Appendix G1: 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 Seabrook and Pilgrim facilities. Life history data and fishing mortality rates were compiled from a variety of sources, with a focus on obtaining data on local stocks whenever possible.

Table G1-1: Alewife Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lb)
Eggs	0.9[a]	0	0	0.0022[c]
Larvae	5.75[a]	0	0	0.00661[c]
Juvenile 1	10.1[a]	0	0	0.022[c]
Age 1+	0.7[b]	0	0	0.0303[a]
Age 2+	0.7[b]	0	0	0.125[a]
Age 3+	0.7[b]	0	0	0.348[d]
Age 4+	0.7[b]	0.1	0.45	0.443[d]
Age 5+	0.7[b]	0.1	0.9	0.496[d]
Age 6+	0.7[b]	0.1	1	0.536[d]
Age 7+	0.7[b]	0.1	1	0.598[d]
Age 8+	0.7[b]	0.1	1	0.723[d]

[a] Based on alewife in the Delaware Estuary, as provided in PSEG, 1999c.
[b] Froese and Pauly, 2001.
[c] Assumed based on size (Able and Fahay, 1998).
[d] Scott and Scott, 1988.

Table G1-2: American Plaice Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.0000000111[f]
Larvae	9.13[b]	0	0	0.0000173[f]
Age 1+	0.2[c]	0	0	0.00537[g]
Age 2+	0.2[c]	0.32	0.5	0.0545[g]
Age 3+	0.2[c]	0.32	1	0.121[h]
Age 4+	0.2[c]	0.32	1	0.212[f]
Age 5+	0.2[c]	0.32	1	0.322[f]
Age 6+	0.2[c]	0.32	1	0.467[f]
Age 7+	0.2[c]	0.32	1	0.652[f]
Age 8+	0.2[c]	0.32	1	0.822[f]
Age 9+	0.2[c]	0.32	1	1.02[f]
Age 10+	0.2[c]	0.32	1	1.25[f]
Age 11+	0.2[c]	0.32	1	1.51[f]
Age 12+	0.2[c]	0.32	1	1.81[f]
Age 13+	0.2[c]	0.32	1	2.15[f]
Age 14+	0.2[c]	0.32	1	2.4[f]
Age 15+	0.2[c]	0.32	1	2.67[f]
Age 16+	0.2[c]	0.32	1	2.96[f]
Age 17+	0.2[c]	0.32	1	3.27[f]
Age 18+	0.2[c]	0.32	1	3.6[f]
Age 19+	0.2[c]	0.32	1	3.96[f]
Age 20+	0.2[c]	0.32	1	4.34[f]
Age 21+	0.2[c]	0.32	1	4.74[f]
Age 22+	0.2[c]	0.32	1	5.17[f]
Age 23+	0.2[c]	0.32	1	5.63[f]
Age 24+	0.2[c]	0.32	1	5.87[f]
Age 25+	0.2[c]	0.32	1	5.94[h]

[a] Calculated from survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Calculated from extrapolated survival using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[c] NOAA, 1993.
[d] O'Brien, 2000. Fraction vulnerable assumed based on size.
[e] Weight calculated from length using the formula: $(4.970 \times 10^{-7}) * \text{Length(mm)}^{3.345}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Scott and Scott (1988).
[g] Length assumed based on Scott and Scott (1988) and Shultz, 2001.
[h] Length from Shultz (2001).

Table G1-3: American Sand Lance Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.000000000353[f]
Larvae	4.19[b]	0	0	0.000485[f]
Age 1+	1[c]	0	0	0.00469[f]
Age 2+	1[c]	0	0	0.0313[f]
Age 3+	1[c]	0	0	0.0636[f]
Age 4+	1[c]	0	0	0.106[f]
Age 5+	1[c]	0	0	0.144[g]
Age 6+	1[c]	0	0	0.19[f]
Age 7+	1[c]	0	0	0.231[g]
Age 8+	1[c]	0	0	0.246[g]
Age 9+	1[c]	0	0	0.262[f]

[a] Calculated from survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) 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 sand lance.
[d] Not a recreational or commercial species, thus no fishing mortality.
[e] Weight calculated from length using the formula: $(3.2\text{x}10^{-7})*\text{Length(mm)}^{3.491}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Scott and Scott (1988).
[g] Length assumed based on Scott and Scott (1988).

