

Appendix D1: Life History Parameter Values Used to Evaluate I&E

The tables in this appendix present the life history parameter values used by EPA to calculate age 1 equivalents, fishery yields, and production foregone from I&E data for the Tampa Bay facilities. Life history data were compiled from a variety of sources, with a focus on obtaining data on local stocks whenever possible. Fishing mortality rates used to calculate yield are target fishing mortality rates, when established. When target rates were unavailable, $F_{0.1}$ or actual fishing mortality was used.

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^c	Fraction Vulnerable to Fishery ^c	Weight ^d (lb)
Eggs	1.94 ^a	0	0	0.0000000579
Larvae	0.4 ^a	0	0	0.0000377
Juvenile 1	0.0822 ^b	0	0	0.000497
Juvenile 2	0.0861 ^b	0	0	0.00128
Juvenile 3	0.129 ^b	0	0	0.0026
Juvenile 4	0.994 ^b	0	0	0.00457
Age 1+	1.62 ^b	0	0	0.00731
Age 2+	1.62 ^b	0	0	0.00901
Age 3+	1.62 ^b	0	0	0.0109

^a Leak and Houde, 1987.

^b Based on Delaware Estuary bay anchovy from PSEG (1999c).

^c Not a commercial or recreational species, thus no fishing mortality.

^d Weight calculated from length for Delaware Estuary bay anchovy from PSEG (1999c) using the formula $(2.624 * 10^{-5}) * \text{Length (mm)}^{2.814} = \text{Weight (g)}$ from Carlander (1969).

Stage Name	Natural Mortality (per stage) ^a	Fishing Mortality (per stage) ^b	Fraction Vulnerable to Fishery ^b	Weight ^c (lb)
Egg	2.27	0	0	0.00000000199 ^d
Prolarvae	3.06	0	0	0.0000000835 ^d
Postlarvae	3.06	0	0	0.000000947 ^d
Juvenile	1.15	0.15	0.5	0.00866 ^e
Age 1+	0.0977	0.15	1	0.337 ^f
Age 2+	0.0977	0.15	1	1.04 ^f
Age 3+	0.0977	0.15	1	2.25 ^f
Age 4+	0.0977	0.15	1	3.98 ^f
Age 5+	0.0977	0.15	1	6.2 ^f
Age 6+	0.0977	0.15	1	8.82 ^f
Age 7+	0.0977	0.15	1	11.7 ^f
Age 8+	0.0977	0.15	1	14.9 ^f
Age 9+	0.0977	0.15	1	18.2 ^f
Age 10+	0.0977	0.15	1	21.5 ^f
Age 11+	0.0977	0.15	1	24.7 ^f
Age 12+	0.0977	0.15	1	28 ^f
Age 13+	0.0977	0.15	1	31 ^f
Age 14+	0.0977	0.15	1	34 ^f
Age 15+	0.0977	0.15	1	36.8 ^f
Age 16+	0.0977	0.15	1	39.3 ^f
Age 17+	0.0977	0.15	1	41.8 ^f
Age 18+	0.0977	0.15	1	44 ^f
Age 19+	0.0977	0.15	1	46 ^f
Age 20+	0.0977	0.15	1	47.9 ^f
Age 21+	0.0977	0.15	1	49.6 ^f
Age 22+	0.0977	0.15	1	51.2 ^f
Age 23+	0.0977	0.15	1	52.6 ^f
Age 24+	0.0977	0.15	1	53.8 ^f
Age 25+	0.0977	0.15	1	55 ^f
Age 26+	0.0977	0.15	1	56 ^f
Age 27+	0.0977	0.15	1	56.9 ^f
Age 28+	0.0977	0.15	1	57.8 ^f
Age 29+	0.0977	0.15	1	58.5 ^f
Age 30+	0.0977	0.15	1	59.2 ^f
Age 31+	0.0977	0.15	1	59.8 ^f
Age 32+	0.0977	0.15	1	60.3 ^f
Age 33+	0.0977	0.15	1	60.8 ^f
Age 34+	0.0977	0.15	1	61.2 ^f
Age 35+	0.0977	0.15	1	61.6 ^f
Age 36+	0.0977	0.15	1	61.9 ^f
Age 37+	0.0977	0.15	1	62.2 ^f
Age 38+	0.0977	0.15	1	62.5 ^f
Age 39+	0.0977	0.15	1	62.7 ^f
Age 40+	0.0977	0.15	1	62.9 ^f

^a Egg to juvenile: Based on Illinois freshwater drum from Bartell and Campbell (2000). Adult stages from Leard et al. (1993).

