.032)	0.979 (0.006)	0.999 (<.001)	1 (0)	1 (0)
9	0.183 (0.014)	0.441 (0.024)	0.955 (0.008)	0.997 (0.001)	1 (0)	1 (0)
10	0.143 (0.010)	0.366 (0.020)	0.924 (0.010)	0.993 (0.002)	0.999 (<.001)	1 (0)
11	0.113 (0.008)	0.306 (0.016)	0.886 (0.012)	0.987 (0.003)	0.998 (<.001)	1 (0)
12	0.092 (0.006)	0.258 (0.013)	0.844 (0.013)	0.977 (0.004)	0.996 (0.001)	1 (0)
13	0.076 (0.005)	0.220 (0.011)	0.801 (0.013)	0.964 (0.004)	0.993 (0.001)	1 (0)
14	0.064 (0.004)	0.190 (0.009)	0.757 (0.013)	0.948 (0.005)	0.989 (0.002)	0.999 (<.001)
15	0.054 (0.003)	0.166 (0.007)	0.715 (0.013)	0.930 (0.006)	0.983 (0.002)	0.999 (<.001)
16	0.047 (0.003)	0.145 (0.006)	0.673 (0.013)	0.909 (0.007)	0.975 (0.003)	0.998 (<.001)
17	0.041 (0.002)	0.128 (0.006)	0.633 (0.012)	0.887 (0.007)	0.966 (0.003)	0.997 (0.001)
18	0.036 (0.002)	0.114 (0.005)	0.597 (0.011)	0.865 (0.007)	0.956 (0.004)	0.995 (0.001)
19	0.032 (0.002)	0.103 (0.004)	0.563 (0.011)	0.842 (0.008)	0.945 (0.004)	0.993 (0.001)
20	0.028 (0.002)	0.092 (0.004)	0.531 (0.010)	0.817 (0.008)	0.932 (0.004)	0.990 (0.001)

Table B12. Estimated proportions (standard error) of **rockfish** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.989 (0.012)	0.999 (0.001)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.871 (0.054)	0.972 (0.018)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.663 (0.062)	0.868 (0.041)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.466 (0.048)	0.708 (0.046)	0.994 (0.003)	1 (0)	1 (0)	1 (0)
7	0.328 (0.033)	0.556 (0.041)	0.973 (0.010)	0.999 (<.001)	1 (0)	1 (0)
8	0.232 (0.022)	0.427 (0.032)	0.927 (0.017)	0.997 (0.001)	1 (0)	1 (0)
9	0.169 (0.015)	0.332 (0.024)	0.862 (0.022)	0.989 (0.003)	0.999 (<.001)	1 (0)
10	0.126 (0.011)	0.258 (0.019)	0.780 (0.025)	0.974 (0.006)	0.997 (0.001)	1 (0)
11	0.096 (0.008)	0.204 (0.014)	0.696 (0.025)	0.949 (0.009)	0.993 (0.002)	1 (0)
12	0.075 (0.006)	0.164 (0.011)	0.614 (0.024)	0.916 (0.011)	0.985 (0.003)	1 (0)
13	0.060 (0.004)	0.133 (0.008)	0.535 (0.022)	0.875 (0.013)	0.972 (0.005)	0.999 (<.001)
14	0.049 (0.003)	0.110 (0.007)	0.467 (0.019)	0.829 (0.014)	0.955 (0.006)	0.997 (0.001)
15	0.040 (0.003)	0.092 (0.005)	0.409 (0.016)	0.781 (0.015)	0.933 (0.007)	0.994 (0.001)
16	0.034 (0.002)	0.078 (0.005)	0.362 (0.014)	0.731 (0.015)	0.908 (0.009)	0.991 (0.002)
17	0.028 (0.002)	0.066 (0.004)	0.321 (0.011)	0.681 (0.015)	0.879 (0.009)	0.985 (0.002)
18	0.024 (0.002)	0.057 (0.003)	0.287 (0.010)	0.632 (0.015)	0.847 (0.010)	0.977 (0.003)
19	0.021 (0.002)	0.049 (0.003)	0.257 (0.009)	0.587 (0.014)	0.814 (0.010)	0.968 (0.003)
20	0.018 (0.001)	0.043 (0.003)	0.231 (0.008)	0.542 (0.013)	0.779 (0.011)	0.957 (0.004)
21	0.016 (0.001)	0.038 (0.002)	0.209 (0.007)	0.502 (0.013)	0.745 (0.011)	0.944 (0.005)
22	0.014 (0.001)	0.034 (0.002)	0.189 (0.007)	0.464 (0.011)	0.711 (0.011)	0.930 (0.005)
23	0.013 (0.001)	0.030 (0.002)	0.172 (0.006)	0.429 (0.011)	0.676 (0.011)	0.914 (0.006)
24	0.011 (0.001)	0.027 (0.002)	0.157 (0.005)	0.397 (0.010)	0.644 (0.010)	0.897 (0.006)
25	0.010 (0.001)	0.024 (0.002)	0.144 (0.005)	0.368 (0.010)	0.612 (0.010)	0.879 (0.006)

