Appendix B2: Delaware Estuary Life History Parameter Values

The tables in this appendix are those life history parameter values used by EPA to calculate age 1 equivalents, fishery yield, and production foregone for transition zone CWIS using Salem's I&E data.

Table B2-1: Alewife Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)[a]
Eggs	0.554	0	0	0.000022[b]
Yolksac larvae	1.81	0	0	0.00606[b]
Post-yolksac larvae	1.72	0	0	0.0121[b]
Juvenile 1	3.11	0	0	0.0181[b]
Juvenile 2	3.11	0	0	0.0242[b]
Age 1+	0.3	0	0	0.0303
Age 2+	0.3	0	0	0.125
Age 3+	0.3	0	0	0.254
Age 4+	0.9	0.1	0.45	0.379
Age 5+	1.5	0.1	0.9	0.485
Age 6+	1.5	0.1	1	0.565
Age 7+	1.5	0.1	1	0.625
Age 8+	1.5	0.1	1	0.666

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-2: American Shad Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)[a]
Eggs	0.496	0	0	0.000022[b]
Yolksac larvae	0.496	0	0	0.0618[b]
Post-yolksac larvae	2.52	0	0	0.124[b]
Juvenile 1	7.4	0	0	0.185[b]
Age 1+	0.3	0	0	0.309
Age 2+	0.3	0	0	1.17
Age 3+	0.3	0	0	2.32
Age 4+	0.54	0.21	0.45	3.51
Age 5+	1.02	0.21	0.9	4.56
Age 6+	1.5	0.21	1	5.47
Age 7+	1.5	0.21	1	6.2
Age 8+	1.5	0.21	1	6.77

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-3: Atlantic Croaker Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)[a]
Eggs	0.817	0	0	0.000022[b]
Yolksac larvae	3.27	0	0	0.0439[b]
Post-yolksac larvae	4.9	0	0	0.0878[b]
Juvenile 1	1.18	0	0	0.132[b]
Juvenile 2	2.2	0	0	0.176[b]
Age 1+	1.09	0.3	0.5	0.22
Age 2+	0.3	0.3	1	0.672
Age 3+	0.3	0.3	1	1.24
Age 4+	0.3	0.3	1	1.88
Age 5+	0.3	0.3	1	2.43
Age 6+	0.3	0.3	1	3.26
Age 7+	0.3	0.3	1	3.26
Age 8+	0.3	0.3	1	3.26

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-4: Atlantic Menhaden Species Parameters.

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery[c]	Weight (lbs)[e]
Eggs	2.07[a]	0[c]	0	0.0000000602[f]
Yolksac larvae	2.85[a]	0[c]	0	0.00000068[f]
Post-yolksac larvae	2.85[a]	0[c]	0	0.545[g]
Juvenile 1	2.85[a]	0[c]	0	0.855[g]
Age 1+	0.45[b]	0[c]	0	1.08[g]
Age 2+	0.45[b]	0.8[d]	0.5	1.31[g]
Age 3+	0.45[b]	0.8[d]	1	1.47[g]
Age 4+	0.45[b]	0.8[d]	1	1.59[g]
Age 5+	0.45[b]	0.8[d]	1	3.1[h]
Age 6+	0.45[b]	0.8[d]	1	5.21[h]
Age 7+	0.45[b]	0.8[d]	1	5.24[h]
Age 8+	0.45[b]	0.8[d]	1	5.28[i]

[a] Calculated from survival data from (Entergy Nuclear Generation Company, 2000) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Atlantic States Marine Fisheries Commission, 2001b.
[c] Assumed based on age of entry into fishery (Durbin et al., 1983).
[d] Ruppert et al., 1985.
[e] Weight calculated from length using the formula: $(6.02*10^{-6})*\text{Length(mm)}^{3.216} = \text{Weight(gm)}$ (Froese & Pauly, 2001).
[f] Able and Fahay, 1998.
[g] Durbin et al., 1983.
[h] Extrapolated by EPA based on weight at Age 4+ (Durbin et al., 1993) and weight at Age 8+ (Scott and Scott, 1988).
[i] Scott and Scott, 1988.