^b Personal communication with Michael D. Murphy, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, January 23, 2002 (F_{0,1}).

^c Weight calculated from length using the formula $(1.33 \times 10^{-7}) * \text{Length (mm)}^{3.696} = \text{Weight (g)}$ from Carlander (1969).

^d Length from Sutter et al. (1986).

^e Length from Able and Fahay (1998).

^f Length from Murphy and Taylor (1989).

Table D1-3: Blue Crab Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^b	Fraction Vulnerable to Fishery ^b	Weight ^c (lb)
Zoea	13.8 ^a	0	0	0.000000136 ^d
Juvenile 1	13.8 ^a	0	0	0.0000059 ^e
Age 1+	1 ^b	1	0.5	0.135 ^e
Age 2+	1 ^b	1	1	0.406 ^e
Age 3+	1 ^b	1	1	0.888 ^e
Age 4+	1 ^b	1	1	0.95 ^f
Age 5+	1 ^b	1	1	1.01 ^e
Age 6+	1 ^b	1	1	1.15 ^e

^a Calculated from survival (Rose and Cowan, 1993) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b F_{target} from Murphy et al. (2000). Fraction vulnerable assumed.

^c Weight calculated from length using the formula $(2.211 * 10^{-4}) * \text{Length (mm)}^{2.721} = \text{Weight (g)}$ from Murphy et al. (2000).

^d Length from Van den Avyle and Fowler (1984).

^e Length from Delaware Estuary blue crab from PSEG (1999b).

^f Length assumed based on PSEG (1999b).

Table D1-4: Chain Pipefish Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^d	Weight ^e (lb)
Egg	2.3 ^a	0	0	0.0000000157 ^f
Larvae	3.31 ^b	0	0	0.00168 ^f
Age 1+	0.75 ^c	0	0	0.00871 ^g
Age 2+	0.75 ^c	0	0	0.0151 ^g
Age 3+	0.75 ^c	0	0	0.0207 ^g
Age 4+	0.75 ^c	0	0	0.0239 ^g
Age 5+	0.75 ^c	0	0	0.0285 ^f

^a Calculated from survival for Atlantic silverside in Massachusetts (Stone and Webster Engineering Corporation, 1977) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Froese and Pauly, 2001. Broad-nosed pipefish.

^d Not a commercial or recreational species, thus no fishing mortality.

^e Weight calculated from length using the formula for Sargassum pipefish $(9.407 * 10^{-6}) * \text{Length (mm)}^{2.66} = \text{Weight (g)}$ from Froese and Pauly (2001).

^f Length for northern pipefish from Scott and Scott (1988).

^g Length assumed based on northern pipefish from Scott and Scott (1988).

Table D1-5: Goby Species Parameters

Stage Name	Natural Mortality (per stage) ^a	Fishing Mortality (per stage) ^a	Fraction Vulnerable to Fishery ^a	Weight (lb)
Egg	0.288	0	0	0.000022 ^b
Larvae	4.09	0	0	0.00022 ^b
Juvenile	2.3	0	0	0.000485 ^a
Age 1+	2.55	0	0	0.00205 ^a

^a Based on Narragansett Bay goby from PG&E National Energy Group (2001).

^b Assumed based on PG&E National Energy Group (2001).

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^d	Weight ^e (lb)
Egg	2.3 ^a	0	0	0.000000864 ^f
Larvae	3 ^b	0	0	0.0000182 ^f
Age 1+	0.777 ^c	0	0	0.0121 ^g
Age 2+	0.777 ^c	0	0	0.0327 ^g
Age 3+	0.777 ^c	0	0	0.0551 ^g
Age 4+	0.777 ^c	0	0	0.0778 ^g
Age 5+	0.777 ^c	0	0	0.0967 ^g
Age 6+	0.777 ^c	0	0	0.113 ^g
Age 7+	0.777 ^c	0	0	0.158 ^g

^a Calculated from survival for Atlantic silverside in Massachusetts (Stone and Webster Engineering Corporation, 1977) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Calculated from survival (Meredith and Lotrich, 1979) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^d Not a commercial or recreational species, thus no fishing mortality.

