Appendix E

Pacific Gas and Electric Company Vested Water Rights on Battle Creek and Battle Creek Tributaries

Pacific Gas and Electric Company
Vested Water Rights on Battle Creek and Battle Creek Tributaries

Pacific Gas and Electric Company claims the following vested water rights:

1. The right to divert water from North Fork Battle Creek, in the SE1/4 OF SE1/4 SECTION 20, T32N, R3E, MDB&M, 1,012 acre-feet to storage in Battle Creek Reservoir, from January 1 to December 31, under prior vested right with a priority of 1909, for electric generation, as specified in Statement of Water Diversion and Use No. 830.

2. The right to divert water from North Fork Battle Creek, in the SW1\4 OF NE1/4 SECTION 15, T31N, R2E, MDB&M, 430 acre-feet to storage in Macumber Reservoir, from January 1 to December 31, under prior vested right with a priority of 1909, for electric generation, as specified in Statement of Water Diversion and Use No. 831.

3. The right to divert water from Bailey Creek, in the NE1/4 OF NE1/4 SECTION 30, T31N, R3E, MDB&M, 20 cubic feet per second into the Loomis Mill Ditch, from January 1 to December 31, under prior vested right with a priority of 1865, for electric generation, as specified in Statement of Water Diversion and Use No. 843.

4. The right to divert water from North Fork Battle Creek, in the NE1/4 OF NE1/4 SECTION 30, T31N, R2E, MDB&M, 45 cubic feet per second into the Al Smith Canal, from January 1 to December 31, under prior vested right with a priority of 1880, for electric generation, as specified in Statement of Water Diversion and Use No. 832.

5. The right to divert water from Ash Creek, in the SW1/4 OF SE1/4 SECTION 28, T31N, R1E, MDB&M, 4 cubic feet per second into the Shingle Creek Canal, from January 1 to December 31, under prior vested right with a priority of 1870, for electric generation, as specified in Statement of Water Diversion and Use No. 846.

6. The right to divert water from Baldwin Creek, in the NW1/4 OF SE1/4 SECTION 33, T31N, R1E, MDB&M, 5 cubic feet per second into the Baldwin-Lake Grace Canal, from January 1 to December 31, under prior vested right with a priority of 1903, for electric generation, as specified in Statement of Water Diversion and Use No. 862.

7. The right to divert water from Millseat Creek, in the NE1/4 OF NW1/4 SECTION 3, T30N, R1E, MDB&M, 70 cubic feet per second into the Lower Mill Creek Canal, from January 1 to December 31, under prior vested right with a priority of 1900, for electric generation, as specified in Statement of Water Diversion and Use No. 834.

8. The right to divert water from North Fork Battle Creek, in the SE1/4 OF SE1/4 SECTION 25, T31N, R1E, MDB&M, 45 cubic feet per second into the Keswick Canal, from January 1 to December 31, under prior vested right with a priority of 1883, for electric generation, as specified in Statement of Water Diversion and Use No. 833.

9. The right to divert water from an unnamed spring, in the NW1/4 OF NE1/4 SECTION 36, T31N, R1E, MDB&M, 3 cubic feet per second into the Keswick Canal,

from January 1 to December 31, under prior vested right with a priority of 1883, for electric generation, as specified in Statement of Water Diversion and Use No. 857.

10. The right to divert water from Millseat Creek, in the NE1/4 OF SW1/4 SECTION 3, T30N, R1E, MDB&M, 10 cubic feet per second into the Keswick Canal, from January 1 to December 31, under prior vested right with a priority of 1883, for electric generation, as specified in Statement of Water Diversion and Use No. 860.

11. The right to divert water from Berry Creek, in the NW1/4 OF NW1/4 SECTION 2, T30N, R1E, MDB&M, 10 cubic feet per second into the Keswick Canal, from January 1 to December 31, under prior vested right with a priority of 1883, for electric generation, as specified in Statement of Water Diversion and Use No. 858.

12. The right to divert water from Galloping Creek, in the NE1/4 OF NE1/4 SECTION 3, T30N, R1E, MDB&M, 10 cubic feet per second into the Keswick Canal, from January 1 to December 31, under prior vested right with a priority of 1883, for electric generation, as specified in Statement of Water Diversion and Use No. 859.

13. The right to divert water from Brush Creek, in the NW1/4 OF NE1/4 SECTION 16, T30N, R1E, MDB&M, 10 cubic feet per second, from January 1 to December 31, under prior vested right with a priority of 1883, for electric generation, as specified in Statement of Water Diversion and Use No. 861.

14. The right to divert water from Millseat Creek, in the NW1/4 OF NE1/4 SECTION 16, T30N, R1E, MDB&M, 20 cubic feet per second into the Cross Country Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 844.

15. The right to divert water from North Fork Battle Creek, in the NW1/4 OF SW1/4 SECTION 15, T30N, R1E, MDB&M, 50 cubic feet per second into the Cross Country Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 836.

16. The right to divert water from Digger Creek, in the SE1/4 OF NE1/4 SECTION 21, T30N, R1E, MDB&M, 20 cubic feet per second into the Cross Country Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 847.

17. The right to divert water from Ripley Creek, in the SE1/4 OF SE1/4 SECTION 33, T30N, R1E, MDB&M, 25 cubic feet per second into the Cross Country Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 845.

18. The right to divert water from Ripley Creek, in the SW1/4 OF SE1/4 SECTION 33, T30N, R1E, MDB&M, 10 cubic feet per second into the Cross Country Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 856.

19. The right to divert water from South Fork Battle Creek, in the SW1/4 OF NW1/4 SECTION 18, T29N, R2E, MDB&M, 100 cubic feet per second into the South Battle Creek Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 837.

20. The right to divert water from Soap Creek, in the NW1/4 OF NW1/4 SECTION 12, T29N, R1E, MDB&M, 35 cubic feet per second into the South Battle Creek Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 838.

21. The right to divert water from North Fork Battle Creek, in the NW1/4 OF SE1/4 SECTION 25, T30N, R1W, MDB&M, 70 cubic feet per second into the Eagle Canyon Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 840.

22. The right to divert water from Digger Creek, in the NE1/4 OF SW1/4 SECTION 30, T30N, R1E, MDB&M, 10 cubic feet per second into the Rice-Bauer Ditch, from January 1 to December 31, under prior vested right with a priority of 1880, for electric generation and irrigation, as specified in Statement of Water Diversion and Use No. 855.

23. The right to divert water from an unnamed spring, in the NW1/4 OF SE 1/4 SECTION 25, T30N, R1W, MDB&M, 10 cubic feet per second into the Eagle Canyon Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 850.

24. The right to divert water from an unnamed spring, in the NW1/4 OF SE 1/4 SECTION 25, T30N, R1W, MDB&M, 10 cubic feet per second into the Eagle Canyon Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 851.

25. The right to divert water from an unnamed spring, in the NW1/4 OF SE 1/4 SECTION 25, T30N, R1W, MDB&M, 10 cubic feet per second into the Eagle Canyon Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 852.

26. The right to divert water from an unnamed spring, in the NW1/4 OF SE1/4 SECTION 25, T30N, R1W, MDB&M, 10 cubic feet per second into the Eagle Canyon Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 853.

27. The right to divert water from an Rice Springs, in the NE1/4 OF NE1/4 SECTION 35, T30N, R1W, MDB&M, 3 cubic feet per second into the Eagle Canyon Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 854.

28. The right to divert water from South Fork Battle Creek, in the NE1/4 OF SE1/4 SECTION 5, T29N, R1E, MDB&M, 200 cubic feet per second into the Inskip Canal, from

January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 839.

29. The right to divert water from Ripley Creek, in the NW1/4 OF NE1/4 SECTION 1, T29N, R1W, MDB&M, 5 cubic feet per second into the Inskip Canal, from January 1 to December 31, under prior vested right with a priority of 1907, for electric generation, as specified in Statement of Water Diversion and Use No. 848.

30. The right to divert water from South Fork Battle Creek, in the NW1/4 OF NW1/4 SECTION 3, T29N, R1W, MDB&M, 280 cubic feet per second into the Coleman Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 841.

31. The right to divert water from North Fork Battle Creek, in the SE1/4 OF SW1/4 SECTION 27, T30N, R1W, MDB&M, 18 cubic feet per second into the Wild Cat Canal, from January 1 to December 31, under prior vested right with a priority of January 9, 1922, for electric generation, as specified in California State Water Rights License No. 549 (Application No. 2754).

32. The right to divert water from Darrah Creek, in the NE1/4 OF NE1/4 SECTION 29, T30N, R1W, MDB&M, 25 cubic feet per second into the Coleman Canal, from January 1 to December 31, under prior vested right with a priority of October 13, 1950, for electric generation and incidental domestic use, as specified in California State Water Rights License No. 7217 (Application No. 13995).

33. The right to divert water from Baldwin Creek, in the SW1/4 OF SW1/4 SECTION 20, T30N, R1W, MDB&M, 45 cubic feet per second into the Coleman Canal, from January 1 to December 31, under prior vested right with a priority of 1910, for electric generation, as specified in Statement of Water Diversion and Use No. 842.

34. The right to divert water from Unnamed Spring, in the SW1/4 OF SE1/4 SECTION 9, T30N, R1E, MDB&M, 150 gallons per minute, from January 1 to December 31, under prior vested right with a priority of 1900, for domestic and incidental irrigation, as specified in Statement of Water Diversion and Use No. 867.

35. The right to divert water from Unnamed Spring, in the NE1/4 OF NW1/4 SECTION 3, T29N, R1W, MDB&M, 200 gallons per minute, from January 1 to December 31, under prior vested right with a priority of 1909, for domestic and incidental irrigation, as specified in Statement of Water Diversion and Use No. 865.

Appendix F

DRAFT—Habitat Assessment Model for Chinook Salmon and Steelhead

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Introduction

A monthly model was developed for chinook salmon (i.e., winter-, spring-, late fall–runs) and steelhead to facilitate assessment of each alternative included in the Battle Creek Salmon and Steelhead Restoration Project Draft Environmental Impact Statement and Environmental Impact Report (EIS/EIR). The habitat assessment model considers the habitat capacity index that depends on streamflow and then links streamflow and water temperature conditions to effects on key habitat quantity and survival. A relative estimate of fry and juvenile capacity and production indices is provided for each reach. The simulated indices are not intended as accurate predictions of magnitude for each life stage, but provide sufficient information to compare the relative life stage capacity and production expected to occur under the No Action and action alternatives.

A key premise of this impact assessment is that the tools applied support the comparison of alternatives based on the available physical and biological information. The water temperature survival indices, flow-habitat relationships, and other elements should not be considered as specific management recommendations or targets for the management of flow, water temperature, or other environmental conditions in Battle Creek or elsewhere in Central Valley rivers. These assessment tools are sufficient for evaluating the relative impacts of the restoration alternatives.

Evaluation of Battle Creek Minimum Flow Requirements

The monthly habitat model was used to simulate the predicted habitat area provided for the minimum flow requirements under each alternative. There are three sets of minimum flow requirements that must be compared among the five alternatives.

1. The No Action minimum flow requirements represent the existing Federal Energy Regulatory Commission (FERC) license flow requirements and are

3 cfs for the North Fork Battle Creek diversion dams and 5 cfs for the South Fork Battle Creek diversion dams.

2. The Anadromous Fish Restoration Program (AFRP) minimum flow requirements are assumed for the No Dam Removal and the Three Dam Removal Alternatives and have higher flow targets for the winter months (December through April) than for the summer months.

3. The 1999 Memorandum of Understanding (MOU) minimum flow requirements are somewhat higher than the AFRP flow requirements and have higher flow targets for the winter months than for the summer months. The MOU flow targets are specified for the Five Dam Removal and Six Dam Removal Alternatives.