Table B2-5: Bay Anchovy Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)
Eggs	1.04	0	0	0.000022[b]
Yolksac larvae	1.57	0	0	0.000551[b]
Post-yolksac larvae (1)	2.11	0	0	0.00108[b]
Post yolksac larvae (2)	4.02	0	0	0.00161[b]
Juvenile 1	0.0822	0	0	0.00214[b]
Juvenile 2	0.0861	0	0	0.00267[b]
Juvenile 3	0.129	0	0	0.00320[b]
Juvenile 4	0.994	0	0	0.00373[b]
Age 1+	1.62	0	0	0.00381[a]
Age 2+	1.62	0	0	0.00496[a]
Age 3+	1.62	0	0	0.00505[a]

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-6: Blue Crab Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[b]	Fraction Vulnerable to Fishery[c]	Weight (lbs)[d]
Entrainable juveniles	0.86	0.48	0.5	0.00000291
Age 1+	1.7	0.48	1	0.111
Age 2+	1.09	0.48	1	0.354
Age 3+	1.39	0.48	1	0.806

[a] Calculated from survival (PSEG, 1999b) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] PSEG, 1999b.
[c] Assumed based on fishing mortality.
[d] Calculated from carapace width (PSEG, 1999b) using the formula: weight(g) = $(9.59*10^{-5})*(\text{width})^{2.86}$.

Table B2-7: Blueback Herring Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery[a]	Weight (lbs)
Eggs	0.558	0[a]	0	0.000022[c]
Yolksac larvae	1.83	0[a]	0	0.00321[c]
Post-yolksac larvae	1.74	0[a]	0	0.0064[c]
Juvenile 1	3.13	0[a]	0	0.00959[c]
Juvenile 2	3.13	0[b]	0	0.0128[c]
Age 1+	0.3	0[b]	0	0.016[a]
Age 2+	0.3	0[b]	0	0.0905[a]
Age 3+	0.3	0[b]	0	0.204[a]
Age 4+	0.9	0[b]	0	0.318[a]
Age 5+	1.5	0[b]	0	0.414[a]
Age 6+	1.5	0[b]	0	0.488[a]
Age 7+	1.5	0[b]	0	0.54[a]
Age 8+	1.5	0[b]	0	0.576[a]

[a] PSEG, 1999c.
[b] Assumed based on landings data. See NMFS, 2001a and b.
[c] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-8: Silversides Species Parameters.

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery	Weight (lbs)[c]
Eggs	2.3[a]	0	0	0.0000000246[e]
Larvae	2.05[b]	0	0	0.000108[e]
Age 1+	2.1[c]	0.2	0.5	0.0101[f]
Age 2+	2.1[c]	0.2	1	0.0139[f]

[a] Calculated from survival (Stone & Webster Engineering Corporation, 1977) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Calculated from survival data (based on egg and age 1 survival) using the equation: (natural mortality) = -LN(survival)-(fishing mortality).
[c] Froese & Pauly, 2001.
[d] Assumed based on Atlantic herring fishing mortality (NOAA, 2001c).
[e] Able and Fahay, 1998.
[f] Scott and Scott, 1988.

Table B2-9: Spot Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery [a]	Weight (lbs)
Eggs	0.825	0	0	0.000022[b]
Yolksac larvae	3.3	0	0	0.0188[b]
Post-yolksac larvae	4.12	0	0	0.0376[b]
Juvenile 1	1.58	0	0	0.0565[b]
Juvenile 2	0.99	0.247	0.3	0.0573[a]
Age 1+	0.463	0.4	1	0.0791[a]
Age 2+	0.4	0.4	1	0.299[a]
Age 3+	0.4	0.4	1	0.507[a]
Age 4+	0.4	0.4	1	0.648[a]
Age 5+	0.4	0.4	1	0.732[a]
Age 6+	0.4	0.4	1	0.779[a]
Age 7+	0.4	0.4	1	0.779[a]
Age 8+	0.4	0.4	1	0.779[a]
Age 9+	0.4	0.4	1	0.779[a]
Age 10+	0.4	0.4	1	0.779[a]
Age 11+	0.4	0.4	1	0.779[a]
Age 12+	0.4	0.4	1	0.779[a]
Age 13+	0.4	0.4	1	0.779[a]
Age 14+	0.4	0.4	1	0.779[a]
Age 15+	0.4	0.4	1	0.779[a]

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-10: Striped Bass Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)
Eggs	1.39	0	0	0.000022[b]
Yolksac larvae	2.22	0	0	0.097[b]
Post-yolksac larvae	5.11	0	0	0.194[b]
Juvenile 1	2.28	0	0	0.291[b]
Juvenile 2	1	0	0	0.388[b]
Age 1+	1.1	0	0	0.485[a]
Age 2+	0.15	0.31	0.06	2.06[a]
Age 3+	0.15	0.31	0.2	3.31[a]
Age 4+	0.15	0.31	0.63	4.93[a]
Age 5+	0.15	0.31	0.94	6.5[a]
Age 6+	0.15	0.31	1	8.58[a]
Age 7+	0.15	0.31	0.9	12.3[a]
Age 8+	0.15	0.31	0.9	14.3[a]
Age 9+	0.15	0.31	0.9	16.1[a]
Age 10+	0.15	0.31	0.9	18.8[a]
Age 11+	0.15	0.31	0.9	19.6[a]
Age 12+	0.15	0.31	0.9	22.4[a]
Age 13+	0.15	0.31	0.9	27[a]
Age 14+	0.15	0.31	0.9	34.6[a]
Age 15+	0.15	0.31	0.9	41.5[a]