Table B13. Estimated proportions (standard error) of **cabezon** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	0.998 (0.003)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.926 (0.048)	0.995 (0.006)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.690 (0.081)	0.934 (0.033)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.431 (0.066)	0.776 (0.057)	0.999 (0.001)	1 (0)	1 (0)	1 (0)
7	0.250 (0.038)	0.572 (0.056)	0.992 (0.004)	1 (0)	1 (0)	1 (0)
8	0.165 (0.016)	0.396 (0.042)	0.968 (0.011)	0.999 (<.001)	1 (0)	1 (0)
9	0.119 (0.011)	0.289 (0.023)	0.918 (0.019)	0.996 (0.002)	1 (0)	1 (0)
10	0.087 (0.008)	0.224 (0.016)	0.842 (0.025)	0.986 (0.004)	0.999 (<.001)	1 (0)
11	0.066 (0.006)	0.177 (0.013)	0.753 (0.028)	0.966 (0.008)	0.996 (0.001)	1 (0)
12	0.052 (0.004)	0.141 (0.010)	0.659 (0.026)	0.934 (0.011)	0.990 (0.003)	1 (0)
13	0.041 (0.003)	0.114 (0.007)	0.587 (0.019)	0.891 (0.014)	0.978 (0.004)	0.999 (<.001)
14	0.033 (0.003)	0.094 (0.006)	0.526 (0.018)	0.838 (0.017)	0.960 (0.007)	0.998 (0.001)
15	0.027 (0.002)	0.079 (0.005)	0.475 (0.015)	0.785 (0.015)	0.936 (0.008)	0.995 (0.001)
16	0.023 (0.002)	0.066 (0.004)	0.426 (0.014)	0.737 (0.013)	0.904 (0.010)	0.990 (0.002)
17	0.019 (0.002)	0.056 (0.003)	0.383 (0.012)	0.693 (0.013)	0.868 (0.011)	0.983 (0.003)
18	0.016 (0.001)	0.048 (0.003)	0.346 (0.011)	0.652 (0.013)	0.833 (0.010)	0.974 (0.004)
19	0.014 (0.001)	0.042 (0.003)	0.313 (0.010)	0.614 (0.012)	0.803 (0.010)	0.961 (0.005)
20	0.012 (0.001)	0.036 (0.002)	0.284 (0.009)	0.576 (0.012)	0.772 (0.010)	0.946 (0.006)
21	0.011 (0.001)	0.032 (0.002)	0.259 (0.008)	0.542 (0.011)	0.742 (0.010)	0.928 (0.006)
22	0.009 (0.001)	0.028 (0.002)	0.236 (0.007)	0.508 (0.010)	0.711 (0.009)	0.909 (0.006)
23	0.008 (0.001)	0.025 (0.002)	0.216 (0.007)	0.477 (0.010)	0.682 (0.010)	0.891 (0.006)
24	0.007 (0.001)	0.022 (0.002)	0.198 (0.006)	0.449 (0.009)	0.653 (0.009)	0.874 (0.006)
25	0.007 (0.001)	0.020 (0.001)	0.182 (0.006)	0.422 (0.009)	0.626 (0.009)	0.856 (0.006)

Table B14. Estimated proportions (standard error) of **sea bass** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths to 25 mm.