Flow-Habitat Relationships

Streamflow directly influences the availability and function of important habitat elements, including water velocity, depth, wetted area, and cover. Flow-habitat relationships for Battle Creek are based on the Instream Flow Incremental Methodology (IFIM) and Physical Habitat Simulation (PHABSIM) system (Milhous et al. 1984, Thomas R. Payne and Associates 1998). IFIM and PHABSIM were applied to on-site studies on Battle Creek. In 1988, an instream flow study on Battle Creek was initiated via the Upper Sacramento River Fisheries and Riparian Habitat Management Plan process (USRFRHAC 1989). A comprehensive study that predicted habitat quantity as a function of flow was conducted under the guidance of a technical committee that included biologists from the fisheries agencies and PG&E (Thomas R. Payne and Associates 1998). The flow-habitat relationships that resulted from the study are presented in Tables F-1 through F-8.

In 1992, the modeling results were used by the fisheries agencies in an effort to identify Battle Creek flow needs below dams, along with other actions, that together might increase the abundance of anadromous fish populations. This effort was part of the AFRP and identified flow releases referred to as the *AFRP flows* (USFWS 2001). It was recognized that these AFRP flow releases for the dams on Battle Creek were subject to revision based upon future analysis (USFWS 2001).

In 1998, the Battle Creek Working Group's (BCWG's) Biological Technical Team analyzed the IFIM data and modeling results. The analysis identified:

1. priority species and life stages of focus for each reach of Battle Creek,
2. flows to facilitate upstream access over obstacles in the stream channel,
3. rates of flow changes to avoid stranding and isolation of juveniles, and
4. water temperatures influenced both by increased flows and releases of cold spring–fed water to adjacent reaches of Battle Creek.

The instream flow releases at each of the dam sites developed through this process are the *MOU flows*.

Spawning and rearing habitat area was calculated for the FERC (No Action Alternative), AFRP (No Dam Removal Alternative and Three Dam Removal Alternative), and MOU (Five Dam Removal Alternative and Six Dam Removal Alternative) minimum flow requirements. Example calculated habitat areas are shown in Table F-9. The habitat areas are based on the flow-habitat relationships in Tables F-1 through F-8.

Fry Capacity Index for Steelhead and Chinook Salmon

The fry capacity index is based on the estimated spawning habitat area provided by minimum flow requirements for each alternative during the spawning and incubation period. The relationship between streamflow and spawning habitat area was developed from existing instream flow studies (Thomas R. Payne and Associates 1998). Habitat area generally increases as flow increases, reaching a maximum area and declining at higher flows (Tables F-1 through F-8). Substrate, depth, and velocity are the primary determinants of spawning habitat quantity. The flow-habitat relationships are slightly different for steelhead and chinook salmon because of differences in substrate, depth, and velocity preferences.

The number of potential redds supported is calculated by dividing spawning habitat area by redd area. Redd size varies by species. A redd area of 56 square feet is assumed for steelhead and 100 square feet is assumed for chinook salmon. Observed redd size for Central Valley chinook salmon ranges from 75 square feet to 650 square feet (Reynolds et al. 1990). A smaller redd size has been documented in the lower American River, where Snider and Vyverberg (1996) calculated an average size of 62 square feet when measured on the ground and 196 square feet when measured from aerial photographs. The average size of a steelhead redd is smaller than a chinook salmon redd (Reynolds et al. 1990). Reiser and White (1981 in Reiser and Bjornn 1979) and Hunter (1973) estimated steelhead redd sizes from 47 to 58 square feet (4.4 square meters to 5.4 square meters). The Central Valley Salmon and Steelhead Restoration and Enhancement Plan indicated steelhead redd sizes ranging from 22.5 to 121 square feet and averaging 56 square feet (Reynolds et al. 1990).

The number of fry in each redd is based on the number of eggs potentially spawned by each species and the expected baseline survival of eggs. The number of eggs in each redd is assumed to be 4,000 for steelhead and 3,800 for chinook salmon (Kier Associates 1999). As a baseline survival, about 25% of the eggs in each redd are assumed to survive through emergence. Therefore, each redd could produce 1,000 steelhead fry or 950 chinook salmon fry. The baseline survival does not include effects of water temperature.

The potential number of redds that could be supported by the available habitat is calculated by dividing spawning habitat area, as predicted from the flow habitat relationships in Tables F-1 through F-8, by approximate redd area for each species. The total potential population of eggs is calculated as number of redds multiplied by the number of eggs for each species that are expected to survive through emergence. Spawning habitat is assumed to be saturated (i.e., all available spawning habitat is used by each species). The proportion of the total potential population of eggs spawned each month is calculated by multiplying the total potential population of eggs by the monthly proportion of the population that would be expected to spawn. Spawning habitat area is the minimum area that is provided by minimum flow requirements during the month of spawning and during subsequent months of incubation. Steelhead fry are assumed to emerge from the redd after 2 months of incubation and chinook after 3 months. Therefore, flow requirements during 2 consecutive months are considered in the calculation of fry capacity index for steelhead and flows during three consecutive months are considered in the calculation for chinook salmon.

The assumed proportion of the population spawning each month is based on existing information on life stage timing. The use of the proportion spawning each month avoids habitat saturation during the first month of spawning and weights spawning habitat use according to the assumed distribution of the life stage through the entire spawning period.

Effects of Water Temperature on the Fry Production Index

The estimated water temperature effect on survival of eggs and larvae varies with temperature and by species (Figure F-1). Survival during incubation is assumed to decline with warming temperature between 54ºF and 62ºF for chinook salmon and 53°F and 59°F for steelhead. Chinook salmon eggs and larvae require temperatures between 39.2ºF and 53.6ºF for the highest survival rates (Myrick and Cech 2001). Chinook salmon eggs that incubated in water above 62ºF experienced 100% mortality before the eyed stage (Hinze 1959 in Myrick and Cech 2001). Studies of fall-run chinook salmon in the Sacramento River showed that eggs survive temperatures between 35ºF and 62ºF (Myrick and Cech 2001). Alderice and Velsen (1978 in Healey 1991) and Seymour (1956 in Alderice and Velsen 1978) found less than 50% egg survival when temperature was greater than 60.8ºF. The optimal water temperature for steelhead spawning and incubation has been reported to fall in the range between 39ºF and 52ºF (Myrick and Cech 2001).

Monthly average water temperature is used to calculate a monthly survival rate (Figure F-1). Monthly average water temperature is simulated for each reach based on average meteorology and the minimum flow requirements for each alternative. Figure F-2 shows the expected water temperatures for the minimum flow requirements under each alternative for the month of July. The effect of water temperature on emergent fry production index is calculated by multiplying the number of emerging fry in a month by the product of water temperature survival rates during the period of incubation. The monthly survival rates include the rate for the month of spawning through the month of emergence (two consecutive months for steelhead and three consecutive months for chinook salmon). Additional temperature information is discussed in Appendix M.

Juvenile Capacity Index for Steelhead and Chinook Salmon

The juvenile capacity index in each reach for each month is dependent on the minimum flow requirement under each alternative and associated habitat area (Table F-9), the fry capacity index in the reach, and the number of surplus fry from upstream reaches. The juvenile capacity index is juvenile rearing habitat area, as predicted from the flow-habitat relationships in Tables F-1 through F-8, divided by the habitat need for each juvenile. For steelhead, the assumed habitat need is 6 square feet for each juvenile. The habitat need is based on the observed density of juveniles in Keswick, North Battle Creek Feeder, and the southern reaches of Battle Creek (Kier Associates 1999) divided by an estimated habitat area calculated from flow estimates and application of the flow-habitat relationship (Tables F-1 through F-8). For chinook salmon, the assumed habitat need is 2 square feet (Kier Associates 1999).

For the purpose of this analysis, the flow-habitat relationships for juveniles are used to calculate the juvenile capacity indices. Flow-habitat relationships for fry are not used. Flow-habitat relationships for fry generally predict the greatest habitat area at low flow, indicating the observed preference of low velocity. Fry distribute themselves near low-velocity shoreline with very shallow depths and cover, such as rootwads, rocks, and debris. The instream flow model may underestimate the actual low-velocity area provided by microhabitat features. Fry habitat capacity, therefore, was not considered in this analysis. At higher flows, low-velocity areas will likely still occur near shore and near microhabitat features. In addition, the habitat area needed to support a fry is substantially less than the habitat need of a juvenile.

The calculated juvenile capacity index is assumed to be the upper limit for the number of juveniles rearing in the reach. If the sum of the number of fry emerging in the reach, the number of juveniles remaining in the reach from the previous month, and the number of surplus fry from the upstream reach is less than the calculated juvenile capacity index, all juveniles are assumed to rear in the reach. If the juvenile capacity index is exceeded, the remaining fry are considered surplus. The number of fry emerging was described above under the fry capacity index.

The surplus fry in a month are assumed to move downstream to the next reach with available habitat area, surviving at an assumed rate of 80%. For steelhead, juveniles are assumed to rear year-round, so the total annual capacity index is the number of juveniles remaining at the end of December, the last month of the simulation. For chinook salmon, fry migration occurs over several months, potentially vacating habitat that could be occupied by newly emergent fry. The monthly capacity index for juvenile chinook salmon is the number of rearing juvenile salmon times the proportion of the population migrating each month. The annual capacity index is the sum of the migrants for each month from all reaches.

Surplus fry may be considered as lost production or may contribute to production in the Sacramento River downstream of Battle Creek. Total surplus is the sum of surplus juveniles for all months that would exit the mainstem reach.

Effects of Water Temperature on the Juvenile Production Index

The estimated water temperature effect on survival of juveniles varies with temperature and by species (Figure F-3). Survival during rearing is assumed to decline with warming temperature between 64ºF and 73ºF for chinook salmon and 65°F and 75°F for steelhead. Marine (1997) and Myrick and Cech (2001) observed maximum growth rates for juvenile chinook salmon at water temperatures of 62.6ºF–68ºF and 66.2ºF, respectively. Rich (1987) found that fish from the Nimbus State Fish Hatchery reared at 75.2ºF died before the end of the experiment. Juvenile rearing success is assumed to deteriorate at water temperatures ranging from 62.6ºF to 77ºF. Nimbus Hatchery steelhead preferred temperatures between 62.6ºF and 68ºF (Cech and Myrick 1999). Steelhead can be expected to show significant mortality at temperatures exceeding 77ºF (Raleigh et al. 1984, Myrick and Cech 2001).

Monthly average water temperatures simulated for the minimum instream flow requirements are used to calculate a monthly survival rate (Figure F-3). Monthly average water temperature is simulated for each reach based on average meteorology and the minimum flow requirements for each alternative. Figure F-2 shows the expected water temperatures for the minimum flow requirements under each alternative for the month of July. The effect of water temperature on juvenile production index is calculated by multiplying the number of rearing juveniles in a month by the water temperature survival rate for the month. Water temperature is cooler at the upstream end of a reach and warmer at the downstream end. Survival rate is the average of the survival rates estimated for the monthly water temperatures at the upstream and downstream ends of the reach. Water temperature effects are not incorporated into the estimate of surplus fry.

The calculation of the juvenile production index assumes that adult steelhead can access all reaches of Battle Creek and that chinook salmon can access all reaches except Keswick. Late fall–run chinook salmon may be limited primarily to reaches downstream of Wildcat and Coleman Diversion Dams; therefore, the production index may be overestimated. Including the production represented by the mainstem of Battle Creek, Coleman and Wildcat reaches might be a better estimate of the expected production index. Production indices for fall-run chinook salmon are not simulated because current management objectives include blocking fall-run chinook salmon from continuing upstream at the

Coleman National Fish Hatchery. Although the timing of spawning, rearing, and outmigration are different between the two runs, the production index for fall-run chinook salmon may be similar in magnitude and pattern to the production index represented by late fall–run chinook salmon.

Additional temperature information is discussed in Appendix M.

