Appendix B-4

Benchmarks

The EDT method associates survival with habitat. The productivity and capacity values derived in the EDT process are characteristics of the environment by time and location as interpreted "though the eyes of salmon" by species and life stage. The procedure for deriving these productivity and capacity values involves what we refer to as a shaping of survival conditions over time and space, as salmon might experience them in completing their life cycle. The shaping of survival conditions is done with reference to a defined set of "benchmark" conditions.

From literature we can identify habitat requirements by life stage for the species. We can take it a step further and describe optimal conditions and the expected survival and density limits by life stage. We refer to the survival and density values associated with optimal conditions as reference benchmarks. Thus benchmarks provide us with a set of descriptions for optimal conditions expressed as productivity survival, maximum densities, and habitat characteristics for each life stage. These conditions constitute what can be thought of "as good as it gets" for survival of the species in nature. We have employed a set of benchmark values derived from reviewing relevant sources of information, including discussions with scientists having expertise in survival of salmonids by life stage under various conditions.

The systematic shaping of survival conditions using the habitat rating procedures is intended to assure that productivity and capacity values for each life history segment along a trajectory are: a) bounded by the biological limits of the species, b) scaled consistently across time, space, and life stage, and c) scaled consistently with the benchmark values.

It is important to keep in mind that benchmark or optimal conditions are different from template (pre-development) conditions. Template conditions were not always optimal for salmon survival. The benchmark descriptions serve as a point of reference for both the patient and template and for all watersheds.

Table 1 provides a list of productivity survival values for chinook salmon used in the Columbia River analysis for freshwater environments. Tables 2 and 3 provide this information for steelhead and bull trout.

Table 1. Benchmark productivity survival values by freshwater life stage for chinook salmon. Values have been rounded. Sterotypical life stage durations are shown.

Life stage	Stereotypical duration (weeks)	Life stage productivity survival
Spawning	1	1
Egg incubation	25	0.57
Fry colonization	2	0.75
0-age resident rearing	30	0.70
0-age migrant	2	0.96
Inactive (full winter)	19	0.70
1-age resident rearing	8	0.97
1-age migrant	2	0.98
Migrant prespawner	8	0.92
Holding prespawner	8	0.98

Table .2. Benchmark productivity survival values and capacity densities at the end of each life stage used in previous EDT analyses for steelhead trout. Values have been rounded.

Life stage	Environmental type	Stereotypical duration (weeks)	Life stage productivity survival	End of life stage density (per sq m)
Spawning	All types	1	1	0.33
Egg incubation	All types	7	0.6	400
Fry colonization	Headwater streams	2	0.65	13.58
Fry colonization	Low order streams	2	0.65	6.79
Fry colonization	Mid order streams	2	0.65	3.40
Fry colonization	High order streams	2	0.65	1.70
Fry colonization	Mainstem reservoirs	2	0.65	1.70
0-age resident rearing	Headwater streams	16	0.5	1.33
0-age resident rearing	Low order streams	16	0.5	0.67
0-age resident rearing	Mid order streams	16	0.5	0.33
0-age resident rearing	High order streams	16	0.5	0.17
0-age resident rearing	Mainstem reservoirs	16	0.5	0.17
0-age migrant	All types	2	0.975	30
0-age inactive	Headwater streams	20	0.85	0.60
0-age inactive	Low order streams	20	0.85	0.30
0-age inactive	Mid order streams	20	0.85	0.15
0-age inactive	High order streams	20	0.85	0.08
0-age inactive	Mainstem reservoirs	20	0.85	0.08
1-age resident rearing	Headwater streams	28	0.95	0.13
1-age resident rearing	Low order streams	28	0.95	0.07
1-age resident rearing	Mid order streams	28	0.95	0.03
1-age resident rearing	High order streams	28	0.95	0.02
1-age resident rearing	Mainstem reservoirs	28	0.95	0.02
1-age migrant	All types	2	0.975	30
1-age inactive	Headwater streams	20	0.95	0.11
1-age inactive	Low order streams	20	0.95	0.06
1-age inactive	Mid order streams	20	0.95	0.03
1-age inactive	High order streams	20	0.95	0.01
1-age inactive	Mainstem reservoirs	20	0.95	0.01
2-age resident rearing	Headwater streams	28	0.95	0.06
2-age resident rearing	Low order streams	28	0.95	0.03
2-age resident rearing	Mid order streams	28	0.95	0.02
2-age resident rearing	High order streams	28	0.95	0.01
2-age resident rearing	Mainstem reservoirs	28	0.95	0.01
2-age migrant	All types	2	0.99	30
2-age inactive	Headwater streams	20	0.95	0.06
2-age inactive	Low order streams	20	0.95	0.03
2-age inactive	Mid order streams	20	0.95	0.02
2-age inactive	High order streams	20	0.95	0.01
2-age inactive	Mainstem reservoirs	20	0.95	0.01
Migrant prespawner	Free flowing rivers and streams	3	1	1
Holding prespawner	All types	8	1	1

Table.3. Benchmark productivity survival values and capacity densities at the end of each life stage used in previous EDT analyses for bull trout.