^e Weight calculated from length using the formula for striped killifish $(2.600 \times 10^{-5}) \times \text{Length (mm)}^{2.96} = \text{Weight (g)}$ from Carlander (1969).

^f Length for striped killifish from Able and Fahay (1998).

^g Length for striped killifish from Carlander (1969).

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^d	Weight ^e (lb)
Egg	2.24 ^a	0	0	0.000000237 ^f
Larvae	6.73 ^b	0	0	0.00123 ^f
Age 1+	0.25 ^c	0	0	0.00778 ^f
Age 2+	0.25 ^c	0	0	0.0295 ^f
Age 3+	0.25 ^c	0	0	0.0877 ^g
Age 4+	0.25 ^c	0	0	0.19 ^g
Age 5+	0.25 ^c	0	0	0.424 ^g
Age 6+	0.25 ^c	0	0	0.561 ^h

^a Calculated from survival for Narragansett Bay hogchoker (New England Power Company and Marine Research Inc., 1995) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Based on Narragansett Bay hogchoker from New England Power Company and Marine Research Inc. (1995).

^d Not a commercial or recreational species, thus no fishing mortality.

^e Weight calculated from length using the formula $(1.947 \times 10^{-4}) \times \text{Length (mm)}^{2.658} = \text{Weight (g)}$ from Froese and Pauly (2001).

^f Length from Able and Fahay (1998).

^g Length assumed based on Able and Fahay (1998) and Froese and Pauly (2001).

^h Length from Froese and Pauly (2001).

Table D1-8: Leatherjacket Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^d	Weight ^e (lb)
Egg	0.817 ^a	0	0	0.0000000209 ^f
Larvae	9.52 ^b	0	0	0.0209 ^f
Age 1+	0.34 ^c	0	0	0.168 ^f
Age 2+	0.34 ^c	0	0	0.46 ^f
Age 3+	0.34 ^c	0	0	0.511 ^f
Age 4+	0.34 ^c	0	0	0.565 ^g

^a Based on Delaware Estuary Atlantic croaker from PSEG (1999c).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Froese and Pauly, 2001. Unicorn leatherjacket.

^d Not a commercial or recreational species, thus no fishing mortality.

^e Weight calculated from length using the formula $(9.497 \times 10^{-6}) \times \text{Length (mm)}^3 = \text{Weight (g)}$ from Froese and Pauly (2001).

^f Length assumed based on Florida Fish and Wildlife Conservation Commission (2001).

^g Length from Florida Fish and Wildlife Conservation Commission (2001).

Table D1-9: Menhaden Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^b	Fraction Vulnerable to Fishery ^c	Weight ^d (lb)
Egg	2.08 ^a	0	0	0.0000000602 ^e
Larvae	8.56 ^a	0	0	0.00000068 ^e
Age 1+	1.1 ^b	0	0	0.545 ^f
Age 2+	1.1 ^b	2	0.5	0.855 ^f
Age 3+	1.1 ^b	2	1	1.08 ^f
Age 4+	1.1 ^b	2	1	1.31 ^f
Age 5+	1.1 ^b	2	1	1.47 ^f
Age 6+	1.1 ^b	2	1	1.59 ^f
Age 7+	1.1 ^b	2	1	3.36 ^g
Age 8+	1.1 ^b	2	1	5.21 ^h

^a Calculated from survival (Entergy Nuclear Generation Company, 2000) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b $F_{0.1}$ from Vaughan et al. (2000).

^c Commercial species. Fraction vulnerable assumed.

^d Weight calculated from length using the formula $(6.021 \times 10^{-6}) \times \text{Length (mm)}^{3.216} = \text{Weight (g)}$ from Froese and Pauly (2001).

^e Length from Able and Fahay (1998).

^f Length from Durbin et al. (1983).

^g Length assumed based on Durbin et al. (1983) and Scott and Scott (1988).