Table F-1. Flow-Habitat Relationships for the Mainstem Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
5	13.2	0.3	4.4	0.5
10	15.1	0.4	6.4	0.8
15	16	0.7	8.6	1.2
20	16.5	1	10.4	1.6
25	16.6	1.1	11.9	1.9
30	16.3	1.2	13.6	2.2
35	15.9	1.3	14.6	2.3
40	15.6	1.4	15.4	2.3
45	15.2	1.5	16	2.4
50	14.7	1.5	16.5	2.3
60	13.8	1.5	17	2.3
70	13.1	1.5	17.1	2.1
80	12.3	1.5	17.1	2
90	11.5	1.5	17	1.8
100	11.2	1.4	16.8	1.8
120	9.9	1.4	16.1	1.7
140	8.9	1.3	15.2	1.5
160	8.1	1.2	14.2	1.4
180	7.4	1.1	13.1	1.3
200	7	1	12.1	1.2
250	6	0.8	10.1	1
300	5.4	0.6	8.7	0.8
350	4.8	0.5	7.5	0.6

Note: cfs = cubic feet per second.

Table F-2. Flow-Habitat Relationships for the Wildcat Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
3	0.9	0	0.4	0
10	1.9	0	1.1	0.2
15	2.3	0.1	1.6	0.3
20	2.4	0.1	1.8	0.3
25	2.6	0.2	2	0.3
30	2.6	0.2	2.2	0.3
35	2.6	0.3	2.2	0.3
40	2.6	0.3	2.3	0.3
45	2.5	0.3	2.2	0.2
50	2.5	0.4	2.2	0.2
60	2.4	0.4	2.1	0.2
70	2.3	0.4	2	0.2
80	2.3	0.4	1.9	0.1
90	2.3	0.3	1.8	0.1
100	2.2	0.3	1.8	0.1
120	2.1	0.3	1.7	0.1
140	2	0.2	1.7	0.1
160	1.8	0.2	1.6	0.1
180	2	0.1	1.5	0.1
200	1.6	0.1	1.4	0.1
220	1.5	0.1	1.4	0.1
240	1.4	0.1	1.3	0

Note: cfs = cubic feet per second.

Table F-3. Flow-Habitat Relationships for the Eagle Canyon Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
3	1	0	0.4	0.1
10	2.1	0.1	1.2	0.3
15	2.6	0.1	1.7	0.4
20	2.7	0.2	2	0.5
25	2.9	0.3	2.2	0.5
30	3	0.4	2.4	0.5
35	2.9	0.5	2.4	0.4
40	2.9	0.5	2.5	0.4
45	2.9	0.6	2.4	0.4
50	2.8	0.6	2.4	0.4
60	2.7	0.6	2.3	0.3
70	2.6	0.6	2.2	0.3
80	2.6	0.6	2.1	0.2
90	2.6	0.5	2.1	0.2
100	2.5	0.5	2	0.2
120	2.4	0.4	2	0.1
140	2.2	0.3	1.9	0.1
160	2.1	0.3	1.9	0.1
180	1.9	0.2	1.8	0.1
200	1.8	0.2	1.7	0.1
220	1.7	0.2	1.6	0.1
240	1.6	0.1	1.5	0.1

Note: cfs = cubic feet per second.

Table F-4. Flow-Habitat Relationships for the North Battle Feeder Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
3	1.6	0	0.6	0
10	3.8	0	2.1	0.2
15	4.7	0.1	3.1	0.3
20	5.1	0.1	3.5	0.4
25	5.6	0.2	4	0.5
30	5.8	0.3	4.3	0.6
35	6	0.4	4.5	0.6
40	6	0.4	4.6	0.7
45	6.1	0.5	4.7	0.7
50	6.1	0.5	4.7	0.7
60	5.9	0.7	4.6	0.7
70	5.6	0.8	4.4	0.7
80	5.3	0.9	4.1	0.6
90	5.1	1	4	0.6
100	4.8	1	3.8	0.5
120	4.3	1	3.4	0.4
140	3.9	0.9	3.2	0.3
160	3.6	0.8	2.9	0.2
180	3.4	0.6	2.9	0.2
200	3.2	0.5	2.6	0.1

Note: cfs = cubic feet per second.

Table F-5. Flow-Habitat Relationships for the Keswick Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
3	1.9	0.1		
10	4	0.1		
15	4.5	0.2		
20	4.6	0.2		
25	4.7	0.3		
30	4.7	0.3		
35	4.7	0.3		
40	4.5	0.4		
45	4.4	0.4		
50	4.4	0.4		
60	4.4	0.4		
70	4.3	0.4		
80	4.3	0.4		
90	4.2	0.3		
100	4.1	0.3		

Note: cfs = cubic feet per second.

Table F-6. Flow-Habitat Relationships for the Coleman Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
5	0.1	0	0.4	0.2
10	2	0	0.8	0.4
15	2.7	0.1	1.4	0.7
20	2.9	0.2	1.8	0.8
25	3.2	0.3	2.1	0.9
30	3.4	0.4	2.4	0.9
35	3.5	0.6	2.6	1
40	3.5	0.7	2.7	1
45	3.5	0.8	2.8	1
50	3.5	0.9	2.9	1
60	3.4	1	2.9	1
70	3.3	1.1	2.8	0.9
80	3.2	1.2	2.7	1
90	3.1	1.3	2.6	0.9
100	3	1.4	2.5	0.9
120	2.8	1.5	2.3	0.7
140	2.6	1.4	2.1	0.6
160	2.3	1.3	2	0.5
180	2.1	1.2	1.8	0.5
200	1.9	1.1	1.7	0.4
220	1.8	1	1.6	3.2
240	1.8	0.9	1.5	0.3
260	1.8	0.8	1.4	0.2

Note: cfs = cubic feet per second.

Table F-7. Flow-Habitat Relationships for the Inskip Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
5	2.3	0	0.5	0.2
10	4.1	0.1	1.6	0.6
15	5.6	0.2	3	1.2
20	6.2	0.3	3.7	1.4
25	6.8	0.5	4.4	1.5
30	7.1	0.8	5	1.6
35	7.3	1.1	5.5	1.6
40	7.4	1.3	5.8	1.6
45	7.4	1.4	6	1.6
50	7.3	1.6	6.1	1.6
60	7	1.8	6.1	1.6
70	6.8	1.9	5.9	1.4
80	6.5	2.1	5.7	1.5
90	6.3	2.2	5.5	1.4
100	6.1	2.3	5.2	1.4
120	5.6	2.4	4.8	1.2
140	5.2	2.3	4.5	1.1
160	4.8	2.1	4.2	1
180	4.3	1.9	3.9	0.8
200	4	1.8	3.6	0.7
220	3.7	1.6	3.3	0.6
240	3.7	1.5	3.1	0.5
260	3.6	1.3	2.9	0.4

Note: cfs = cubic feet per second.

Table F-8. Flow-Habitat Relationships for the South Reach of Battle Creek

Flow (cfs)	Steelhead Rearing (acres)	Steelhead Spawning (acres)	Chinook Rearing (acres)	Spring Spawning (acres)
5	4.3	0.1	2.2	0.4
10	5.3	0.2	3	0.6
15	6.4	0.4	3.6	0.6
20	6.7	0.5	4	0.6
25	6.9	0.6	4.3	0.7
30	7	0.6	4.6	0.7
35	6.9	0.7	4.7	0.7
40	6.8	0.7	4.7	0.7
45	6.7	0.7	4.8	0.7
50	6.7	0.8	4.8	0.7
60	6.4	0.8	4.6	0.8
70	6.2	0.9	4.5	0.8
80	5.9	0.9	4.4	0.7
100	5.5	1	4.1	0.5
120	5.2	1	3.9	0.4
140	5	0.9	3.7	0.4
160	4.8	0.8	3.7	0.3
180	4.7	0.7	3.7	0.3
200	4.6	0.6	3.6	0.3

Note: cfs = cubic feet per second.

Table F-9. Calculated Rearing and Spawning Area (acres) for Peak Months of Steelhead and Chinook Salmon Lifestage Occurrence Under Minimum Flows

	Steelhead Rearing Area [i]	Steelhead Spawning Area [ii]	Spring-run Chinook Rearing Area [iii]	Spring-run Chinook Spawning Area [iv]	Winter-run Chinook Rearing Area [v]	Winter-run Chinook Spawning Area [vi]	Late Fall–run Chinook Rearing Area [vii]	Late Fall–run Chinook Spawning Area [viii]
No Action								
Keswick	1.92	0.06	–	–	–	–	–	–
NBC Feeder	1.62	0.01	0.62	0.04	0.62	0.04	0.62	0.04
Eagle Canyon	1.02	0.01	0.41	0.07	0.41	0.07	0.41	0.07
Wildcat	0.9	–	0.36	0.05	0.36	0.05	0.36	0.05
South	4.26	0.12	2.17	0.39	2.17	0.39	2.17	0.39
Inskip	2.3	–	0.53	0.2	0.53	0.2	0.53	0.2
Coleman	0.11	–	0.37	0.17	0.37	0.17	0.37	0.17
Main	13.18	0.27	4.39	0.55	4.39	0.55	4.39	0.55
Total	**25.31**	**0.47**	**8.85**	**1.47**	**8.85**	**1.47**	**8.85**	**1.47**
Five Dam Removal								
Keswick	1.92	0.06	–	–	–	–	–	–
NBC Feeder	6.06	0.89	4.14	0.69	4.68	0.69	4.68	0.63
Eagle Canyon	2.93	0.57	2.42	0.44	2.42	0.44	2.42	0.39
Wildcat	2.62	0.34	2.23	0.28	2.23	0.28	2.23	0.25
South	6.82	0.95	4.38	0.71	4.75	0.71	4.75	0.67
Inskip	7.37	2.08	5.72	1.62	5.85	1.62	5.85	1.47
Coleman	3.53	1.22	2.74	0.98	2.73	0.98	2.73	0.96
Main	12.3	1.36	16.15	1.96	17.14	1.96	17.14	1.67
Total	**43.55**	**7.47**	**37.78**	**6.68**	**39.8**	**6.68**	**39.8**	**6.04**

Table F-9. Continued

	Steelhead Rearing Area [i]	Steelhead Spawning Area [ii]	Spring-run Chinook Rearing Area [iii]	Spring-run Chinook Spawning Area [iv]	Winter-run Chinook Rearing Area [v]	Winter-run Chinook Spawning Area [vi]	Late Fall–run Chinook Rearing Area [vii]	Late Fall–run Chinook Spawning Area [viii]
No Dam Removal								
Keswick	1.92	0.06	–	–	–	–	–	–
NBC Feeder	5.81	0.42	4.63	0.66	4.63	0.59	4.28	0.66
Eagle Canyon	2.96	0.6	2.39	0.46	2.35	0.46	2.35	0.35
Wildcat	2.65	0.36	2.2	0.29	2.17	0.29	2.17	0.23
South	6.74	0.63	4.56	0.62	3.99	0.62	3.99	0.68
Inskip	7.12	1.27	5.85	1.58	5.05	1.58	5.05	1.62
Coleman	3.37	0.88	2.88	1.02	2.88	0.92	2.36	1.02
Main	13.84	1.44	16.81	1.96	17.14	2.25	17.03	1.8
Total	**44.41**	**5.66**	**39.32**	**6.59**	**38.21**	**6.71**	**37.23**	**6.36**
Six Dam Removal								
Keswick	1.92	0.06	–	–	–	–	–	–
NBC Feeder	6.06	0.89	4.14	0.69	4.68	0.69	4.68	0.63
Eagle Canyon	2.93	0.57	2.42	0.44	2.42	0.44	2.42	0.39
Wildcat	2.62	0.34	2.23	0.28	2.23	0.28	2.23	0.25
South	6.82	0.95	4.38	0.71	4.75	0.71	4.75	0.67
Inskip	7.37	2.08	5.72	1.62	5.85	1.62	5.85	1.47
Coleman	3.53	1.22	2.74	0.98	2.73	0.98	2.73	0.96
Main	12.3	1.36	16.15	1.96	17.14	1.96	17.14	1.67
Total	**43.55**	**7.47**	**37.78**	**6.68**	**39.8**	**6.68**	**39.8**	**6.04**

	Steelhead Rearing Area [i]	Steelhead Spawning Area [ii]	Spring-run Chinook Rearing Area [iii]	Spring-run Chinook Spawning Area [iv]	Winter-run Chinook Rearing Area [v]	Winter-run Chinook Spawning Area [vi]	Late Fall–run Chinook Rearing Area [vii]	Late Fall–run Chinook Spawning Area [viii]
Three Dam Removal								
Keswick	1.92	0.06	–	–	–	–	–	–
NBC Feeder	5.81	0.42	4.63	0.66	4.63	0.59	4.28	0.66
Eagle Canyon	2.96	0.6	2.39	0.46	2.35	0.46	2.35	0.35
Wildcat	2.65	0.36	2.2	0.29	2.17	0.29	2.17	0.23
South	6.74	0.63	4.56	0.62	3.99	0.62	3.99	0.68
Inskip	7.12	1.27	5.85	1.58	5.05	1.58	5.05	1.62
Coleman	3.37	0.88	2.88	1.02	2.88	0.92	2.36	1.02
Main	13.84	1.44	16.81	1.96	17.14	2.25	17.03	1.8
Total	**44.41**	**5.66**	**39.32**	**6.59**	**38.21**	**6.71**	**37.23**	**6.36**

Note: If the removal of a dam under an alternative precludes the need for a minimum flow requirement, the minimum flow requirement for the adjacent upstream or downstream dam is applied.