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-11: Weakfish Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)
Eggs	1.04	0	0	0.000022[b]
Yolksac larvae	1.34	0	0	0.026[b]
Post-yolksac larvae	6.33	0	0	0.052[b]
Juvenile 1	2.44	0	0	0.078[b]
Juvenile 2	1.48	0	0	0.13[a]
Age 1+	0.349	0.25	0.1	0.26[a]
Age 2+	0.25	0.25	0.5	0.68[a]
Age 3+	0.25	0.25	1	1.12[a]
Age 4+	0.25	0.25	1	1.79[a]
Age 5+	0.25	0.25	1	2.91[a]
Age 6+	0.25	0.25	1	6.21[a]
Age 7+	0.25	0.25	1	7.14[a]
Age 8+	0.25	0.25	1	9.16[a]
Age 9+	0.25	0.25	1	10.8[a]
Age 10+	0.25	0.25	1	12.5[a]
Age 11+	0.25	0.25	1	12.5[a]
Age12+	0.25	0.25	1	12.5[a]
Age 13+	0.25	0.25	1	12.5[a]
Age 14+	0.25	0.25	1	12.5[a]
Age 15+	0.25	0.25	1	12.5[a]

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-12: White Perch Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)
Eggs	2.75	0	0	0.000022[b]
Yolksac larvae	2.1	0	0	0.00946[b]
Post-yolksac larvae	3.27	0	0	0.0189[b]
Juvenile 1	0.947	0	0	0.0283[b]
Juvenile 2	0.759	0	0	0.0378[b]
Age 1+	0.693	0	0	0.0472[a]
Age 2+	0.693	0	0	0.0567[a]
Age 3+	0.693	0.15	0.0008	0.103[a]
Age 4+	0.689	0.15	0.0266	0.15[a]
Age 5+	1.58	0.15	0.212	0.214[a]
Age 6+	1.54	0.15	0.48	0.265[a]
Age 7+	1.48	0.15	0.838	0.356[a]
Age 8+	1.46	0.15	1	0.387[a]
Age 9+	1.46	0.15	1	0.516[a]
Age 10+	1.46	0.15	1	0.619[a]

[a] PSEG, 1999c.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-13: Non-RIS Forage Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lbs)
Eggs	1.04	0	0	0.000022[b]
Yolksac larvae	1.57	0	0	0.000551[b]
Post-yolksac larvae 1	2.11	0	0	0.00108[b]
Post-yolksac larvae 2	4.02	0	0	0.00161[b]
Juvenile 1	0.0822	0	0	0.00214[b]
Juvenile 2	0.0861	0	0	0.00267[b]
Juvenile 3	0.129	0	0	0.0032[b]
Juvenile 4	0.994	0	0	0.00373[b]
Age 1+	1.62	0	0	0.00381[a]
Age 2+	1.62	0	0	0.00496[a]
Age 3+	1.62	0	0	0.00505[a]

[a] PSEG, 1999c. Bay anchovy.
[b] Extrapolated by EPA based on weight at Age 1+ (PSEG, 1999c).

Table B2-14: Non-RIS Commercial Fish Species Parameters.

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[b]	Fraction Vulnerable to Fishery[b]	Weight (lbs)[c]
Eggs	0.84	0	0	0.0000000602[d]
Yolksac larvae	1.95	0	0	0.00000068[d]
Post-yolksac larvae	4.1	0	0	0.545[e]
Juvenile 1	2.1	0	0	0.855[e]
Juvenile 2	2.32	0.2	0.5	0.929[f]
Age 1+	0.397	0.2	1	1.08[e]

[a] Calculated from survival (PSEG, 1999c) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] PSEG, 1999c. Atlantic menhaden.
[c] Weight calculated from length using the formula: $(6.02*10^{-6})*\text{Length(mm)}^{3.216} = \text{Weight(gm)}$ (Froese & Pauly, 2001). Atlantic menhaden.
[d] Able and Fahay, 1998.
[e] Durbin et al., 1983.
[f] Extrapolated by EPA based on weight of Juvenile 1 and weight at Age 1+ (Durbin et al., 1983).