Length (mm)	Screen Slot Dimension (mm) 0.75	1	2	3	4	6
1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
2	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
3	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.792 (0.278)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.013 (0.027)	0.947 (0.091)	1 (0)	1 (0)	1 (0)	1 (0)
6	0 (0)	0.151 (0.187)	1 (0)	1 (0)	1 (0)	1 (0)
7	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)	1 (0)
8	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)	1 (0)
9	0 (0)	0 (0)	0.997 (0.005)	1 (0)	1 (0)	1 (0)
10	0 (0)	0 (0)	0.804 (0.143)	1 (0)	1 (0)	1 (0)
11	0 (0)	0 (0)	0.220 (0.137)	1 (0)	1 (0)	1 (0)
12	0 (0)	0 (0)	0.012 (0.012)	1 (0)	1 (0)	1 (0)
13	0 (0)	0 (0)	0 (0)	0.997 (0.004)	1 (0)	1 (0)
14	0 (0)	0 (0)	0 (0)	0.923 (0.052)	1 (0)	1 (0)
15	0 (0)	0 (0)	0 (0)	0.597 (0.128)	1 (0)	1 (0)
16	0 (0)	0 (0)	0 (0)	0.202 (0.084)	1 (0)	1 (0)
17	0 (0)	0 (0)	0 (0)	0.032 (0.020)	0.994 (0.005)	1 (0)
18	0 (0)	0 (0)	0 (0)	0.003 (0.002)	0.941 (0.033)	1 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0.751 (0.080)	1 (0)
20	0 (0)	0 (0)	0 (0)	0 (0)	0.429 (0.094)	1 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0.167 (0.054)	1 (0)
22	0 (0)	0 (0)	0 (0)	0 (0)	0.044 (0.019)	1 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0.009 (0.004)	1 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0.001 (0.001)	0.997 (0.002)
25	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.983 (0.008)

Table B15. Estimated proportions (standard error) of **prickleback** larvae entrained through six different size screen slot openings based on head capsule allometric regressions on notochord lengths **to 25 mm**.

Length (mm)	Screen Slot Dimension (mm)					
	0.75	1	2	3	4	6
3	0.964 (0.025)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
4	0.826 (0.053)	0.991 (0.006)	1 (0)	1 (0)	1 (0)	1 (0)
5	0.639 (0.054)	0.952 (0.017)	1 (0)	1 (0)	1 (0)	1 (0)
6	0.472 (0.042)	0.878 (0.025)	1 (0)	1 (0)	1 (0)	1 (0)
7	0.348 (0.030)	0.787 (0.028)	1 (0)	1 (0)	1 (0)	1 (0)
8	0.260 (0.022)	0.692 (0.028)	1 (0)	1 (0)	1 (0)	1 (0)
9	0.195 (0.015)	0.599 (0.025)	1 (0)	1 (0)	1 (0)	1 (0)
10	0.151 (0.012)	0.520 (0.023)	0.999 (<.001)	1 (0)	1 (0)	1 (0)
11	0.119 (0.009)	0.450 (0.020)	0.998 (<.001)	1 (0)	1 (0)	1 (0)
12	0.094 (0.006)	0.389 (0.016)	0.996 (0.001)	1 (0)	1 (0)	1 (0)
13	0.076 (0.005)	0.338 (0.014)	0.992 (0.001)	1 (0)	1 (0)	1 (0)
14	0.063 (0.004)	0.296 (0.012)	0.988 (0.002)	1 (0)	1 (0)	1 (0)
15	0.052 (0.003)	0.260 (0.011)	0.981 (0.002)	1 (0)	1 (0)	1 (0)
16	0.043 (0.003)	0.229 (0.009)	0.973 (0.003)	1 (0)	1 (0)	1 (0)
17	0.037 (0.002)	0.203 (0.008)	0.964 (0.004)	1 (0)	1 (0)	1 (0)
18	0.032 (0.002)	0.181 (0.007)	0.953 (0.004)	0.999 (<.001)	1 (0)	1 (0)
19	0.027 (0.002)	0.161 (0.006)	0.940 (0.004)	0.999 (<.001)	1 (0)	1 (0)
20	0.024 (0.002)	0.145 (0.006)	0.927 (0.005)	0.999 (<.001)	1 (0)	1 (0)
21	0.021 (0.001)	0.130 (0.005)	0.912 (0.005)	0.998 (<.001)	1 (0)	1 (0)
22	0.019 (0.001)	0.118 (0.005)	0.896 (0.005)	0.997 (<.001)	1 (0)	1 (0)
23	0.017 (0.001)	0.107 (0.004)	0.880 (0.006)	0.996 (0.001)	1 (0)	1 (0)
24	0.015 (0.001)	0.098 (0.004)	0.864 (0.006)	0.995 (0.001)	1 (0)	1 (0)
25	0.013 (0.001)	0.089 (0.004)	0.846 (0.006)	0.994 (0.001)	1 (0)	1 (0)