[i] Values are for the month of July.

[ii] Values are for the month of February.

[iii] Values are for the month of February.

[iv] Values are for the month of September.

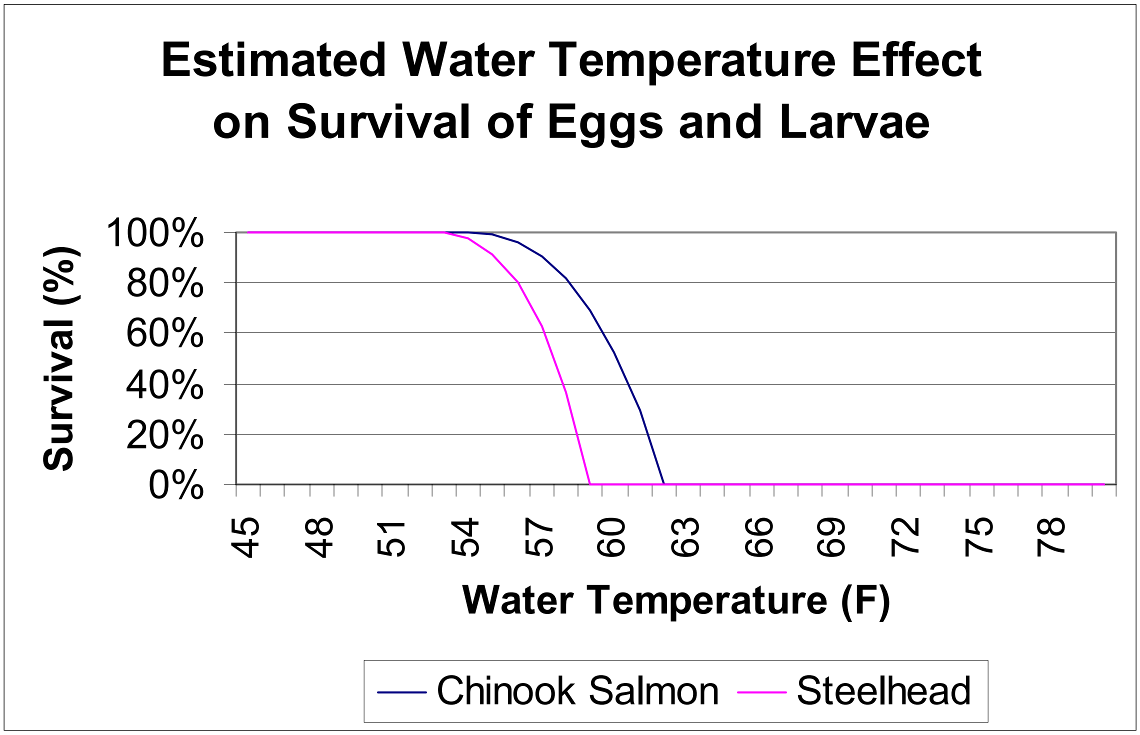
[v] Values are for the month of October.

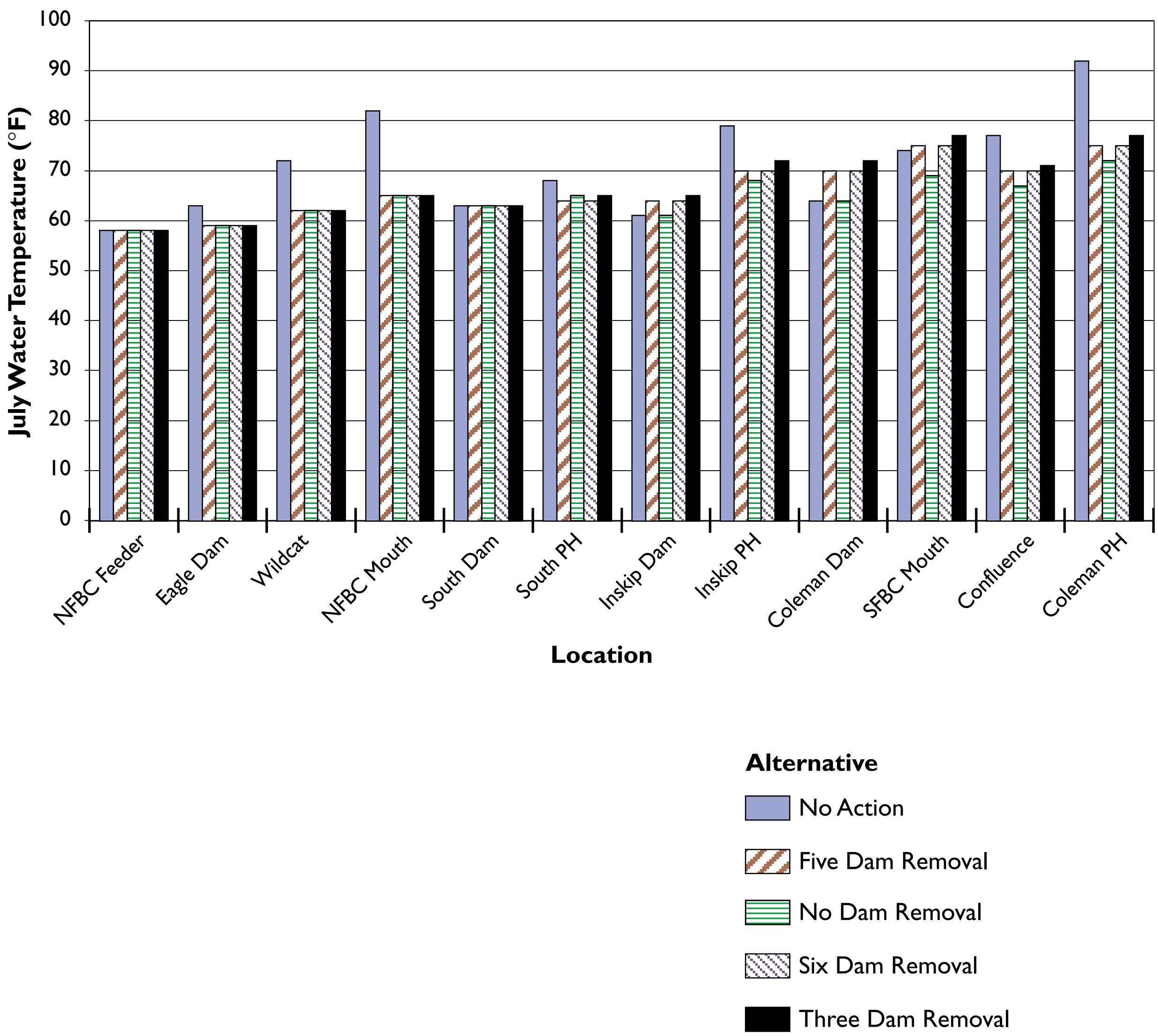
[vi] Values are for the month of June.

[vii] Values are for the month of July.

[viii] Values are for the month of March.

Figure F-1. Estimated Water Temperature Effect on Survival of Eggs and Larvae of Chinook Salmon and Steelhead

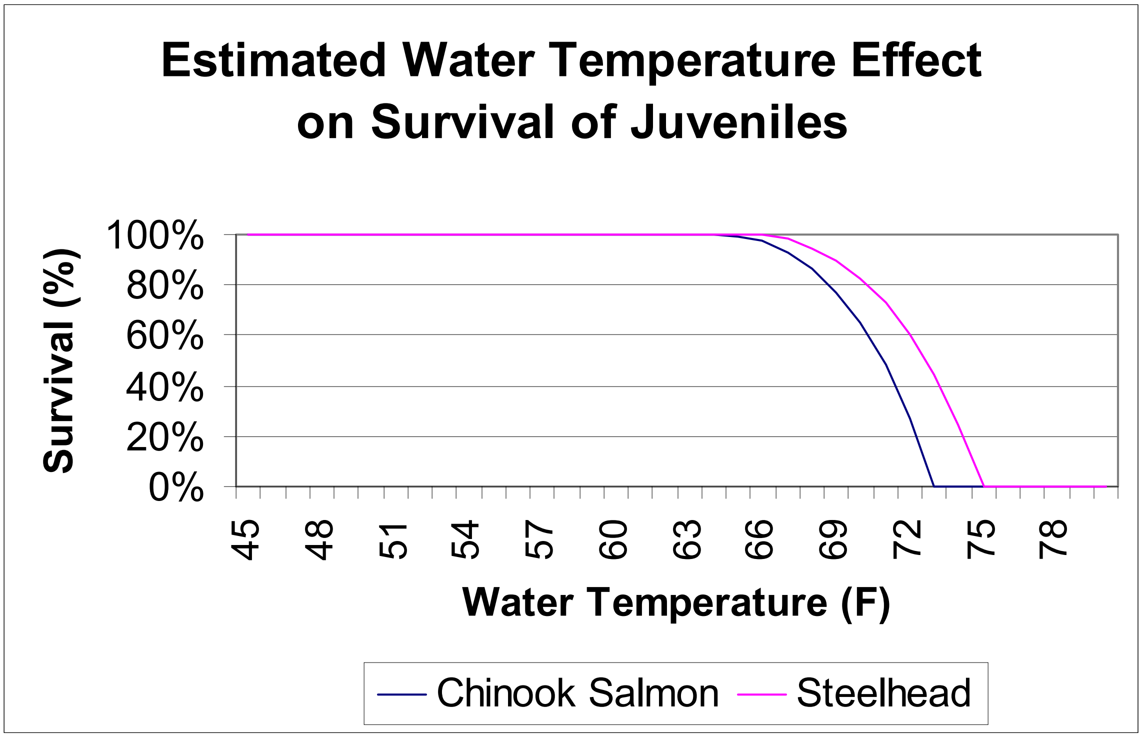




03035.03-004

Figure F-2
Simulated Water Temperatures for the Month of July at all Locations for Each Alternative

Figure F-3. Estimated Water Temperature Effect on Survival of Juvenile Chinook Salmon and Steelhead



Appendix G

Methodologies

Appendix G
Methodologies

Introduction

This appendix provides the reader with descriptions of the methodologies used to prepare the impact analyses presented in this environmental impact statement/environmental impact report (EIS/EIR) for Volume 1, Chapter 4, Sections 4.2 through 4.20.

Botanical, Wetlands, and Wildlife Resources

Biological resource surveys were performed in the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project) area in 2000 and 2001. Detailed biological survey results are discussed in Volumes I and II of the *Biological Survey Summary Report for the Battle Creek Salmon and Steelhead Restoration Project* (Summary Report) (Jones & Stokes 2001a, 2001b). The following sections describe the evaluation methodology used for different biological resources.

