



Appendix H

ESTIMATING FISH DENSITIES

APPENDIX H: ESTIMATING FISH DENSITIES

ESTIMATING REPRODUCING DENSITIES OF FISH

Fish density was determined by using available data from existing reports and research that was conducted to measure fish densities in lakes. The Liss et al. 1999 Phase II report contains a table (table 4.3) of mark-and-recapture densities for 10 lakes with reproducing (self-sustaining) fish populations. In that table, the average reported density for each of the 10 lakes was applied to each year between 1989 and 2003. For these 10 lakes, the data collected by Oregon State University and the U.S. Geological Survey are listed in table H-1.

For some of the lakes, fish densities were estimated from mark-and-recapture data for sampled reproducing populations (Liss et al. 1998), stocking records, and calculated annual mortality rates of stocked fish. Others were estimated from a variety of other information reported in Liss et al. 1998, including apparent impacts to long-toed salamanders and the condition of fish in a particular lake. A density of 222 fish/acre was considered to be the average density for reproducing fish populations in lakes with high densities of fish. Unless a lake was reported to have a lower density of reproducing fish or a population of brook trout, a density of 222 fish/acre was used for each year for lakes with reproducing fish.

Reproducing brook trout populations are seldom maintained at low densities and have been reported to reach densities as high as 700 fish/acre. For lakes in the North Cascades Complex with reproducing brook trout populations, the following numbers were used: an average of 222 fish/acre for lakes with high densities and a maximum of 700 fish/acre (average of 461 fish/acre).

There were few lakes with low densities of reproducing fish; the densities in these lakes ranged from 11 to 53 fish/acre, for an average of 33 fish/acre. Other lakes contained low densities of reproducing fish, where reproduction was inadequate to sustain fish populations. If these low-density reproducing populations are not supplemented with hatchery fish, they would likely be eliminated over a period of a few decades due to variations in reproductive success. The average value of 33 fish/acre was applied to these lakes for each year between 1989 to 2003.

ESTIMATING DENSITIES FOR LAKES WITH NONREPRODUCING FISH AND MIXED-MANAGEMENT LAKES

Maximum literature values for yearly survival rates of fish stocked in mountain lakes (including both natural and angling mortalities) are about 90% survival for the first two years (before fish are large enough to be caught by anglers) and 60% each year after they enter the sport fishery. For the first two years after stocking, the stocking density was multiplied by a 90% survival rate. After the first two years, a 60% survival rate was used. Year-by-year after stocking, fish numbers for a stocked year class generally declined in an exponential fashion until about the 10th year after stocking, when approximately 1 fish/acre would be left.

Some lakes have a combination of nonreproducing and reproducing fish. In these mixed-management lakes, both approaches were used for estimating density. For each lake, the total density per year was calculated. This number represents the total number of stocked fish from each stocked year class and fish from natural reproduction that were present in a lake for each calendar year. The total yearly densities for each year from 1989 to 2003 are presented in table H-1 for each of the 91 lakes in the North Cascades Complex that has a history of fish stocking.

Using this information, table 6 in the “Alternatives” chapter was generated to show the average density for each lake.



TABLE H-1: FISH SURVIVAL CALCULATIONS

Lake Name	NPS Lake Code	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Azure	MP-09-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Battalion	MLY-02-01	237	289	280	272	252	237	230	267	261	256	242	232	227	225	223
Bear	MC-12-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Berdeen	M-08-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Berdeen, Lower	M-07-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Berdeen, Upper	M-09-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Blum (Largest / Middle No. 3)	M-11-01	222	222	222	222	382	420	400	344	287	255	238	230	226	224	223
Blum (Lower / West, No. 4)	LS-07-01	461	461	461	461	461	461	461	461	461	461	461	461	461	461	461
Blum (Small / North, No. 2)	MC-01-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blum (Vista / Northwest, No. 1)	MC-02-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bouck, Lower	DD-04-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Bouck, Upper	DD-05-01	27	69	56	48	28	14	62	53	46	28	69	56	48	28	14
Bowan	MR-12-01	77	65	57	34	17	8	111	98	88	53	26	13	7	111	99
Coon	MM-10-01	159	213	154	210	152	111	64	32	16	8	4	104	93	83	50
Copper	MC-06-01	105	90	78	47	77	60	50	29	15	76	66	58	34	17	9
Dagger	MR-04-01	259	259	259	259	259	259	259	259	259	259	259	259	259	259	259
Dee Dee, Upper	MR-15-01	53	52	52	51	51	51	51	51	51	51	92	88	84	71	61
Dee Dee (Tamarack, Lower)	MR-15-02	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Despair, Lower	M-14-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Despair, Upper	M-13-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diobsud No. 1	LS-01-01	11	61	56	52	35	23	17	14	13	12	11	0	0	0	11
Diobsud No. 2, Lower	LS-02-01	74	274	254	236	171	123	98	86	80	77	76	75	74	74	74
Diobsud No. 3, Upper	LS-03-01	35	30	27	16	98	85	75	45	99	80	68	40	20	10	5



TABLE H-1: FISH SURVIVAL CALCULATIONS (CONTINUED)

