

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

Field Date	Field Location	Projection	Total Volume Dredged (cy)
1998-2002	MCR - Contractor	5 Yr Average	1831427

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	6133.7		0.10	0.017	10.12		4.55	
1+	0.01440	26372.4		0.60	0.160	2531.75		1139.29	
2+	0.03218	58939.3		0.86	0.649	32896.37		14803.36	
3+	0.01040	19041.0		0.86	2.222	36385.83		16373.62	
All		110486.4				71824.07		32320.83	

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	5.06		0.50	5.06		R = Crab Entrainment Rate (crabs/cy)
1+	0.61	1535.65		0.39	996.10		E = Crabs Entrained (number of Crabs)
2+	0.82	26936.88		0.18	5959.49		M = Post-Entrainment Mortality (proportion)
3+	0.83	30112.41		0.17	6273.42		S = Natural Survivorship (proportion); survival to 3+ is assumed to be 45%
All		58590.00			13234.06		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	2.28		0.50	2.28		R = Crab Entrainment Rate (crabs/cy)
1+	0.61	691.04		0.39	448.24		E = Crabs Entrained (number of Crabs)
2+	0.82	12121.60		0.18	2681.77		M = Post-Entrainment Mortality (proportion)
3+	0.83	13550.58		0.17	2823.04		S = Natural Survivorship (proportion); survival to 3+ is assumed to be 45%
All		26365.50			5955.33		AEL = Adult Equivalent Loss
							VAR(AEL) = AEL Variance

32320.830

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	110486.4
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+	71824.1
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+	32320.8
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+	5955.3
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+	26365.5
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)
5955.3	0.70	4168.7

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

Loss to Fishery with Confidence Limits

Loss to Fishery	4168.7
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.