Botanical and Wetland Study Methods

The areas studied for botanical and wetland resources varied at each Restoration Project site and include a combination of diversion dams, flumes, pipelines, open canals, access roads, and potential staging areas. The study area for each Restoration Project site was based on proposed construction methods, use of existing or new access roads, terrain constraints, private property boundaries, fence lines, and dense vegetation that would not be removed during construction. The study areas for the Restoration Project sites are shown on the maps in Volume II of the Summary Report (Jones & Stokes 2001b). Along existing access roads, the study area consisted of a 20-foot corridor on each side of the road edge (approximately 60 feet total).

Information reviewed to determine the location and types of vegetation that could exist in the Restoration Project area included:

- the California Department of Fish and Game's (DFG) California Natural Diversity Database (CNDDB) (CNDDB 2000);
- the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants of California, sixth edition (CNPS 2000); and
- previously prepared environmental documents (Jones & Stokes Associates file information 1998; Oswald and Ahart 1994).

When appropriate, state and federal resource specialists were asked to provide information on special-status plants, noxious weeds, and local ordinances (e.g., oak tree ordinances or policies).

Botanists conducted a reconnaissance-level field visit on March 24 and 25, 2000, to evaluate existing conditions and to determine the extent of detailed botanical and wetland surveys. Protocol-level botanical surveys and wetland delineations were conducted at various times between April and August 2000 (Table G-1). The purposes of the field surveys were to:

- characterize plant communities and unique plant assemblages,
- identify special-status plant occurrences or suitable habitat for special-status plants,
- delineate waters of the United States (including wetlands) using the *Corps of Engineers Wetlands Delineation Manual* (Corps 1987),
- map noxious weed infestations (see the definition below for species considered as noxious weeds in this analysis), and
- coordinate with state and federal resource agencies to develop measures that avoid or minimize impacts on vegetation and wetland resources.

Special-Status Plant Surveys

Special-status plants are species that are legally protected under the state and federal endangered species acts or other regulations and species that are considered sufficiently rare by the scientific community to qualify for such listing. For the purpose of this document, special-status plants include species in the following categories:

- Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (ESA) (50 CFR 17.12 for listed plants and various notices in the *Federal Register* for proposed species).
- Candidates for possible future listing as threatened or endangered under the ESA (64 FR 57534, October 25, 1999).
- Federal species of concern (former C2 candidates).

- Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (CESA) (14 CCR 670.5).
- Plants listed as rare under the California Native Plant Protection Act of 1977 (Fish and Game Code §1900 *et seq.*).
- Plants considered by the CNPS to be "rare, threatened, or endangered in California" (Lists 1B and 2) (Skinner and Pavlik 1994); and
- Plants considered by the CNPS to be plants about which more information is needed or plants of limited distribution (Lists 3 and 4) (Skinner and Pavlik 1994).

Information on occurrences of special-status plants in the Restoration Project area was obtained initially from the CNDDB (CNDDB 2000), the U.S. Fish and Wildlife Service (USFWS), and reconnaissance-level surveys. Additional information on species' habitat requirements, blooming periods, and field identifying characteristics was obtained from state lists of flora (Munz and Keck 1968; Hickman 1993) and the CNPS fifth-edition (Skinner and Pavlik 1994) and sixth-edition inventories. This information was used to develop a list of special-status plants that have the potential to occur in the Battle Creek region (Table G-2). This table was used to identify habitats that have the highest potential to support special-status plants and to develop survey dates.

The floristic survey methods used to locate special-status plants in the Restoration Project area are based on guidelines recommended by the DFG and involve identifying all species to the level necessary to determine whether they qualify as a special-status plant or are plant species with unusual or significant range extensions (Nelson 1987). To account for different special-status plant identification periods biologists conducted several series' of field surveys between April and August 2000 (refer to Table G-1 for survey dates).

Depending on the terrain, various survey patterns were used, including meandering and intuitive controlled transects (i.e., transects that rely on the location and quality of habitat in the study area and focus efforts on those areas) in areas that contained suitable habitat for special-status plants. Survey intensity varied depending on species richness, habitat type and quality, and the probability of special-status species occurring in a particular habitat type.

Plant Community Characterization and Mapping

Plant communities at each Restoration Project site were mapped in the field on aerial photographs (one inch equals approximately 250 feet). Descriptions and names of plant communities were based on field surveys and on descriptions from the list of California terrestrial natural communities recognized by the CNDDB (CNDDB 2000), Holland (1986), and Sawyer and Keeler-Wolf (1995). Although the classification system of Sawyer and Keeler-Wolf represents the most recent treatment and includes greater community detail than the CNDDB list, it is incomplete for many geographical areas in California. Additionally, some of the plant communities described in this report do not fit well into the communities that were defined by either Holland or Sawyer and Keeler-Wolf. Therefore, some community-type names have been modified based on field observations.

Noxious Weed Surveys

Noxious weeds were documented as part of the special-status plant surveys. For the purpose of this document, a *noxious weed* is defined as a plant that has the potential to displace native plants and natural habitats, affect the quality of forage on range lands, or affect cropland productivity (CNDDB 2000). High-priority noxious weeds include all California Department of Food and Agriculture “A”-rated species. Some “B”- and “C”-rated species were included in this analysis if the county agricultural commissioners identified them as target noxious weeds. Additional weeds were included if they were considered to have great potential for displacing native plants and damaging natural habitats and were not considered too widespread to be effectively controlled.

Noxious weed infestation and dispersal have been identified by federal, state, and county agencies as issues of concern and, therefore, are addressed in this document. Two federal acts and one executive order direct weed control: the Carlson-Foley Act of 1968 (42 USC 1241-1243), the Federal Noxious Weed Act of 1974 (7 USC 2814), and Executive Order 13112, Invasive Species (64 FR 6183, February 8, 1999). Local counties are also concerned about noxious weed infestation and dispersal on private and public lands. To identify noxious weed species of concern in the Restoration Project area, the following sources were consulted:

- a list of species designated as federal noxious weeds by the U.S. Department of Agriculture;
- Shasta and Tehama Counties’ agricultural commissioners;
- the California Department of Food and Agriculture’s “A,” “B,” and “C” lists of noxious weeds; and
- the California Exotic Pest Plant Council’s list of pest plants of ecological concern.

Wetland Delineation

The term *waters of the United States* is used by the Corps to include areas that would qualify for federal regulation under Section 404 of the Clean Water Act (33 USC 1251-1376). For the purpose of this document, waters of the United States are separated into wetlands and other waters of the United States.

Wetlands are defined as areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that, under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3[b]; 40 CFR 230.3). For a wetland to qualify as jurisdictional by the U.S. Army Corps of Engineers and, therefore, subject to regulation under Section 404 of the Clean Water Act (33 USC 1251-1376), the site must support a prevalence of (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology. Wetlands were identified in the field based on the U.S. Army Corps of Engineers' definition. Wetlands were delineated using the methods outlined in the *Corps of Engineers Wetlands Delineation Manual* (Corps 1987).

Other waters of the United States are sites that typically lack one or more of the three indicators identified above. For the purpose of this document, drainages include all streams, creeks, rivers, and other surface features with defined beds and banks. The jurisdictional boundary for other waters of the United States was determined during the wetland delineation using the estimated ordinary high-water mark (based on an estimated two-year flood event).

Waters of the United States (including wetlands) at each Restoration Project site were mapped in the field on aerial photographs (one inch equals approximately 250 feet). A detailed description of the methods used to delineate waters of the United States is provided in a separate wetland delineation report (Jones & Stokes 2001c).

Wildlife Resource Study Methods

For the purpose of this document, the areas studied for special-status wildlife varied at each Restoration Project site and included a combination of diversion dams, flumes, pipelines, open canals, access roads, and staging areas. The study area for each Restoration Project site was based on the presence of suitable habitat for special-status wildlife, proposed construction methods, use of existing or new access roads, terrain constraints, private property boundaries, fence lines, and dense vegetation that would not be removed during construction. The study areas for each Restoration Project site are shown on the maps presented in Volume II of the Summary Report (Jones & Stokes 2001b). Along existing access roads, the study area for valley elderberry longhorn beetle (VELB) habitat surveys consisted of a 100-foot-wide corridor along both sides of the road (approximately 220 feet total). Raptor nest surveys included a one-half-mile area around all Restoration Project features and access roads. Nighttime calling surveys for the California spotted owl were conducted around diversion dams in suitable foraging, nesting, or roosting habitat. These surveys would detect owls within one-quarter mile.

Existing information was reviewed to determine the location and types of wildlife resources that could exist in the Restoration Project area. The sources of this information included:

- DFG's CNDDB (CNDDB 2000);
- Jones & Stokes file information (1998);
- bird lists for Shasta County Wintu Audubon Society Checklist Committee 2001and Tehama County (Laymon and Deuel 2003);
- Volumes I, II, and III of *California's Wildlife* (Zeiner et al. 1988, 1990a, 1990b); and
- Dr. Hartwell Welsh (pers. comm.).

Wildlife biologists conducted a reconnaissance-level field visit of the entire study area on March 24 and 25, 2000. The goals of this field visit were to evaluate existing conditions and to determine the approximate locations and extent of required future wildlife surveys. Protocol-level wildlife surveys were conducted at various times between April and August in 2000 and 2001 (Table G-3). The overall objectives of the field surveys were to:

- identify and describe wildlife habitat uses associated with plant communities, and
- identify special-status wildlife occurrences and suitable habitats for special-status wildlife.

Special-Status Wildlife Surveys

Special-status wildlife are species that are legally protected under the CESA, the ESA, or other regulations and species that are considered sufficiently rare by the scientific community to qualify for such listing. For the purpose of this report, the term *special-status wildlife* refers to:

- Species that are listed or proposed for listing as threatened or endangered under the ESA (50 CFR 17.11 [listed animals] and various notices in the *Federal Register* [proposed species]).
- Species that are candidates for possible future listing as threatened or endangered under the ESA (61 FR 40:7596–7613, February 28, 1996).
- Species of concern to the USFWS.
- Species that meet the definitions of rare or endangered under the California Environmental Quality Act (CEQA) (State CEQA Guidelines, Section 15380).
- Species that are listed or proposed for listing by the State of California as threatened or endangered under the CESA (14 CCR 670.5).
- Species that are fully protected in California (Fish and Game Code §§3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians]).
- Nesting raptors protected in California (Fish and Game Code §3503.5).
- Birds considered Species of Special Concern by the DFG (Remsen 1978).

- Migratory birds protected under the Migratory Bird Treaty Act (16 USC 703-712).
- Information on occurrences of special-status wildlife in the Restoration Project area was obtained initially from the CNDDB (CNDDB 2000), USFWS (Appendix H), and the reconnaissance-level surveys. This information was used to develop a list of special-status wildlife that have the potential to occur in the Battle Creek region (Table G-4) and to identify suitable habitats and dates for the special-status wildlife surveys.

Wildlife surveys were used to locate special-status wildlife and to identify sensitive habitats in the Restoration Project area. To account for different seasonal occurrences of special-status wildlife, several series of field surveys were conducted between April and August in 2000 and 2001 (Table G-3). These field surveys included the following elements:

- Two biologists performed two series of field surveys to identify birds that breed either in the early spring or in the late spring or early summer. The surveys consisted of visual and aural detections at all Restoration Project sites and habitats. Suitable breeding habitat was surveyed for evidence of breeding at the appropriate time of year for each species (see Appendix J). All evidence of breeding, such as singing male birds, territorial behavior, and courtship behavior, was recorded. All plant communities were surveyed, and all wildlife species detected were noted.
- With the exception of bats, biologists identified all vertebrates encountered during field surveys to the level necessary to determine whether they qualified as special-status species, unique occurrences, or extensions of species' documented ranges.
- Biologists visually surveyed for bats at dusk at each of the canal tunnel openings, but the species were not identified.
- Using high-powered spotting scopes and binoculars, biologists visually surveyed for raptor nests on all suitable trees and cliff sites within ½ mile of Restoration Project sites and access roads.
- Using USFWS protocols, biologists assessed the Restoration Project area for red-legged frog habitat. Protocol-level surveys were not conducted because of the lack of suitable habitat as established in the reconnaissance-level surveys and site assessments.
- Biologists conducted tailed frog surveys at two Restoration Project sites with the highest potential for occurrence: Soap Creek Feeder and South Diversion Dam. Survey methods followed methods developed by Dr. Hartwell Welsh, Redwood Sciences Laboratory, Pacific Southwest Research Station, U.S. Forest Service (Welsh pers. comm.).
- Biologists conducted area-constrained surveys for other amphibian species following methods proposed by Welsh (1987).
- Elderberry bushes that provide habitat for the listed VELB were plotted on U.S. Geological Survey (USGS) 7.5-minute topographic maps and aerial

photographs of the Restoration Project area and recorded in field notes. The gathering of data for each occurrence followed USFWS protocols. The survey included a search for exit holes on living stems, counts of stems in three size classes, and a physical description of the location.