Lake Name	NPS Lake Code	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Doubtful	CP-01-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Doug's Tarn	M-21-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
East, Lower	MC-14-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East, Upper	MC-14-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Firn	MP-02-01	82	73	44	22	11	5	3	1	1	0	0	26	23	21	13
Green	M-04-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Green Bench	LS-04-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanging	MC-08-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Hidden	SB-01-01	127	115	82	58	93	82	75	58	93	82	75	58	94	83	76
Hidden Lake Tarn	EP-14-01	10	5	53	47	42	25	13	6	54	47	42	25	13	62	54
Hi-Yu	M-01-01	20	10	5	3	1	112	100	90	138	103	82	48	108	87	74
Hozomeen	HM-02-01	461	461	461	461	461	461	461	461	461	461	461	461	461	461	461
Ipsoot	LS-06-01	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Jeanita	DD-01-01	78	56	44	39	36	34	34	33	33	33	33	33	33	33	33
Kettling	MR-05-01	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103
Kwahnesum	MC-07-01	199	173	128	72	188	155	132	78	39	182	156	136	81	41	20
McAlester	MR-10-01	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204
Middle, Lower	MC-16-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middle, Upper	MC-16-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monogram	M-23-01	264	243	232	227	225	223	275	269	264	247	235	228	225	224	223
Monogram Tarn	M-23-11	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Nert	M-05-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noisy Creek, Upper	LS-14-01	0	0	0	0	0	0	0	0	0	0	0				0
No Name	PM-01-01	83	69	58	35	84	69	59	35	17	9	4	2	1	1	0
Panther Potholes, Lower	RD-05-02	77	141	106	80	46	98	79	67	39	20	10	5	2	1	1
Panther Potholes, Upper	RD-05-01	288	234	137	69	34	17	9	4	2	1	0	0	0	0	0
Pegasus	EP-10-01	0	0	0	0	0	0	0	0	0	0	0				0

TABLE H-1: FISH SURVIVAL CALCULATIONS (CONTINUED)

Lake Name	NPS Lake Code	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pond SE of Kettling Lakes	MR-09-01	29	26	16	8	44	38	33	20	10	45	38	34	20	10	5
Quill, Lower	M-24-02	58	56	53	45	39	36	35	34	33	33	33	33	33	68	65
Quill, Upper	M-24-01	54	52	50	43	38	36	34	34	33	33	33	33	33	62	59
Rainbow	MR-14-01	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233
Rainbow, Upper (North)	MR-13-01	646	578	346	173	87	43	22	11	5	3	1	1	0	0	0
Rainbow, Upper (South)	MR-13-02	114	150	105	71	39	20	10	34	29	25	15	7	4	2	1
Rainbow, Upper (West)	MM-11-01	112	100	60	30	15	8	4	2	1	40	36	33	19	10	5
Redoubt	MC-11-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reveille, Lower	MC-21-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reveille, Upper	MC-21-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ridley	HM-03-01	108	87	51	57	42	32	65	51	42	71	54	89	67	50	29
Sky	EP-13-01	0	0	0	0	0	0	0	0	0	0	0				0
Skymo	PM-03-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Sourdough	PM-12-01	461	461	461	461	612	748	719	657	571	652	611	585	534	497	479
Sourpuss	ML-01-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stiletto	MR-01-01	47	40	36	21	11	5	41	36	31	19	9	5	2	1	1
Stout	EP-09-02	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Stout, Lower	EP-09-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Sweet Pea	ML-02-01	36	30	25	15	36	30	25	15	8	4	41	36	32	19	10
Talus Tarn	M-06-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tapto, Lower	MC-17-03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tapto, Middle	MC-17-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tapto, Upper	MC-17-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tapto, West	MC-17-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thornton, Lower	M-20-01	95	85	51	26	13	6	3	2	1	112	101	91	54	27	14
Thornton, Middle	M-19-01	98	72	57	33	162	139	122	73	165	134	114	67	34	51	39
Thunder	RD-02-01	628	413	269	190	124	90	64	48	40	37	35	34	33	33	33



TABLE H-1: FISH SURVIVAL CALCULATIONS (CONTINUED)

Lake Name	NPS Lake Code	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Tiny	MC-15-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torment	ML-03-01	7	40	35	31	18	9	47	40	35	21	10	5	3	1	1
Trapper	GM-01-01	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Triplet, Lower	SM-02-01	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193
Triplet, Upper	SM-02-02	186	186	186	186	186	186	186	186	186	186	186	186	186	186	186
Triumph	M-17-01	75	61	51	30	108	91	79	47	94	75	63	37	18	43	35
Unnamed	FP-01-01	0	0	0	0	0	0	0	0	0	0	0				0
Unnamed	MR-11-01	29	81	65	52	71	51	92	70	54	71	52	40	23	66	54
Unnamed	MR-16-01	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Vulcan	ML-04-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wilcox/Lillie, Upper	EP-06-01	257	240	301	289	281	257	240	231	226	224	223	223	222	222	222
Wilcox/Sandie, Lower	EP-05-01	256	239	230	226	298	290	282	258	240	231	227	224	223	223	222
Wild	MC-27-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Willow	HM-04-01	210	166	97	80	80	74	106	86	71	96	90	129	98	90	57