Table G1-4: Atlantic Cod Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	4.87[a]	0	0	0.0000000974[f]
Larvae	6.75[b]	0	0	0.00000186[f]
Age 1+	0.4[c]	0	0	0.0225[g]
Age 2+	0.2[c]	0.29	0.5	0.245[g]
Age 3+	0.2[c]	0.29	1	0.628[g]
Age 4+	0.2[c]	0.29	1	1.29[g]
Age 5+	0.2[c]	0.29	1	2.45[g]
Age 6+	0.2[c]	0.29	1	3.33[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] Entergy Nuclear Generation Company, 2000.
[d] NOAA, 2001c.
[e] Weight calculated from length using the formula: $(8.85\text{x}10^{-6})*\text{Length(mm)}^{3.031}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Froese and Pauly (2001).
[g] Length from Scott and Scott (1988).

Table G1-5: Atlantic Herring Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[b]	Fraction Vulnerable to Fishery[c]	Weight (lb)[d]
Eggs	3.36[a]	0	0	0.0000000170[e]
Larvae	6.53[a]	0	0	0.000222[f]
Age 1+	0.2[b]	0.28	0.5	0.0243[g]
Age 2+	0.2[b]	0.28	1	0.158[h]
Age 3+	0.2[b]	0.28	1	0.291[h]
Age 4+	0.2[b]	0.28	1	0.42[h]
Age 5+	0.2[b]	0.28	1	0.467[h]
Age 6+	0.2[b]	0.28	1	0.535[h]
Age 7+	0.2[b]	0.28	1	0.607[h]
Age 8+	0.2[b]	0.28	1	0.668[h]
Age 9+	0.2[b]	0.28	1	0.734[h]
Age 10+	0.2[b]	0.28	1	0.716[h]
Age 11+	0.2[b]	0.28	1	0.812[h]
Age 12+	0.2[b]	0.28	1	0.907[h]
Age 13+	0.2[b]	0.28	1	0.915[i]
Age 14+	0.2[b]	0.28	1	0.924[i]
Age 15+	0.2[b]	0.28	1	0.932[i]
Age 16+	0.2[b]	0.28	1	0.941[i]

[a] Calculated from survival (Entergy Nuclear Generation Company, 2000) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] NOAA, 2001c.
[c] Commercial species vulnerable to fishing mortality at age 1.
[d] Weight calculated from length using the formula: $(1.22 \times 10^{-6}) * \text{Length(mm)}^{3.328}$ = weight(g) (Froese and Pauly, 2001).
[e] Length from Froese and Pauly (2001).
[f] Length from Reid et al. (1999).
[g] Length from Atlantic States Marine Fisheries Commission (2001a).
[h] Length from Scott and Scott (1988).
[i] Length assumed based on Scott and Scott (1988).

Table G1-6: Atlantic Mackerel Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[c]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.39[a]	0	0	0.0000000362[f]
Larvae	10.6[a]	0	0	0.0000008[g]
Age 1+	0.52[b]	0	0	0.309[h]
Age 2+	0.37[b]	0.25	0.5	0.51[h]
Age 3+	0.37[b]	0.25	1	0.639[h]
Age 4+	0.37[b]	0.25	1	0.752[h]
Age 5+	0.37[b]	0.25	1	0.825[h]
Age 6+	0.37[b]	0.25	1	0.918[h]
Age 7+	0.37[b]	0.25	1	1.02[h]
Age 8+	0.37[b]	0.25	1	1.1[h]
Age 9+	0.37[b]	0.25	1	1.13[i]
Age 10+	0.37[b]	0.25	1	1.15[h]
Age 11+	0.37[b]	0.25	1	1.22[h]
Age 12+	0.37[b]	0.25	1	1.22[h]
Age 13+	0.37[b]	0.25	1	1.22[h]
Age 14+	0.37[b]	0.25	1	1.22[h]

[a] Calculated from survival (Entergy Nuclear Generation Company, 2000) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Overholtz et al., 1991.
[c] NOAA, 2001c.
[d] Recreational and commercial species. Vulnerable to fishing mortality at age 2.
[e] Weight calculated from length using the formula: $(3.039 \times 10^{-6}) * \text{Length(mm)}^{3.18}$ = weight(g) (Froese and Pauly, 2001). Atlantic cod.
[f] Length assumed based on Atlantic cod (Froese and Pauly, 2001).
[g] Length from Froese and Pauly (2001).
[h] Length from Scott and Scott (1988).
[i] Length assumed based on Scott and Scott (1988).

Table G1-7: Atlantic Menhaden Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[c]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.08[a]	0	0	0.0000000602[f]
Larvae	8.56[a]	0	0	0.00000068[f]
Age 1+	0.45[b]	0	0	0.545[d]
Age 2+	0.45[b]	0.8	0.5	0.855[d]
Age 3+	0.45[b]	0.8	1	1.08[d]
Age 4+	0.45[b]	0.8	1	1.31[d]
Age 5+	0.45[b]	0.8	1	1.47[d]
Age 6+	0.45[b]	0.8	1	1.59[d]
Age 7+	0.45[b]	0.8	1	3.36[g]
Age 8+	0.45[b]	0.8	1	5.21[h]

[a] Calculated from survival (Entergy Nuclear Generation Company, 2000) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] NOAA, 2001c.
[c] Ruppert et al., 1985.
[d] Durbin et al., 1983.
[e] Weight calculated from length using the formula: $(6.02 \times 10^{-6}) * \text{Length(mm)}^{3.216}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Able and Fahay (1998).
[g] Length assumed based on Durbin et al. (1983) and Scott and Scott (1988).
[h] Length from Scott and Scott (1988).