^h Length from Scott and Scott (1988).

Table D1-10: Pinfish Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^e	Weight ^f (lb)
Egg	2.3 ^a	0	0	0.0000000118
Larvae	7.39 ^b	0	0	0.0000238
Juvenile	1.91 ^c	0	0	0.00669
Age 1+	0.34 ^d	0.34	0.5	0.0791
Age 2+	0.34 ^d	0.34	1	0.218

^a Calculated from assumed survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Nelson, 1998.

^d Annual fishing mortality rate (F) from Froese and Pauly (2001). Assumed that half of mortality was natural and half was fishing.

^e Commercial and recreational species. Fraction vulnerable assumed.

^f Weight calculated from length (Muncy, 1984) using the formula $(5.792 \times 10^{-6}) \times \text{Length (mm)}^{3.25} = \text{Weight (g)}$ from Froese and Pauly (2001).

Table D1-11: Pink Shrimp Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^c	Fraction Vulnerable to Fishery ^c	Weight ^d (lb)
Egg	3.22 ^a	0	0	0.000000000209 ^e
Prolarvae	1.7 ^b	0	0	0.00000274 ^f
Postlarvae	1.7 ^b	0	0	0.0000268 ^e
Juvenile	0.14 ^c	0.14	1	0.0473 ^e
Age 1+	0.14 ^c	0.14	1	0.077 ^e

^a Calculated from survival for pink shrimp in Massachusetts (Stone and Webster Engineering Corporation, 1980a) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Costello and Allen, 1970.

^c Annual total mortality (Z), fishing mortality (F), and fraction vulnerable from Bielsa et al. (1983).

^d Weight calculated from length using the formula $(6.247 \times 10^{-6}) \times \text{Length (mm)}^{3.290} = \text{Weight (g)}$ from Bielsa et al. (1983).

^e Length from TBNEP (1992b).

^f Length assumed based on TBNEP (1992b).

Table D1-12: Scaled Sardine Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^e	Fraction Vulnerable to Fishery ^e	Weight ^f (lb)
Egg	2.12 ^a	0	0	0.000000903 ^g
Prolarvae	0.56 ^b	0	0	0.0000139 ^h
Postlarvae	6.53 ^c	0	0	0.000226 ^h
Age 1+	1.02 ^d	0	0	0.0324 ⁱ

^a Calculated from survival for scaled sardine in Massachusetts (Stone and Webster Engineering Corporation, 1980a) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Daily mortality: Institute for Marine Research (2002). Duration of stage for scaled sardine in Massachusetts (Stone and Webster Engineering Corporation, 1980a).

^c Extrapolated.

^d Froese and Pauly, 2001.

^e Not a commercial or recreational species, thus no fishing mortality.

^f Weight calculated from length using the formula $(8.166 \times 10^{-6}) * \text{Length (mm)}^{3.163} = \text{Weight (g)}$ from Pierce et al. (2001).

^g Length from Houde et al. (1974).

^h Length from Stone and Webster Engineering Corporation (1980a).

ⁱ Length from Springer and Woodburn (1960) and Stone and Webster Engineering Corporation (1980a).

Table D1-13: Searobin Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^d	Weight ^e (lb)
Egg	2.3 ^a	0	0	0.00000286 ^f
Larvae	4.57 ^b	0	0	0.0000229 ^f
Age 1+	0.42 ^c	0	0	0.0231 ^f
Age 2+	0.42 ^c	0	0	0.0779 ^f
Age 3+	0.42 ^c	0	0	0.185 ^f
Age 4+	0.42 ^c	0	0	0.361 ^f
Age 5+	0.42 ^c	0	0	0.455 ^f
Age 6+	0.42 ^c	0	0	0.507 ^f
Age 7+	0.42 ^c	0	0	0.564 ^f
Age 8+	0.42 ^c	0	0	0.624 ^g

^a Calculated from assumed survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Froese and Pauly, 2001. Northern searobin.

^d Not caught in measurable quantities, thus no fishing mortality (Personal communication with Michael D. Murphy, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, January 23, 2002).

^e Weight calculated from length using the formula for longhorn sculpin $(1.034 \times 10^{-5}) * \text{Length (mm)}^{3.003} = \text{Weight (g)}$ from Clayton et al. (1978).

