

MODIFIED DREDGE IMPACT MODEL FOR ESTIMATING HOPPER DREDGE ENTRAINMENT IMPACTS TO COLUMBIA RIVER CRAB

Field Date	Field Location	Projection	Total Volume Dredged (cy)
2002	MCR - Essayons	2002 Total	3017176

Sex Ratios by Age Class, Derived from July-Oct Data

Age Class	Total			Proportion		
	Male	Female	Sexed	Male	Female	
YOY	2	5	7	0.50	0.50	* binomial distribution p>0.05; low sample size - assumed to be 1:1.
1+	24	37	61	0.39	0.61	binomial distribution p=0.026; significantly different from 1:1
2+	25	113	138	0.18	0.82	binomial distribution p<0.001; significantly different from 1:1
3+	5	24	29	0.17	0.83	binomial distribution p<0.001; significantly different from 1:1

Estimates of Crab Entrainment Rate (R), Number of Crabs Entrained (E), Adult Equivalent Loss (AEL), and Variance (AEL)

Age Class	R	E	Var(E)	M	S to 2+	AEL at 2+	VAR(AEL 2+)	AEL at 3+	VAR(AEL 3+)
YOY	0.00335	10104.9		0.10	0.017	16.67		7.50	
1+	0.01440	43447.1		0.60	0.160	4170.92		1876.92	
2+	0.03218	97099.2		0.86	0.649	54194.97		24387.73	
3+	0.01040	31369.0		0.86	2.222	59943.67		26974.65	
All		182020.3				118326.23		53246.80	

Note: Entrained 3+ crab are back-calculated to provide AEL at 2+.

AGE 2+ Calculations

Contribution to Adult Equivalent Loss (AEL at 2+) and Variance (AEL at 2+) by Sex (MALE/FEMALE) and Age Class

Age Class	Female			Male		
	Proportion	AEL	VAR(AEL)	Proportion	AEL	VAR(AEL)
YOY	0.50	8.34		0.50	8.34	
1+	0.61	2529.90		0.39	1641.02	
2+	0.82	44377.04		0.18	9817.93	
3+	0.83	49608.55		0.17	10335.12	
All		96523.83			21802.40	

R = Crab Entrainment Rate (crabs/cy)  
E = Crabs Entrained (number of Crabs)  
M = Post-Entrainment Mortality (proportion)  
S = Natural Survivorship (proportion); survival to 3+ is assumed to be 45%  
AEL = Adult Equivalent Loss  
VAR(AEL) = AEL Variance

Age Class Distribution

Age Class	% of Total	
	of Entrained	of AEL
YOY	5.55	0.00
1+	23.87	3.52
2+	53.35	45.80
3+	17.23	50.66

Age Class	Proportion of Total AEL	
	Male	Female
YOY	0.0001	0.0001
1+	0.0139	0.0214
2+	0.0830	0.3750
3+	0.0873	0.4193
ALL	0.18	0.82

AGE 3+ Calculations

Contribution to Adult Equivalent Loss (AEL at 3+) and Variance (AEL at 3+) by Sex (MALE/FEMALE) and Age Class

Age Class	Female			Male		
	Proportion	AEL	VAR(AEL)	Proportion	AEL	VAR(AEL)
YOY	0.50	3.75		0.50	3.75	
1+	0.61	1138.46		0.39	738.46	
2+	0.82	19969.67		0.18	4418.07	
3+	0.83	22323.85		0.17	4650.80	
All		43435.72			9811.08	

R = Crab Entrainment Rate (crabs/cy)  
E = Crabs Entrained (number of Crabs)  
M = Post-Entrainment Mortality (proportion)  
S = Natural Survivorship (proportion); survival to 3+ is assumed to be 45%  
AEL = Adult Equivalent Loss  
VAR(AEL) = AEL Variance

53246.803

Age Class Distribution

Age Class	% of Total	
	of Entrained	of AEL at 3+
YOY	5.55	0.01
1+	23.87	3.52
2+	53.35	45.80
3+	17.23	50.66

Age Class	Proportion of Total AEL at 3+	
	Male	Female
YOY	0.0001	0.0001
1+	0.0139	0.0214
2+	0.0830	0.3750
3+	0.0873	0.4193
ALL	0.18	0.82

**SUMMARY VARIANCE DATA**

Entrainment with Confidence Limits

E	182020.3
Var(E)	
SE E	
Z at 0.975	1.95996
95% C. I.	
CV E (%)	

SE = Standard Error  
Z = Value of Z from Normal Distribution

TOTAL AEL at 2+ with Confidence Limits

AEL at 2+	118326.2
Var(AEL2+)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

C.I. = Confidence Interval  
CV = Coefficient of Variation in %

TOTAL AEL at 3+ with Confidence Limits

AEL at 3+	53246.8
Var(AEL3+)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

MALE AEL at 3+ with Confidence Limits

AEL at 3+	9811.1
Var(AEL)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

FEMALE AEL at 3+ with Confidence Limits

AEL at 3+	43435.7
Var(AEL)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

**TOTAL LOSS TO MALE FISHERY**

(This total would be distributed over 3-4 years)

Male Age 3+ (number of crab)	Harvest Rate (proportion)	Lost to Fishery (number of crab)
9811.1	0.70	6867.8

Harvest rate of 0.70 is taken from Armstrong et al. (1987).

Loss to Fishery with Confidence Limits

Loss to Fishery	6867.8
Var(AEL)	
SE LF	
Z at 0.975	1.95996
95% C. I.	
CV LF (%)	

**ADDITIONAL NOTES:**

Mortality Rates (M) for crabs collected in June-September are from Armstrong et al. 1987 (Table 3.3, p. 61)  
Survival rates (S) to age 2+ for crab collected from June-September are from Wainwright et al. 1992 (Table 6, p. 178), and thereafter survival rate from 2+ to age 3+ is 0.45 (Armstrong et al. 1987).  
Sex ratios used were those observed or assumed to be 1:1 where sample size was low.