Table G1-8: Atlantic Silverside Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.3[a]	0	0	0.0000000246[g]
Larvae	6.12[b]	0	0	0.000108[g]
Age 1+	2.1[c]	0.19	0.5	0.0101[h]
Age 2+	2.1[c]	0.19	1	0.0186[h]

[a] Calculated from survival (Stone & 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.
[d] NOAA, 2001c. Atlantic herring.
[e] Commercial species. Vulnerable to fishing mortality at age 1.
[f] Weight calculated from length using the formula: $(5.691 \times 10^{-6}) * \text{Length(mm)}^{3.023}$ = weight(g) (Froese and Pauly, 2001).
[g] Length from Able and Fahay (1998).
[h] Length from Scott and Scott (1988).

Table G1-9: Bay Anchovy Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lb)
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	0.0037[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] Assumed based on PSEG, 1999c.

Table G1-10: Blue Mussel Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.3[a]	0[d]	0	0.00022
Larvae	4.61[b]	0[d]	0	0.0022
Age 1+	0.602[c]	0.602[c]	0.5	0.0662
Age 2+	0.602[c]	0.602[c]	1	0.0728
Age 3+	0.0555[c]	0.0555[c]	1	0.0794
Age 4+	0.0555[c]	0.0555[c]	1	0.0833
Age 5+	0.0555[c]	0.0555[c]	1	0.0838
Age 6+	0.0555[c]	0.0555[c]	1	0.084
Age 7+	0.0555[c]	0.0555[c]	1	0.0842
Age 8+	0.0555[c]	0.0555[c]	1	0.0843
Age 9+	0.0555[c]	0.0555[c]	1	0.0843
Age 10+	1.2[c]	1.2[c]	1	0.0843
Age 11+	1.2[c]	1.2[c]	1	0.0843
Age 12+	1.2[c]	1.2[c]	1	0.0843

[a] Calculated from assumed survival using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Calculated from survival (Stone & Webster Engineering Corporation, 1977) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[c] Calculated from survival (Author Unknown, 2001) using the equation: (natural mortality) = -LN(survival) - (fishing mortality). Assumed half of mortality was natural and half was fishing.
[d] Shaw et al., 1988.
[e] Commercial species. Vulnerable to fishing mortality at age 1.
[f] Newell, 1989.

Table G1-11: Blueback Herring Species Parameters

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

[a] PSEG, 1999c.
[b] Assumed based on PSEG, 1999c.

Table G1-12: Bluefish Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.3[a]	0	0	0.0000000386[g]
Larvae	5.27[b]	0	0	0.00000333[g]
Juvenile 1	5.27[b]	0	0	0.000116[g]
Age 1+	0.35[c]	0.4	0.5	0.54[h]
Age 2+	0.35[c]	0.4	1	0.785[h]
Age 3+	0.35[c]	0.4	1	1.91[h]
Age 4+	0.35[c]	0.4	1	2.45[i]
Age 5+	0.35[c]	0.4	1	3.06[i]
Age 6+	0.35[c]	0.4	1	3.78[i]
Age 7+	0.35[c]	0.4	1	4.58[i]
Age 8+	0.35[c]	0.4	1	5.49[i]
Age 9+	0.35[c]	0.4	1	6.5[i]
Age 10+	0.35[c]	0.4	1	7.64[i]
Age 11+	0.35[c]	0.4	1	8.87[i]
Age 12+	0.35[c]	0.4	1	10.3[h]

[a] Calculated from survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Calculated from extrapolated survival using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[c] NOAA, 1993.
[d] NOAA, 2001c.
[e] Commercial and recreational species. Assumed to be vulnerable to fishing mortality at age 1.
[f] Weight calculated from length using the formula: $(1.749 \times 10^{-5}) * \text{Length(mm)}^{2.77}$ = weight(g) (Froese and Pauly, 2001).
[g] Length from Wang and Kernehan (1979).
[h] Length from Clayton et al. (1978).
[i] Length assumed based on Clayton et al. (1978).