^f Length assumed based on Froese and Pauly (2001).

^g Length from Froese and Pauly (2001).

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^e	Fraction Vulnerable to Fishery ^f	Weight ^g (lb)
Egg	2.3 ^a	0	0	0.000000490 ^h
Larvae	7.39 ^b	0	0	0.0000241 ^h
Juvenile	1.91 ^c	0	0	0.00167 ⁱ
Age 1+	1.98 ^d	0	0	0.981 ⁱ
Age 2+	1.98 ^d	0	0	1.22 ^j
Age 3+	1.98 ^d	0.45	0.5	1.56 ⁱ
Age 4+	1.98 ^d	0.45	1	2.33 ⁱ
Age 5+	1.98 ^d	0.45	1	2.43 ^j
Age 6+	1.98 ^d	0.45	1	2.45 ^j
Age 7+	1.98 ^d	0.45	1	2.47 ^j
Age 8+	1.98 ^d	0.45	1	2.49 ^j
Age 9+	1.98 ^d	0.45	1	2.51 ^j
Age 10+	1.98 ^d	0.45	1	2.53 ^j
Age 11+	1.98 ^d	0.45	1	2.55 ^j
Age 12+	1.98 ^d	0.45	1	2.57 ^j
Age 13+	1.98 ^d	0.45	1	2.59 ^j
Age 14+	1.98 ^d	0.45	1	2.61 ^j
Age 15+	1.98 ^d	0.45	1	2.63 ^j
Age 16+	1.98 ^d	0.45	1	2.65 ^j

^a Calculated from survival for sheepshead in Massachusetts (Stone and Webster Engineering Corporation, 1977) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Nelson, 1998.

^d Froese and Pauly, 2001. Western Atlantic seabream.

^e F_{0.1} from personal communication with Michael D. Murphy, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, January 23, 2002.

^f Commercial and recreational species. Vulnerable to fishing at 12 inches or age 3 (Murphy et al., 2000).

^g Weight calculated from length using the formula $(2.247 \times 10^{-5}) * \text{Length (mm)}^{2.907} = \text{Weight (g)}$ from Florida Fish and Wildlife Conservation Commission (2002b).

^h Length from Pattillo et al. (1997).

ⁱ Length from Florida Fish and Wildlife Conservation Commission (2002b).

^j Length extrapolated.

Table D1-15: Silver Perch Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^c	Fraction Vulnerable to Fishery ^c	Weight ^d (lb)
Egg	2.75 ^a	0	0	0.000000272 ^e
Larvae	5.37 ^a	0	0	0.00000771 ^e
Juvenile	1.71 ^a	0	0	0.0445 ^e
Age 1+	3.84 ^b	0	0	0.273 ^e
Age 2+	3.84 ^b	0.1	0.5	0.415 ^f
Age 3+	3.84 ^b	0.1	1	0.607 ^g

^a Based on Delaware Estuary white perch from PSEG (1999c).

^b Froese and Pauly, 2001.

^c Annual fishing mortality rate (F) and fraction vulnerable from personal communication with Michael D. Murphy, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, January 23, 2002.

^d Weight calculated from length using the formula $(2.683 \times 10^{-5}) \times \text{Length (mm)}^{2.971} = \text{Weight (g)}$ from Froese and Pauly (2001).

^e Length from Able and Fahay (1998).

^f Length assumed based on Able and Fahay (1998) and Florida Fish and Wildlife Conservation Commission (2001).

^g Length from Florida Fish and Wildlife Conservation Commission (2001).

Table D1-16: Spotted Seatrout Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^e	Fraction Vulnerable to Fishery ^f	Weight ^g (lb)
Egg	2.3 ^a	0	0	0.0000000737 ^h
Prolarvae	1.5 ^b	0	0	0.000000698 ^h
Postlarvae	6.92 ^c	0	0	0.00000356 ^h
Juvenile	0.436 ^d	0.3	0.5	0.589 ⁱ
Age 1+	0.436 ^d	0.3	1	0.962 ⁱ
Age 2+	0.436 ^d	0.3	1	1.67 ⁱ
Age 3+	0.436 ^d	0.3	1	2.75 ⁱ
Age 4+	0.436 ^d	0.3	1	3.5 ⁱ
Age 5+	0.436 ^d	0.3	1	3.95 ⁱ
Age 6+	0.436 ^d	0.3	1	4.97 ⁱ
Age 7+	0.436 ^d	0.3	1	5.63 ⁱ
Age 8+	0.436 ^d	0.3	1	5.65 ^j

^a Based on Massachusetts spotted seatrout from Stone and Webster Engineering Corporation (1980a).