- In 2000, biologists surveyed for California spotted owls in potential habitats near North Battle Creek Feeder Diversion Dam. Both visual and daytime calling surveys were conducted. In 2001, biologists began a two-year survey at five additional sites, including Eagle Canyon Diversion Dam, Wildcat Diversion Dam, Coleman Diversion Dam/Inskip Powerhouse, Inskip Diversion Dam/South Powerhouse, and South Diversion Dam. California spotted owl survey methods followed the USFWS-endorsed *Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls* (USFWS 1992). According to USFWS representatives, the survey protocol for the California spotted owl will be similar to the survey protocol for the northern spotted owl. A survey protocol will be developed in consultation with USFWS to survey for winter roosting California spotted owls at sites with suitable habitat.
- VELB habitats and other special-status wildlife occurrences were mapped on topographic maps. The topographic maps are provided in Volume II of the Summary Report (Jones & Stokes 2001b).

Hydrology

Hydrologic analyses were required as the basis for the surface water hydrology, fisheries, water quality, and power generation and economics analyses in this EIS/EIR. Data and findings included in the three reports listed below were used as a basis for the impact evaluations in this EIS/EIR.

- The report, *Hydrology of North and South Fork Battle Creek, Battle Creek Salmon and Steelhead Restoration Project* (Reclamation 2001a). This report uses data from the stream gage downstream of the CNFH. Reclamation modeled flows in North Fork and South Fork Battle Creek using the historic flow data from this gage, and augmented that data with more recent information from the gage downstream of Wildcat Diversion Dam. The report, which provides a summary of hydrological conditions, was developed to determine flood flows, scouring, and other parameters fundamental to facility design. Because of its role in guiding dam removal design, this report provided the basis for the identification of several impacts in this analysis and is hereby incorporated by reference because the methods used in its development support the impact assessment in Volume I, Section 4.3.
- The draft report, Sediment Impact Analysis of the Removal of Coleman, South, and Wildcat Diversion Dams on South and North Fork Battle Creek, Battle Creek Salmon and Steelhead Restoration Project (Reclamation 2001b). Reclamation used the same streamflow data as the document discussed in the previous paragraph and quantified the possible impacts resulting from the sediment releases that would occur after the removal of Coleman, South, and

Wildcat Diversion Dams. A numerical model of water surface elevations and sediment transport was used by Reclamation to study the sediment impacts on Battle Creek resulting from the dam removals. The channel geometry described in Reclamation (2001b) provided the necessary input to the model. The output from the model included streambed elevations, sediment size gradations, and water surface elevations as a function of time after dam removal. The model's water routing component solves the steady one-dimensional flow equations. Its sediment routing component solves the sediment routing equation, ignoring changes in suspended concentration or including them, depending upon user input. It also tracks changes in bed elevation and bed sorting in a manner similar to GSTARS2.0. Dam removal sites were modeled independently. The report is hereby incorporated by reference because the methods used in its development support the impact assessment in Volume I, Section 4.4

- *Stream Temperature Model for the Battle Creek Salmon and Steelhead Restoration Project*, a report prepared by PG&E's Land and Water Quality Unit for the PG&E Technical and Ecological Services Department (PG&E 2001). The report uses 20 years of flow data (water years 1980 through 1999) from the U.S. Geological Survey station at the CNFH. It is hereby incorporated by reference because the methods used in its development support the impact assessment in Volume I, Section 4.4

Each of these reports uses slightly different methods to characterize water years as representative of dry, normal, or wet conditions. These differences were reconciled in direct consultation with Reclamation and PG&E. These discussions supported the development of a generalized water year classification system capable of supporting the analyses found in Section 4.1, "Fish," and Section 4.16, "Other Nepa Analyses." The following discussion provides an overview of the development of this classification scheme.

General Hydrology Methodology

Five water year classes (wettest, representative wet, normal, representative dry, and driest) were developed to support the fisheries and power generation and economics analyses in this EIS/EIR. Daily streamflows in cfs for the period from October 1, 1961, through September 30, 1996, were used to classify the water years (Figure G-1). The data originated from the stream gage located downstream of the CNFH.

The average flow in cfs was calculated for each of the 35 water years. Then, the water years were ranked from the largest to the smallest flow and a threshold exceedence probability was calculated for each year. Table G-5 provides the ranking of the water years in quartiles. Quartiles are ranges in which the water years are divided into four groups, each group containing 25% of the data. Because there is an odd number of years of data, the wettest quartile has only eight water years instead of nine.

Next, a variety of methods can be used to calculate threshold exceedence probabilities. The Weibull relationship was chosen for the purpose of this classification scheme because it has been shown to provide estimates that are more consistent with experience (Hann 1977). The Weibull relationship is calculated from the equation m/(n+1), where m is the rank of the water year and n is the total number of years.

From these data, the initial identification of the five water year classes was based on their ranking position, using the threshold exceedence probabilities or extreme positions as shown in Table G-5. Next, the year closest to the exceedence probability of interest was compared to the other members of its respective quartile to ensure that its hydrograph had a shape typical of the other members in the quartile. The actual threshold exceedence probabilities for the representative wet, average, and representative dry years are 1982, 13.89%; 1989, 52.78%; and 1994, 86.11%. Water year 1983 was the overall wettest year and water year 1977 was the overall driest year for the 35-year period. Figures G-2 through G-5 illustrate the key relationships in this classification methodology.

Power Generation Analysis

The Battle Creek Hydrology and Hydroelectric Power Model (Appendix K) was used as a basis for the power generation and economics analysis because it provides the most accurate, consistent, and expeditious hydrologic data for use in power generation impact analyses. This model provides streamflow estimates at each current diversion point within the defined Restoration Project area, including unimpaired instream flows, inflows between diversion points, diversions to the Hydroelectric Project conveyance facilities, and instream flows after diversions. Hydrologic data from the model is presented as an average daily flow (in cfs) by month for a defined water year (October 1 through September 30). A more thorough discussion of the assumptions underlying the model and the consideration of other methods of estimating the hydrology of the Battle Creek watershed can be found in the report *Development and Assumptions of the Battle Creek Hydrology and Hydroelectric Model* (Appendix K).

Power generation estimates under the various operating conditions specified within each alternative are directly related to the hydrology of the watershed and hydroelectric system constraints (as defined by instream flow requirements and facility capacities). To most closely simulate a reasonable range of expected generation impacts, the power generation analysis modeled hydrology and generation for each alternative using a set of representative water years that correlate to wet, dry, and normal hydrologic conditions. Determination of these representative wet, representative dry, and normal water years is consistent with the classification scheme developed above. The representative water years were used for modeling power generation.

Median flow values for the representative water years were used in the power generation analysis. The median of a data set is the middle number when the number is ranked in either ascending or descending order and is one of several measures of central tendency (median, average, and mode). For nearly all of the 35 water years, the median value is slightly less than the calculated average value.

Actual representative water years are used rather than the synthetic water years used in the fisheries analysis, which is discussed below. In addition to being standard practice for power generation impact analyses, this approach is used because it more closely approximates a likely range of expected generation within a single year. The approach is also consistent with preliminary analyses developed within the Battle Creek watershed that were performed as a part of negotiations between the Resource Agencies[1] and PG&E, the Hydroelectric Project owner.

Despite this difference, power generation analyses using synthetic water years are not expected to differ greatly from generation estimates developed using actual representative water years. This is primarily true because the method by which the actual representative years were chosen considered the shape of the annual hydrograph in order to limit strong spikes or dips in observed streamflows. In addition, most observed spikes in instream flows within an actual water year would not greatly alter generation because the limiting factor is likely to be facility capacity rather than available instream water.

Fish Analysis

Because fish habitat requirements change continuously throughout the calendar year, depending on what life-history stage is present in the stream in any given month, it is important to consider seasonal variations in streamflow when modeling hydrology for an evaluation of fish habitat. Therefore, the approach of identifying "representative" water years based on a single annual flow statistic (e.g., annual average flow) does not generate the best starting hydrograph for fish habitat modeling. For instance, a representative dry water year might be typified by some relatively low annual average flow. However, flows during June, for example, may have been quite high if the weather had been stormy in the spring. In this specific case, the seasonal variation would invalidate the dry water year modeling of habitat for winter-run chinook salmon that spawn in spring.

A better method, often used to generate hydrographs for season-specific modeling of fish habitat (e.g., Zedonis 1997, PG&E 2001), is to generate "hypothetical-year types" based, in the Battle Creek analysis, on exceedence probabilities of monthly average flows independently generated for each month over the 35-year period of record. For determining hydrographs for fish habitat modeling in Battle Creek, the monthly average flows were calculated, ranked, and assigned exceedence probabilities (representative wet, 13.9%; normal, 52.8%; and representative dry, 86.1% exceedence), using the same methods used

[1] References to *Resource Agencies* refer to the Bureau of Reclamation, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Game, as appropriate.

to determine exceedence probabilities for representative water years. Then the hypothetical year was generated by combining the January monthly average flow matching that year-type's exceedence probability with the corresponding flow for February, March, and the other months. In this way, "representative wet-year," "normal-year," and "representative dry-year" hydrographs were created. Thus, these water year types are not used to evaluate a year as a whole (i.e., one would not expect to observe consecutive months of these conditions over a long period of time). Instead, they are used to show the sensitivity of combinations of variables (e.g., flow, month, fish life history, or fish habitat requirements) on fish habitat (PG&E 2001; Zedonis 1997).

Power Generation and Economics

The analyses performed in this section required the development of annual estimates of generation and revenue from the Hydroelectric Project under various alternative configurations and operating conditions (described within each of the Restoration Project alternatives). These estimates were developed using the Battle Creek Hydrologic/Economic Model, which is described in greater detail in Appendix K, "Development and Assumptions of the Battle Creek Hydrology and Hydroelectric Model." Output from the modeled generation results is provided in Appendix L, "Results from Monthly Flow and Power Generation Model."

Water Quality

Water Temperature

An assessment of potential water temperatures for the various Battle Creek system alternatives was made using information presented in PG&E (2001). In 1988–1989, Thomas R. Payne and Associates (1996a, 1996b) developed a predictive water temperature model for the Battle Creek watershed, using the USGS Biological Resources Division's and Midcontinent Ecological Science Center's Stream Network Temperature Model (SNTEMP). In 1999–2000, PG&E updated, modified, further refined, and validated this model. PG&E (2001) summarizes the modeling conducted by Thomas R. Payne and Associates and documents the results of PG&E's additional modeling efforts.