Table G1-13: Butterfish Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.3[a]	0	0	0.00000000248[g]
Larvae	8.13[b]	0	0	0.00000151[g]
Age 1+	0.4[c]	0.76	0.5	0.0272[h]
Age 2+	0.4[c]	0.76	1	0.0986[h]
Age 3+	0.4[c]	0.76	1	0.944[h]

[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] NOAA, 1993.
[d] NOAA, 2001c.
[e] Commercial and recreational species. Assumed to be vulnerable to fishing mortality at age 1.
[f] Weight calculated from length using the formula: $(3.6x10^{-6})*Length(mm)^{3.26}$ = weight(g) (Froese and Pauly, 2001).
[g] Length from Able and Fahay (1998).
[h] Length from Scott and Scott (1988).

Table G1-14: Cunner Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[c]	Fraction Vulnerable to Fishery[c]	Weight (lb)[d]
Eggs	3.49[a]	0	0	0.00000000877[e]
Larvae	5.8[a]	0	0	0.00000236[e]
Age 1+	0.831[b]	0	0	0.00311[ff]
Age 2+	0.831[b]	0.1	0.5	0.0246[f]
Age 3+	0.286[b]	0.1	1	0.0749[f]
Age 4+	0.342[b]	0.1	1	0.145[f]
Age 5+	0.645[b]	0.1	1	0.229[f]
Age 6+	1.26[b]	0.1	1	0.624[g]

[a] Calculated from survival (Entergy Nuclear Generation Company, 2000) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Entergy Nuclear Generation Company, 2000.
[c] Commercial and recreational species, of minimal catch (Entergy Nuclear Generation Company, 2000). Fishing mortality and fraction vulnerable assumed.
[d] Weight calculated from length using the formula: $(6.0x10^{-6})*Length(mm)^{3.22}$ = weight(g) (Serchuk and Cole, 1974).
[e] Length from Able and Fahay (1998).
[f] Length from Serchuk and Cole (1974).
[g] Length from Scott and Scott (1988).

Table G1-15: Fourbeard Rockling Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.00000000605[f]
Larvae	5.17[b]	0	0	0.000000896[f]
Age 1+	0.49[c]	0	0	0.00403[f]
Age 2+	0.49[c]	0	0	0.0347[f]
Age 3+	0.49[c]	0	0	0.0848[f]
Age 4+	0.49[c]	0	0	0.149[f]
Age 5+	0.49[c]	0	0	0.241[f]
Age 6+	0.49[c]	0	0	0.331[f]
Age 7+	0.49[c]	0	0	0.482[f]
Age 8+	0.49[c]	0	0	0.623[f]
Age 9+	0.49[c]	0	0	0.788[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.
[d] Not a commercial or recreational species, thus no fishing mortality.
[e] Weight calculated from length using the formula: $(12.74 \times 10^{-6})*\text{Length(mm)}^{3.106}$ = weight(g) (Froese and Pauly, 2001).
[f] Length assumed based on Froese and Pauly (2001).
[g] Length from Froese and Pauly (2001).

Table G1-16: Grubby Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.000000211[f]
Larvae	4.7[b]	0	0	0.000359[f]
Age 1+	0.46[c]	0	0	0.00404[f]
Age 2+	0.46[c]	0	0	0.139[f]
Age 3+	0.46[c]	0	0	0.332[f]
Age 4+	0.46[c]	0	0	0.42[f]
Age 5+	0.46[c]	0	0	0.475[f]
Age 6+	0.46[c]	0	0	0.541[f]
Age 7+	0.46[c]	0	0	0.576[f]
Age 8+	0.46[c]	0	0	0.612[f]
Age 9+	0.46[c]	0	0	0.637[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. Longhorn sculpin.
[d] Not a commercial or recreational species, thus no fishing mortality.
[e] Weight calculated from length using the formula for longhorn sculpin: $(1.034 \times 10^{-5})*\text{Length(mm)}^{3.003}$ = weight(g) (Clayton et al., 1978).
[f] Length assumed based on Clayton et al. (1978).
[g] Length for longhorn sculpin from Clayton et al. (1978).

Table G1-17: Hogchocker Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	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 (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] 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: $(1.947 \times 10^{-4}) * \text{Length(mm)}^{2.658}$ = weight(g) (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 G1-18: Little Skate Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.94[a]	0	0	0.000774
Larvae	0.252[b]	0	0	0.0138
Age 1+	0.4[c]	0.4	0.5	0.157
Age 2+	0.4[c]	0.4	1	0.394
Age 3+	0.4[c]	0.4	1	0.75
Age 4+	0.4[c]	0.4	1	1.15
Age 5+	0.4[c]	0.4	1	1.51
Age 6+	0.4[c]	0.4	1	1.62
Age 7+	0.4[c]	0.4	1	1.65
Age 8+	0.4[c]	0.4	1	1.72

[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] NOAA, 1993.
[d] NOAA, 2001c.
[e] Commercial species assumed to be vulnerable to fishing mortality at age 1.
[f] Weight calculated from length (Scott and Scott, 1988) using the formula: $(8.32 \times 10^{-6}) * \text{Length(mm)}^{2.972}$ = weight(g) (Froese and Pauly, 2001).