^b Daily mortality rate: Institute for Marine Research, Kiel (2002). Stage duration for Massachusetts spotted seatrout (Stone and Webster Engineering Corporation, 1980a).

^c Extrapolated.

^d Calculated from survival (Johnson and Seaman, 1986) using the equation $(\text{natural mortality}) = -\text{LN}(\text{survival}) - (\text{fishing mortality})$; 80% of mortality natural (Johnson and Seaman, 1986).

^e $F_{0.1}$ from Murphy et al. (2000) and personal communication with Michael D. Murphy, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, January 23, 2002.

^f Recreational species. Vulnerable to fishing mortality at 12 inches or juvenile stage (Johnson and Seaman, 1986).

^g Weight calculated from length using the formula $(4.642 \times 10^{-6}) \times \text{Length (mm)}^{3.113} = \text{Weight (g)}$ from Johnson and Seaman (1986).

^h Length for Massachusetts spotted seatrout from Stone and Webster Engineering Corporation (1980a).

ⁱ Length from Murphy and Taylor (1994).

^j Length assumed based on Murphy and Taylor (1994).

Table D1-17: Stone Crab Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^b	Fraction Vulnerable to Fishery ^c	Weight ^d (lb)
Zoea 1	1.97 ^a	0	0	0.000000101 ^e
Zoea 2	1.97 ^a	0	0	0.000000417 ^e
Zoea 3	1.97 ^a	0	0	0.00000109 ^e
Zoea 4	1.97 ^a	0	0	0.00000226 ^e
Zoea 5	1.97 ^a	0	0	0.00000405 ^e
Megalopa	1.97 ^a	0	0	0.00000662 ^e
Juvenile	1.97 ^a	0	0	0.0000182 ^f
Age 1+	0.939 ^b	0.751	0.5	1.02 ^f
Age 2+	0.939 ^b	0.751	1	3.63 ^f
Age 3+	0.939 ^b	0.751	1	7.12 ^f
Age 4+	0.939 ^b	0.751	1	10 ^f

^a Calculated from survival (Bert et al., 1978) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Annual fishing mortality rate (F) from Ehrhardt et al. (1990).

^c Commercial and recreational species. Fraction vulnerable assumed.

^d Weight calculated from length using the formula $(0.003) * \text{Length (mm)}^{3.016} = \text{Weight (g)}$ from Sullivan (1979).

^e Length from Van den Avyle and Fowler (1984).

^f Length from Lindberg and Marshall (1984).

Table D1-18: Tidewater Silverside Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage) ^d	Fraction Vulnerable to Fishery ^d	Weight ^e (lb)
Egg	2.3 ^a	0	0	0.0000000526 ^f
Prolarvae	3.06 ^b	0	0	0.00000163 ^g
Postlarvae	3.06 ^b	0	0	0.00000554 ^h
Age 1+	2.1 ^c	0	0	0.0119 ^f
Age 2+	2.1 ^c	0	0	0.0224 ⁱ

^a Calculated from survival (Bert et al., 1978) using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^b Calculated from extrapolated survival using the equation (natural mortality) = -LN (survival) - (fishing mortality).

^c Froese and Pauly, 2001.

^d Not a commercial or recreational species, thus no fishing mortality.

^e Weight calculated from length using the formula $(5.69 * 10^{-6}) * \text{Length (mm)}^{3.023} = \text{Weight (g)}$ from Froese and Pauly (2001).

^f Length for Massachusetts tidewater silverside from Stone and Webster Engineering Corporation (1980a).

^g Length from Hildebrand (1922).

^h Length from Garwood (1968).

ⁱ Length for Atlantic silverside from Scott and Scott (1988).