The SNTEMP model, as modified by Thomas R. Payne and Associates and as applied to the Battle Creek system, was developed to predict daily average water temperatures for a network of natural channels and canals (PG&E 2001). The model used hydrology, meteorology, and stream geometry data from the Restoration Project area. It conceptualized the Battle Creek watershed as 10 separate segments, consisting of the following six natural channels and four canals:

- Al Smith Reach – North Fork Battle Creek from Al Smith Diversion Dam to North Fork Battle Creek Feeder Diversion Dam (6.5 miles).
- North Fork Battle Creek Feeder Reach – North Fork Battle Creek from North Fork Battle Creek Feeder Diversion Dam to the confluence of Digger Creek (4 miles).
- Eagle Canyon Reach – North Fork Battle Creek from Eagle Canyon Diversion Dam to Wildcat Diversion Dam (2.7 miles).
- South Reach – South Fork Battle Creek from South Diversion Dam to South Powerhouse (5.8 miles).
- Inskip Reach – South Fork Battle Creek from Inskip Diversion Dam to Inskip Powerhouse (5.2 miles).
- Lower Battle Creek Reach – Combination of North Fork from Wildcat Diversion Dam to confluence (2.5 miles), South Fork from Coleman Diversion Dam to confluence (2.5 miles), and mainstem from confluence to above Coleman Powerhouse (9.4 miles).
- AAA system – Al Smith system (Al Smith Canal, Lower Mill Creek Canal, Baldwin Creek, Lake Grace Canal, Lake Grace, and Millseat Creek Flume [13.5 miles]) and Keswick system (Keswick Canal and Lake Nora [5.8 miles]).
- XXX system – Cross Country Canal (4.2 miles), South Canal (5.7 miles), and Union Canal (1 mile).
- III system – Inskip Canal (5 miles) and Eagle Canyon Canal (2.6 miles).
- CCC system – Coleman Canal (10.5 miles) and Wildcat Canal (1.8 miles).

The model was used to predict daily average temperatures for June through September for each alternative. For the model simulations, three conditions were chosen that bracketed all possible variations—normal-normal, dry-warm, and wet-cold. The normal-normal condition represented normal hydrology and normal meteorology. The dry-warm and wet-cold conditions represented the extreme case in which dry (or wet) hydrology occurred concurrently with a warm (or cold) climate.

Surface Water Quality Data

A field survey of the Restoration Project area was conducted on August 17 and 18, 2000. The survey included on-site inspections and photo-documentation of existing conditions. In addition, a meeting with DFG representatives was held on November 9, 2000, in Redding, California, to review available information.

Historic and recent water quality data collected by the USGS, USEPA, DWR, and State Board and stored in the USEPA's Storage and Retrieval database were used to analyze the surface water quality impacts. A summary of these data can be found in Appendix N. Recent water quality and sediment data collected by Reclamation are also summarized in Appendix N.

Groundwater

Historic and recent groundwater quality data from the USEPA's Storage and Retrieval database were analyzed for groundwater quality impacts. In addition, USGS and DWR technical documents were also consulted.

Land Use

Methods used to determine potential land use impacts consisted of consulting readily available information, including applicable federal, state, and local planning documents. The Shasta and Tehama County General Plans (Shasta County 1998; Tehama County Community Development Group 1983) were also reviewed to assess the Restoration Project's conformance with county planning frameworks. Additional land use information was also obtained from the BLM, other agency representatives, and PG&E staff. The Restoration Project sites were also visited. The proposed Restoration Project activities, described in Chapter 3, "Project Alternatives," were analyzed for their potential impacts on existing land uses.

Socioeconomics

Regional Sales and Jobs

Tehama and Shasta Counties comprise the potentially affected area for regional socioeconomic impact assessments. They provide the baseline data from which analyses of short-term and long-term impacts on the region were conducted. It was determined to look at the two counties combined because Battle Creek runs through both counties, and in many cases, impacts will be shared, often indivisibly, between them. Quantified impacts are measured, therefore, on a regional basis. A direct measurement of a particular impact was applied to the regional data on a macro basis.

For the purposes of this EIS/EIR, the impacts on sales and jobs analyzed are those associated with each alternative's demolition, construction, and operation and maintenance of structures and access roads, and the abandonment of canals. The short-term demolition and construction costs and the annual operation and maintenance (O&M) costs were directly measured against regional sales data and jobs to determine if a significant impact was observed.

Typically, a multiplier such as RIMS 11 or the IMPLAN model is used in socioeconomic analyses. This approach imparts not only direct impacts, but also measures indirect and induced impacts for each analyzed action alternative. Because of the inherent size and scope of the various levels of effort associated with the construction, demolition, annual O&M, and canal reconfigurations, this analysis does not use a multiplier approach. This is because the socioeconomic impacts are intuitively small when measured directly against the regional data and the addition of indirect and induced factors would have little consequence to the outcome. Those impacts that cannot be quantified, nonetheless, have a narrative description of the qualified nature of those impacts and possible mitigation measures.

For each of the alternatives, the short-term and recurring costs and jobs created or lost were analyzed against regional data (Shasta and Tehama Counties). This was a direct measurement. The associated cost estimates and job implications for each alternative were applied against the regional baseline data, and a resulting estimated percentage of that direct measurement against existing conditions was determined.

Trout Farming

The descriptions of the conditions prevailing at potentially affected trout farming operations were based on field observations and interviews with trout farmers and fishery biologists with expertise on Battle Creek stocks.[2] Potential impacts from Restoration Project implementation are predicated on a risk analysis that accounts for the amount of risk that trout farmers currently accept, the level of anticipated increase in risk associated with long-term Restoration Project implementation, and appropriate mitigation. No determination to date has been made as to the marginal value of production of the Mount Lassen Trout Farms, Inc. (MLTF) and its income elasticity.

Typically, socioeconomic analyses address the impacts of a given project on the local economy and social structure of the affected environment. This could be a county or a target region where the impacts are expected to occur. This macro-perspective helps planners determine if the magnitude of a project is enough to cause a significant impact, whether beneficial or negative, on the financial and social infrastructure of a targeted environment, both in the short term and the long term.

Occasionally, socioeconomic analyses are adjusted to the micro level to examine the impacts of a project to a targeted enterprise. This is consistent with NEPA regulations (40 CFR Part 1500-1508) addressing the "context" of an action. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected

[2] Studies of disease transmission cited herein, especially surveys of disease in naturally produced fish, may be viewed as "snapshots." The incidence of disease in naturally produced fish may fluctuate over time.

interests, and the locality. Potential socioeconomic impacts may not qualify as significant when compared to society as a whole or at a national level or, more relevantly, when this loss is measured against county or regional revenues or against a sector's revenues.

The rationale used in this analysis of trout farming, however, is that the local enterprise may be impacted to the level of financial demise. This potential demise is significant to that enterprise and to the affected region and interests. Further, the demise of an enterprise may have indirect and induced impacts that could significantly affect dependent economies.

For the purpose of this EIS/EIR, potential socioeconomic impacts on the MLTF are examined at the enterprise and stakeholder level in the Restoration Project vicinity. The analysis is limited to the MLTF and potential implications to lessees associated with the MLTF.

In response to MLTF concerns, Reclamation consultants toured the MLTF's Battle Creek and Paynes Creek facilities on December 14, 2000, with MLTF owner, Phil Mackey, and interviewed Mr. Mackey and Mr. Dan Brown of the MLTF's technical staff. The tour included seven of the nine facilities in the area that could be affected by the Restoration Project and an eighth was viewed from a distance. Table O-3 in Appendix O is a synopsis of what was observed on the tour.

Reclamation consultants also reviewed MLTF's CALFED proposal for measures to reduce disease risks associated with Restoration Project implementation; interviewed state, federal, and industry fish pathologists; and reviewed published literature relevant to the critical issues discussed in this section.

Applicable Laws and Regulations

Title 14, Section 245 of the California Code of Regulations and the California Fish and Game Code govern the movement and disease certification of aquacultural products. Generally, Section 245 states that disease certification and stocking permits are not required if products are shipped between registered aquaculturalists or if the product is stocked in certain bodies of water (possibly including the fee-fishing lakes stocked by the MLTF). It is possible, therefore, that the MLTF could still sell its product even if it were infected with infectious hematopoietic necrosis (IHN). However, if IHN were detected at MLTF and DFG notified, the Aquaculture Disease Committee, a non-state regulatory board, would assess the case and submit recommendations to the DFG. Depending on the severity of the case, the recommended action could range from monitoring the stock to destroying the stock and disinfecting the facility. However, it is rare that stock destruction is ordered. This action has not been taken within the last 11 years (Cox pers. comm.). Further, if the stock were destroyed, the MLTF would be compensated in an amount equal to 75 percent of the market value of the destroyed fish. Even if IHN were to infect the MLTF, therefore, the reimbursement policy and allowances within relevant regulations would likely forestall any catastrophic financial loss by the MLTF.

Geology and Soils

A geologic field survey of the Restoration Project vicinity was conducted on August 17 and 18, 2000. The visits included on-site inspections and photo-documentation of existing conditions.

The Restoration Project area geology was also researched, using reference material that included Reclamation's technical reconnaissance reports, region specific geologic reports, conceptual design reports, a value engineering report, a sediment management report, and related web sites. The USGS and the California Department of Conservation, Division of Mines and Geology were also contacted to verify and substantiate the information.

Geologic impacts were evaluated by "overlaying" Restoration Project construction activities on geologic features within or adjacent to the Restoration Project vicinity and including such considerations as blasting noise and vibrations, road construction, toe-slope stability, and other impacts that could result from changes in slope and rock formation stability.

The *Soil Survey of Tehama County, California* (Soil Conservation Service 1967) and *Soil Survey of Shasta County Area, California* (Soil Conservation Service 1974) were used to identify potentially affected soil resources. Applicable soil survey maps, map unit descriptions, and supporting tabular information were summarized, based on the extent of physical environmental impact that would result from the construction and removal activities planned for the Restoration Project. Geology and soils impacts were assessed from current Restoration Project plans as overlain on soil survey map units.

Proposed Restoration Project features were then compared to the same locations on the soil survey maps prepared for *Soil Survey of Tehama County California* (Soil Conservation Service 1967) and *Soil Survey of Shasta County Area, California* (Soil Conservation Service 1974). Soil map units and the corresponding soils were then identified as potentially affected by the development of the particular Restoration Project elements identified under the scenario.

Aesthetics and Visual Resources

Methods used to determine potential visual impacts included completing a field reconnaissance to evaluate visibility of Restoration Project facilities from adjacent areas as well as reviewing and applying the U.S. Forest Service's National Forest Landscape Management System to assess impacts on visual resources. In addition, BLM staff completed a photosimulation of proposed facilities at one site, because of the visual sensitivity of the adjacent area.

Although scenic quality is high in the vicinity of all Restoration Project facilities, the visual sensitivity of each facility must be determined to assess impacts on visual resources. The visual sensitivity of each facility was evaluated by determining visibility of each facility from the following receptors (U.S. Department of Agriculture, Forest Service 1974):

- Primary and secondary roads and trails including scenic highways or roads leading directly to major areas of interest (national parks, national recreation areas, wilderness, dedicated wild areas, major recreation composites, historic sites and areas, and botanical sites).
- Fishing, swimming, and boating areas and other active/passive recreational areas located adjacent to water bodies such as creeks or lakes.
- Recreation areas such as vista points, campgrounds, picnic grounds, visitor centers, and trail camps.
- Resorts and winter sports areas.
- Geological and botanical areas.
- Historical sites.
- Areas of primary importance for observation of wildlife.
- Tracts of primarily summer homes.
- Highly sensitive communities such as one where a large portion of the population is not directly related to performing land management activities.

Transportation

Data collection and analysis focused on the best available information. Available reports and planning and agency documents were used to describe the existing transportation network and those roadways that could potentially be affected by the implementation of the Restoration Project. Information on county roadways was obtained from local transportation planning agencies. Information on private access routes was obtained from local agency representatives and field surveys. Information on access routes to the Restoration Project sites were derived from the project design and construction plans discussed in Chapter 3, "Project Alternatives."

The analysis of impacts on transportation in the Restoration Project vicinity focused on additional increased traffic associated with construction activities, including the use of heavy equipment, and included effects on local traffic circulation and potential impacts on existing roadways. Traffic related to construction and facility removals was evaluated for the impacts that both worker-commute traffic and material- and equipment-haul trucks could have on potentially affected roadways. To evaluate potentially significant impacts associated with the implementation of the Restoration Project, the estimated construction-related traffic, provided by facility, was compared to the existing levels of service for the roadways used during construction. Additionally, the types of construction activities that may occur along roadways in the Restoration Project vicinity and their potential effects were estimated.