Table G1-19: Lumpfish Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.0000004[f]
Larvae	9.39[b]	0	0	0.000993[f]
Age 1+	0.19[c]	0	0	0.0147[g]
Age 2+	0.19[c]	0	0	0.0584[h]
Age 3+	0.19[c]	0	0	0.149[g]
Age 4+	0.19[c]	0	0	0.686[h]
Age 5+	0.19[c]	0	0	1.86[g]

[a] Calculated from survival for Atlantic silverside (Stone & 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.
[d] Not a commercial or recreational species, thus no fishing mortality.
[e] Weight calculated from length using the formula: (6.755×10^{-5})*Length(mm)$^{2.939}$ = weight(g) (Froese and Pauly, 2001).
[f] Length for rock gunnel from Able and Fahay (1998).
[g] Length assumed based on Able and Fahay (1998).

Table G1-20: Northern Pipefish Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	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	0.0124[g]
Age 3+	0.75[c]	0	0	0.0168[g]
Age 4+	0.75[c]	0	0	0.0222[g]
Age 5+	0.75[c]	0	0	0.0285[f]

[a] Calculated from assumed survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) 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})*Length(mm)$^{2.66}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Scott and Scott (1988).
[g] Length assumed based on Scott and Scott (1988).

Table G1-21: Pollock Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[b]	Fraction Vulnerable to Fishery[c]	Weight (lb)[d]
Eggs	0.922	0	0	0.0000000203[e]
Larvae	4.07	0	0	0.00000104[f]
Juvenile	6.93	0	0	0.00166[e]
Age 1+	0.2	0	0	0.657[f]
Age 2+	0.2	0.2	0.5	1.3[f]
Age 3+	0.2	0.2	1	1.73[f]
Age 4+	0.2	0.2	1	3.24[f]
Age 5+	0.2	0.2	1	4.93[f]
Age 6+	0.2	0.2	1	5.7[f]
Age 7+	0.2	0.2	1	6.83[f]
Age 8+	0.2	0.2	1	8.46[f]
Age 9+	0.2	0.2	1	9.93[f]
Age 10+	0.2	0.2	1	12[f]
Age 11+	0.2	0.2	1	14.8[f]
Age 12+	0.2	0.2	1	16.4[f]
Age 13+	0.2	0.2	1	18.1[f]
Age 14+	0.2	0.2	1	19.9[f]
Age 15+	0.2	0.2	1	21.2[f]

[a] Saila et al., 1997.
[b] NOAA, 2001c.
[c] Commercial and recreational species. Assumed to be vulnerable to fishing mortality at age 2.
[d] Weight calculated from length using the formula: $(6.894 \times 10^{-6}) * \text{Length(mm)}^{3.048} = \text{weight(g)}$ (Froese and Pauly, 2001).
[e] Length from Able and Fahay (1998).
[f] Length from Saila et al. (1997).

Table G1-22: Radiated Shanny Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.0000000091[f]
Larvae	3.11[b]	0	0	0.00000948[f]
Age 1+	0.44[c]	0	0	0.000622[f]
Age 2+	0.44[c]	0	0	0.00415[f]
Age 3+	0.44[c]	0	0	0.00846[f]
Age 4+	0.44[c]	0	0	0.0151[f]
Age 5+	0.44[c]	0	0	0.0194[f]
Age 6+	0.44[c]	0	0	0.0244[f]
Age 7+	0.44[c]	0	0	0.0303[f]
Age 8+	0.44[c]	0	0	0.0336[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.
[d] Not a commercial or recreational species, thus no fishing mortality.
[e] Weight calculated from length using the formula for rock gunnel: (4.125×10^{-6})*Length(mm)$^{3.018}$ = weight(g) (Froese and Pauly, 2001).
[f] Length assumed based on Froese and Pauly (2001).
[g] Length from Froese and Pauly (2001).