Life stage	Environmental type	Sterotypical duration (weeks)	Life stage productivity survival	End of life stage density (per sq m)
Spawning	Headwater	1	1	0.22
Spawning	Low Stream Order	1	1	0.22
Spawning	Mid Stream Order	1	1	0.22
Egg incubation	Headwater	27	0.6	400
Egg incubation	Low Stream Order	27	0.6	400
Egg incubation	Mid Stream Order	27	0.6	400
Fry colonization	Headwater	2	0.75	16.7
Fry colonization	Low Stream Order	2	0.75	16.7
Fry colonization	Mid Stream Order	2	0.75	16.7
0-age resident rearing	Headwater	27	0.6	3
0-age resident rearing	Low Stream Order	27	0.6	3
0-age resident rearing	Mid Stream Order	27	0.6	3
0-age transient rearing	Headwater	27	0.5	3
0-age transient rearing	Low Stream Order	27	0.5	3
0-age transient rearing	Mid Stream Order	27	0.5	3
0-age migrant	Headwater	2	0.9	3
0-age migrant	Low Stream Order	2	0.9	3
0-age migrant	Mid Stream Order	2	0.9	3
0-age inactive	Headwater	18	0.6	2.3
0-age inactive	Low Stream Order	18	0.6	2.3
0-age inactive	Mid Stream Order	18	0.6	2.3
1-age resident rearing	Headwater	34	0.75	1
1-age resident rearing	Low Stream Order	34	0.75	1
1-age resident rearing	Mid Stream Order	34	0.75	1
1-age transient rearing	Headwater	34	0.6	1
1-age transient rearing	Low Stream Order	34	0.6	1
1-age transient rearing	Mid Stream Order	34	0.6	1
1-age migrant	Headwater	2	0.95	1
1-age migrant	Low Stream Order	2	0.95	1
1-age migrant	Mid Stream Order	2	0.95	1
1-age inactive	Headwater	18	0.75	0.5
1-age inactive	Low Stream Order	18	0.75	0.5
1-age inactive	Mid Stream Order	18	0.75	0.5
2+-age resident rearing	Headwater	34	0.9	0.09
2+-age resident rearing	Low Stream Order	34	0.9	0.09
2+-age resident rearing	Mid Stream Order	34	0.9	0.09
2+-age transient rearing	Headwater	6	0.95	0.09
2+-age transient rearing	Low Stream Order	6	0.95	0.09
2+-age transient rearing	Mid Stream Order	6	0.95	0.09
2+-age migrant	Headwater	2	0.975	0.5
2+-age migrant	Low Stream Order	2	0.975	0.5
2+-age migrant	Mid Stream Order	2	0.975	0.5
2+-age inactive	Headwater	18	0.9	0.09
2+-age inactive	Low Stream Order	18	0.9	0.09
2+-age inactive	Mid Stream Order	18	0.9	0.09
5+-age resident rearing	Headwater	34	0.95	0.005
5+-age resident rearing	Low Stream Order	34	0.95	0.005
5+-age resident rearing	Mid Stream Order	34	0.95	0.005
5+-age transient rearing	Headwater	6	0.95	0.005
5+-age transient rearing	Low Stream Order	6	0.95	0.005
5+-age transient rearing	Mid Stream Order	6	0.95	0.005
5+-age migrant	Headwater	2	1	0.09

5+-age migrant	Low Stream Order	2	1	0.09
5+-age migrant	Mid Stream Order	2	1	0.09
5+-age inactive	Headwater	18	0.95	0.005
5+-age inactive	Low Stream Order	18	0.95	0.005
5+-age inactive	Mid Stream Order	18	0.95	0.005
Transient prespawner	Headwater	6	0.95	0.005
Transient prespawner	Low Stream Order	6	0.95	0.005
Transient prespawner	Mid Stream Order	6	0.95	0.005
Holding prespawner	Headwater	10	0.95	0.005
Holding prespawner	Low Stream Order	10	0.95	0.005
Holding prespawner	Mid Stream Order	10	0.95	0.005
Post spawner holding/migrant	Headwater	2	0.7	0.005
Post spawner holding/migrant	Low Stream Order	2	0.7	0.005
Post spawner holding/migrant	Mid Stream Order	2	0.7	0.005