Table G1-23: Rainbow Smelt Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[c]	Fraction Vulnerable to Fishery[c]	Weight (lb)[d]
Eggs	3.32[a]	0	0	0.0000000861[e]
Larvae	2.66[a]	0	0	0.00273[e]
Age 1+	0.72[b]	0	0	0.0359[f]
Age 2+	0.72[b]	0	0	0.134[f]
Age 3+	0.72[b]	0	0	0.289[f]
Age 4+	0.72[b]	0	0	0.585[f]
Age 5+	0.72[b]	0	0	0.942[f]
Age 6+	0.72[b]	0	0	1.27[g]

[a] Calculated from survival (Stone & Webster Engineering Corporation, 1977) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Froese and Pauly, 2001.
[c] Not a commercial or recreational species, thus no fishing mortality.
[d] Weight calculated from length using the formula: (3.903×10^{-5})*Length(mm)$^{2.81}$ = weight(g) (Froese and Pauly, 2001).
[e] Length from Able and Fahay (1998).
[f] Length assumed based on Able and Fahay (1998) and Froese and Pauly (2001).
[g] Length from Froese and Pauly (2001).

Table G1-24: Red Hake Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[b]	Fraction Vulnerable to Fishery[c]	Weight (lb)[d]
Eggs	1.22	0	0	0.00000000238[e]
Larvae 2mm	0.67	0	0	0.0000000535[f]
Larvae 2.5mm	0.67	0	0	0.000000109[f]
Larvae 3.0mm	0.67	0	0	0.000000194[f]
Larvae 3.5mm	0.67	0	0	0.000000316[f]
Larvae 4.0mm	0.67	0	0	0.000000482[f]
Larvae4.5mm	3.35	0	0	0.000000701[f]
Juvenile	4.83	0	0	0.00145[f]
Age 1+	0.4	0.39	0.5	0.124[f]
Age 2+	0.4	0.39	1	0.465[g]
Age 3+	0.4	0.39	1	0.578[g]
Age 4+	0.4	0.39	1	0.723[g]
Age 5+	0.4	0.39	1	0.928[g]
Age 6+	0.4	0.39	1	1.17[h]
Age 7+	0.4	0.39	1	1.45[h]
Age 8+	0.4	0.39	1	1.78[h]
Age 9+	0.4	0.39	1	2.15[h]
Age 10+	0.4	0.39	1	2.3[g]

[a] Saila et al., 1997.
[b] NOAA, 2001c.
[c] Commercial species. Assumed to be vulnerable to fishing mortality at age 1.
[d] Weight calculated from length using the formula for white hake: $(2.692 \times 10^{-6}) * \text{Length(mm)}^{3.172}$ = weight(g) (Froese and Pauly, 2001).
[e] Length from Able and Fahay (1998).
[f] Length from Saila et al. (1997).
[g] Length from Scott and Scott (1988).
[h] Length assumed based on Scott and Scott (1988).

Table G1-25: Rock Gunnel Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.0000000737[f]
Larvae	2.57[b]	0	0	0.00000948[g]
Age 1+	0.44[c]	0	0	0.00382[f]
Age 2+	0.44[c]	0	0	0.0128[f]
Age 3+	0.44[c]	0	0	0.0223[f]
Age 4+	0.44[c]	0	0	0.0371[f]
Age 5+	0.44[c]	0	0	0.049[f]

[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. Radiated shanny.
[d] Not a commercial or recreational species, thus no fishery mortality.
[e] Weight calculated from length using the formula: $(4.125 \times 10^{-6}) * \text{Length(mm)}^{3.018}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Scott and Scott (1988).
[g] Length assumed based on Scott and Scott (1988).

Table G1-26: Sculpin Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.000000211[f]
Larvae	4.7[b]	0	0	0.000359[f]
Age 1+	0.46[c]	0	0	0.00404[g]
Age 2+	0.46[c]	0	0	0.139[g]
Age 3+	0.46[c]	0	0	0.332[g]
Age 4+	0.46[c]	0	0	0.42[g]
Age 5+	0.46[c]	0	0	0.475[g]
Age 6+	0.46[c]	0	0	0.541[g]
Age 7+	0.46[c]	0	0	0.576[g]
Age 8+	0.46[c]	0	0	0.612[g]
Age 9+	0.46[c]	0	0	0.637[g]

[a] Calculated from assumed survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) 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. Longhorn sculpin.
[d] Not a commercial or recreational species, thus no fishing mortality.
[e] Weight calculated from length using the formula for longhorn sculpin: $(1.034 \times 10^{-5}) * \text{Length(mm)}^{3.003}$ = weight(g) (Clayton et al., 1978).
[f] Length assumed based on Clayton et al. (1978).
[g] Length from Clayton et al. (1978). Longhorn sculpin.

Table G1-27: Scup Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.3[a]	0	0	0.000000354[g]
Larvae	5.47[b]	0	0	0.00107[g]
Age 1+	0.29[c]	0.14	0.5	0.073[g]
Age 2+	0.29[c]	0.14	1	0.244[g]
Age 3+	0.29[c]	0.14	1	0.495[h]
Age 4+	0.29[c]	0.14	1	0.806[h]
Age 5+	0.29[c]	0.14	1	1.1[h]
Age 6+	0.29[c]	0.14	1	1.46[h]
Age 7+	0.29[c]	0.14	1	1.88[h]
Age 8+	0.29[c]	0.14	1	2.37[h]
Age 9+	0.29[c]	0.14	1	2.94[h]
Age 10+	0.29[c]	0.14	1	3.58[h]
Age 11+	0.29[c]	0.14	1	4.3[h]
Age 12+	0.29[c]	0.14	1	4.83[h]
Age 13+	0.29[c]	0.14	1	4.97[g]

[a] Calculated from assumed survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) 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] NOAA, 2001c.
[e] Commercial and recreational species. Assumed to be vulnerable to fishing mortality at age 1.
[f] Weight calculated from length using the formula for sheepshead porgy: $(1.649 \times 10^{-4}) * \text{Length(mm)}^{2.666}$ = weight(g) (Froese and Pauly, 2001).
[g] Length from Clayton et al. (1978).
[h] Length assumed based on Clayton et al. (1978).

Table G1-28: Searobin Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.3[a]	0	0	0.00000286[g]
Larvae	4.57[b]	0	0	0.0000229[g]
Age 1+	0.42[c]	0.1	0.5	0.0231[g]
Age 2+	0.42[c]	0.1	1	0.185[g]
Age 3+	0.42[c]	0.1	1	0.361[g]
Age 4+	0.42[c]	0.1	1	0.564[g]
Age 5+	0.42[c]	0.1	1	0.758[g]
Age 6+	0.42[c]	0.1	1	0.992[g]
Age 7+	0.42[c]	0.1	1	1.17[g]
Age 8+	0.42[c]	0.1	1	1.27[h]

[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] Assumed based on hake (Saila et al., 1997).
[e] Recreational species. Assumed to be vulnerable to fishing mortality at age 1.
[f] Weight calculated from length using the formula for longhorn sculpin: $(1.034 \times 10^{-5}) * \text{Length(mm)}^{3.003}$ = weight(g) (Clayton et al., 1978).
[g] Length assumed based on Froese and Pauly (2001).
[h] Length from Froese and Pauly (2001).

Table G1-29: Striped Bass Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[b]	Fraction Vulnerable to Fishery[a]	Weight (lb)
Eggs	1.39	0	0	0.000022[c]
Yolksac larvae	2.22	0	0	0.097[c]
Post-yolksac larvae	5.08	0	0	0.194[c]
Juvenile 1	2.28	0	0	0.291[c]
Juvenile 2	1	0	0	0.388[c]
Age 1+	1.1	0	0	0.485[d]
Age 2+	0.15	0.31	0.06	2.06[d]
Age 3+	0.15	0.31	0.2	3.31[d]
Age 4+	0.15	0.31	0.63	4.93[d]
Age 5+	0.15	0.31	0.94	6.5[d]
Age 6+	0.15	0.31	1	8.58[d]
Age 7+	0.15	0.31	0.9	12.3[d]
Age 8+	0.15	0.31	0.9	14.3[d]
Age 9+	0.15	0.31	0.9	16.1[d]
Age 10+	0.15	0.31	0.9	18.8[d]
Age 11+	0.15	0.31	0.9	19.6[d]
Age 12+	0.15	0.31	0.9	22.4[d]
Age 13+	0.15	0.31	0.9	27[d]
Age 14+	0.15	0.31	0.9	34.6[d]
Age 15+	0.15	0.31	0.9	41.5[d]

[a] PSEG, 1999c.
[b] NOAA, 2001c.
[c] Length assumed based on PSEG (1999c).
[d] Length from PSEG (1999c).

Table G1-30: Striped Killifish Species Parameters

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

[a] Calculated from survival for Atlantic silverside (Stone & Webster Engineering Corporation, 1977) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Calculated from survival for mummichog (Meredith and Lotrich, 1979) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[c] Not a commercial or recreational species, thus no fishing mortality.
[d] Weight calculated from length using the formula: $(2.6\text{x}10^{-5})*\text{Length(mm)}^{2.96}$ = weight(g) (Carlander, 1969).
[e] Length from Able and Fahay (1998).
[f] Length from Carlander (1969).

Table G1-31: Tautog Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[c]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.53[a]	0	0	0.0000000689[f]
Larvae	9.75[a]	0	0	0.00000185[f]
Age 1+	0.06[b]	0.29	0.5	0.0104[g]
Age 2+	0.06[b]	0.29	1	0.183[h]
Age 3+	0.06[b]	0.29	1	1.4[h]
Age 4+	0.06[b]	0.29	1	3.27[h]
Age 5+	0.06[b]	0.29	1	4.62[h]
Age 6+	0.06[b]	0.29	1	6.3[g]

[a] Calculated from survival (New England Power Company and Marine Research Inc., 1995) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] New England Power Company and Marine Research Inc., 1995.
[c] Atlantic States Marine Fisheries Commission, 2000e.
[d] Commercial and recreational species. Assumed to be vulnerable to fishing mortality at age 1.
[e] Weight calculated from length using the formula: $(3.318 \times 10^{-5}) * \text{Length(mm)}^{2.94}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Able and Fahay (1998).
[g] Length from Scott and Scott (1988).
[h] Length assumed based on Scott and Scott (1988).

Table G1-32: Threespine Stickleback Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[d]	Weight (lb)[e]
Eggs	2.3[a]	0	0	0.0000000227[f]
Larvae	3.53[b]	0	0	0.00000127[f]
Age 1+	0.9[c]	0	0	0.000064[g]
Age 2+	0.9[c]	0	0	0.000244[g]
Age 3+	0.9[c]	0	0	0.000422[g]
Age 4+	0.9[c]	0	0	0.00203[g]

[a] Calculated from survival (Stone & Webster Engineering Corporation, 1977) (Atlantic silverside) 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 for sea stickleback: $(2.10 \times 10^{-6}) * \text{Length(mm)}^{3.00}$ = weight(g) (Froese and Pauly, 2001).
[f] Length from Wang (1986a).
[g] Length from Scott and Scott (1988).

Table G1-33: White Perch Species Parameters

Stage Name	Natural Mortality (per stage)[a]	Fishing Mortality (per stage)[a]	Fraction Vulnerable to Fishery[a]	Weight (lb)
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] Assumed based on PSEG, 1999c.

Table G1-34: Windowpane Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[e]	Weight (lb)[f]
Eggs	2.64[a]	0	0	0.0000000818
Larvae	6.47[b]	0	0	0.00000847
Age 1+	0.39[c]	1.6	0.02	0.00634
Age 2+	0.39[c]	1.6	0.25	0.0409
Age 3+	0.39[c]	1.6	0.61	0.188
Age 4+	0.39[c]	1.6	1	0.384
Age 5+	0.39[c]	1.6	1	0.548
Age 6+	0.39[c]	1.6	1	0.663
Age 7+	0.39[c]	1.6	1	0.808
Age 8+	0.39[c]	1.6	1	2.53

[a] Calculated from survival (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] Froese and Pauly, 2001.
[d] NOAA, 2001c.
[e] USGen New England, 2001. Winter flounder.
[f] Weight calculated from length (Clayton et al., 1978) using the formula: $(2.10\text{x}10^{-6})*\text{Length(mm)}^{3.00}$ = weight(g) (Clayton et al., 1978).

Table G1-35: Winter Flounder Species Parameters

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)[d]	Fraction Vulnerable to Fishery[c]	Weight (lb)[e]
Eggs	5.39[a]	0	0	0.00000000726[f]
Larvae 1	0.354[bb]	0	0	0.000000442[g]
Larvae 2	0.708[b]	0	0	0.00000108[g]
Larvae 3	2.83[b]	0	0	0.00000933[g]
Larvae 4	0.708[b]	0	0	0.0000135[g]
Juvenile	1.77[b]	0	0	0.000161[h]
Age 1+	0.2[c]	0.24	0.01	0.012[i]
Age 2+	0.2[c]	0.24	0.29	0.182[i]
Age 3+	0.2[c]	0.24	0.8	0.425[i]
Age 4+	0.2[c]	0.24	0.92	0.738[i]
Age 5+	0.2[c]	0.24	0.83	1.08[i]
Age 6+	0.2[c]	0.24	0.89	1.4[i]
Age 7+	0.2[c]	0.24	0.89	1.69[i]
Age 8+	0.2[c]	0.24	0.89	1.94[i]
Age 9+	0.2[c]	0.24	0.89	2.16[i]
Age 10+	0.2[c]	0.24	0.89	2.33[i]
Age 11+	0.2[c]	0.24	0.89	2.49[i]
Age 12+	0.2[c]	0.24	0.89	2.61[i]

[a] Calculated from survival (PG&E Generating and Marine Research Inc., 1999) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[b] Calculated from survival (Saila et al., 1997) using the equation: (natural mortality) = -LN(survival) - (fishing mortality).
[c] Colarusso, 2000.
[d] NOAA, 2001c.
[e] Weight calculated from length using the formula: $(6.591 \times 10^{-6}) * \text{Length(mm)}^{3.109}$ = weight(g) (Colarusso, 2000).
[f] Length from Able and Fahay (1998).
[g] Length from Saila et al. (1997).
[h] Length assumed based on Saila et al. (1997) and Colarusso (2000).
[i] Length from Colarusso (2000).