Noise

The existence and severity of noise impacts are largely subjective, primarily because of variations in individual tolerances. A common way to determine the potential for noise impacts is to compare anticipated project-related noise levels to existing noise levels at or near sensitive receptors. Generally, as noise levels increase at sensitive receptor locations, the potential for noise impacts to occur at those locations also increases. Noise impacts were assessed by first estimating the noise levels that could be generated during construction, modification, and/or facility removal activities at the Restoration Project sites. The noise levels produced during construction were compared to acceptable noise levels for adjacent areas based on federal, state and local standards to determine the potential noise level increases at locations of the closest sensitive receptors. In addition to the effects on increased noise levels, the effects of increased noise levels on construction workers were also evaluated. Available information on noise emissions from construction equipment was also obtained and used in this analysis.

Air Quality

Air quality impacts were evaluated based on professional experience and criteria identified in Appendix G of the CEQA Guidelines and the California Air Resources Board's air quality standards and area designation maps.

Public Health and Safety

Potential impacts on public health and safety are identified by how the implementation of the Proposed Restoration Project or action alternatives could change or alter existing public health and safety in the Restoration Project vicinity. For the evaluation of public health and safety, typical hazards associated the construction of new facilities or the removal and/or modification of existing facilities proposed to occur at the Restoration Project sites were identified and evaluated. Data collection and analysis focused on the best available information.

Public Services and Utilities

Data collection and analysis focused on the best available information. Existing reports, planning and agency documents, public records of service levels, and facility locations were used to describe the public services and utilities that would be potentially affected by the implementation of the Proposed Action or action alternatives and to determine the impacts on potential end users and distribution systems. Information was also collected though interviews with local agency representatives and was gathered during field visits. Physical impacts, service level requirements, and utility demands were based on the information on project construction and design plans discussed or referenced in Chapter 3, "Project Alternatives."

Recreation

Data collection and analysis focused on the best available information. Information on recreational use in the area was obtained through a review of existing reports and documentation. Information was also obtained from PG&E, discussions with agency representatives, a review of project files at the DFG office in Redding, and phone interviews. All of the Restoration Project sites were visited.

Information on recreational use in the Restoration Project vicinity was primarily qualitative in nature. Specific information quantifying use for recreational activities such as fishing, rafting, kayaking, and others, as discussed later in this section, was not readily available. Because of limited public access to the Restoration Project vicinity and predominantly private lands, studies indicating recreational use in the area in terms of the number of recreational user-days were not available and were not conducted as part of this analysis. Therefore, the potential impacts on recreational resources associated with the Restoration Project were not calculated in terms of the specific increases or decreases in the number of recreational user-days. All impacts in this section are discussed in terms of the potential for the general decrease or increase in recreational activities.

Cultural Resources

The proposed area of potential effect was discussed with staff of the State Historic Preservation Officer in 1999. Reclamation determined that the area of potential effect consists of the specific locations of each diversion dam, affected canals, flumes, and tunnels, construction zones, adjacent staging areas, new or modified access routes, and a swath of land that parallels the existing Inskip Penstock. These areas were examined for the proposed project. Standard survey techniques included pedestrian transects for areal coverage and specific examination of the dams and canals. A widespread examination of the upland area in the vicinity of the Inskip Junction Box was conducted since the route for the bypass penstock was not known at the time of fieldwork. Portions of flumes and canals that might be affected were examined. The entrances and exits of a number of tunnels were examined but none was entered.

Prior to fieldwork, a records search was completed at the Northeast Center of the California Historical Resources Information System at Chico State University. Reclamation staff met with representatives of Manton Historical Society and a grant was let to collect oral history information about the hydroelectric system from retired workers and long-time residents. Maintenance records and drawings held by PG&E were examined. The Historic American Engineering Record: The Battle Creek Hydroelectric System (Reynolds and Scott 1980) provided a wealth of information. Library searches were conducted via the Internet and, finally, records at the California Department of Parks and Recreation facility in West Sacramento were consulted.

Environmental Justice

The Environmental Justice section was written using the best information available. To identify and evaluate potential environmental justice issues and the consequences of Restoration Project implementation, analysts obtained and cited the most recent relevant federal regulations and used professional judgment, based on socioeconomic, land use, and other impacts analyses in this EIS/EIR and their knowledge of environmental justice issues in the area potentially affected.

Other NEPA/CEQA Analyses

The other NEPA/CEQA analysis was conducted using the best available scientific and commercial information. The discussions of areas of potential controversy, growth-inducing impacts, and irreversible and/or irretrievable commitments of resources were based on an in-depth review of several related projects, growth trends in Shasta and Tehama Counties, and the effects that the Restoration Project could have on the existing resource base.

Table G-1. Botanical Survey and Wetland Delineation Dates

Restoration Project Area	Survey Dates	Survey Purpose
North Fork Battle Creek		
North Battle Creek Feeder Diversion Dam	April 13, 2000 August 4, 2000	Botanical surveys and wetland delineation
Eagle Canyon Diversion Dam	April 20, 2000 May 26, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
Wildcat Diversion Dam	April 25, 2000 August 4 and 11, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
South Fork Battle Creek		
Coleman Diversion Dam/Inskip Powerhouse	April 4 and 5, 2000 June 15, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Penstock Junction Box	April 4 and 5, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Lower Ripley Creek Feeder	April 12, 2000 August 8, 2000	Botanical surveys and wetland delineation
Inskip Diversion Dam/South Powerhouse	April 6, 2000 June 13 and 14, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Soap Creek Feeder	April 12, 2000 August 8, 2000	Botanical surveys and wetland delineation
South Diversion Dam	April 7 and 25, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Access Roads		
Eagle Canyon Access Road	April 20, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
Wildcat Dam Access Road	April 13 and 25, 2000 August 4 and 11, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
Lower Ripley Creek Feeder Access Road	April 12 and 24, 2000 August 8, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
South Powerhouse Road to Inskip Diversion Dam/South Powerhouse Access Road	April 6 and 21, 2000 August 8, 2000	Botanical surveys and wetland delineation

Restoration Project Area	Survey Dates	Survey Purpose
	March 20, 2001	Butte County fritillary surveys
East of Bar Ranch and South Powerhouse Access Road	April 20, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Bluff Springs to South Powerhouse Access Road	April 19, 2000 August 13 and 14, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Soap Creek Feeder Access Road	April 12, 2000 August 8, 2000	Botanical surveys and wetland delineation
South Diversion Dam Access Road	April 7, 14, and 25, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys

Table G-2. Special-Status Plants Documented or Identified as Potentially Occurring in the Restoration Project Area

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				
State- and Federally Listed Plants							
Boggs Lake hedge-hyssop *Gratiola heterosepala*	–	E	1B	Fresno, Lake, Lassen, Madera, Modoc, Placer, Sacramento, Shasta, San Joaquin, Solano, and Tehama Counties; also in Oregon	Shallow water, vernal pools, marshes, and lake margins (below 3,940 feet elevation)	None	April–June
Slender orcutt grass *Orcuttia tenuis*	T	E	1B	Lake, Lassen, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties	Vernal pools (660 to 5,760 feet elevation)	None	May–July
CNPS List 1B and 2 Plants							
Adobe-lily *Fritillaria puriflora*	SC	–	1B	Butte, Colusa, Glenn, Lake, Napa, Plumas, Solano, and Tehama Counties	Chaparral, cismontane woodland, and clayey foothill valley grasslands (below 1,640 feet elevation)	None	February–April
Ahart's paronychia[3] *Paronychia ahartii*	SC	–	1B	Butte, Shasta, and Tehama Counties	Well-drained rocky outcrops, often vernal pool edges, volcanic uplands (below 1,650 feet elevation)	None	April–June
Big-scale balsamroot *Balsamorhiza macrolepis* var. *macrolepis*	–	–	1B	Alameda, Butte, Mariposa, Napa, Placer, Santa Clara, and Tehama Counties	Cismontane woodland, valley and foothill grassland, and sometimes serpentine (below 4,600 feet elevation)	None	March–June
Brandegee's eriastrum *Eriastrum brandegeae*	SC	–	1B	Colusa, Glenn, Lake, Santa Clara, Tehama, and Trinity Counties	Chaparral, and cismontane woodland on volcanic soil (2,600 to 3,300 feet elevation)	None	May–August
Canyon Creek stonecrop *Sedum paradisum*	SC	–	1B	Shasta and Trinity Counties	Broad-leaved upland forest, chaparral, lower montane conifer forest, and subalpine conifer forest on granitic outcrops (980 to 4,600 feet elevation)	None	May–June
Dimorphic snapdragon *Antirrhinum subcordatum*	–	–	1B	Colusa, Glenn, Lake, and Tehama Counties	Chaparral, lower conifer forest, and sometimes on serpentine (980 to 2,600 feet elevation)	None	April–July

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				
Dwarf downingia *Downingia pusilla*	–	–	2	Merced, Mariposa, Napa, Placer, Sacramento, Solano, Sonora, Stanislaus, and Tehama Counties	Vernal pools and other seasonally wet places in valley and foothill annual grasslands (490 feet elevation)	None	March–May
Eel-grass pondweed *Potamogeton zosteriformis*	–	–	2	Contra Costa, Lake, Lassen, Modoc, and Shasta Counties; also in Washington and Oregon	Marshes and swamps (below 4,300 feet elevation)	None	June–July
Four-angled spikerush *Eleocharis quadrangularis*	–	–	2	Butte, Merced, and Tehama Counties	Marshes and swamps with seasonally or permanently saturated soils (below 1,600 feet elevation)	None	July–September
Legenere *Legenere limosa*	SC	–	1B	Lake, Napa, Placer, Sacramento, San Mateo, Solano, Sonoma, Stanislaus, and Tehama Counties	Vernal pools (below 490 feet elevation)	None	May–June
Marsh skullcap *Scutellaria galericulata*	–	–	2	Plumas, Placer, Nevada, El Dorado, and Shasta Counties	Wet meadows, marshes, and stream banks in montane conifer forest (3,275 to 6,895 feet elevation)	None	June–September
Obtuse starwort[3] *Stellaria obtusa*	–	–	2	Butte, Glenn, Humboldt, and Tuolumne Counties; also in Idaho, Oregon, and Washington	Mesic areas in upper montane conifer forest (5,250 to 6,500 feet elevation)	None	July
Red Bluff dwarf rush[3] *Juncus leiospermus* var. *leiospermus*	–	–	1B	Butte, Shasta, and Tehama Counties	Vernal pools and other seasonally wet sites in chaparral, oak woodland, and annual grassland (900 to 1,620 feet elevation)	None	March–May
Red-flowered lotus *Lotus rubriflorus*	SC	–	1B	Colusa, Stanislaus, and Tehama Counties	Cismontane woodland and foothill valley grassland (±660 feet elevation)	None	April–June

Common Name/ Scientific Name	Legal Status[1] Federal	State	CNPS	Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
Sanford's arrowhead *Sagittaria sanfordii*	SC	–	1B	Butte, Del Norte, Fresno, Kern, Merced, Marin, Orange, Sacramento, Shasta, San Joaquin, Tehama, and Ventura Counties	Slow-moving water often within saltwater and freshwater marshes (above 990 feet elevation)	None	May–August
Silky cryptantha[3] *Cryptantha crinita*	SC	–	1B	Shasta and Tehama Counties	Cismontane woodland, lower conifer forest, riparian forests, riparian woodland, and gravelly areas with valley foothill grasslands (490 to 990 feet elevation)	Known from several occurrences along the edge of Battle Creek; no populations documented during 2000 field surveys	April–May
Water bulrush *Scirpus subterminalis*	–	–	2	Butte, Plumas, Tehama, El Dorado, Del Norte, and Humboldt Counties; also in Oregon	Lake margins, ponds, and marshes (2,460 to 7,385 feet elevation)	None	July–August
Western compion *Silene occidentalis* ssp. *longistipitata*	–	–	1B	Butte, Plumas, Shasta, and Tehama Counties	Chaparral and lower montane conifer forest (3,280 to 6,565 feet elevation)	None	July–August
White-stemmed pondweed [3] *Potamogeton praelongus*	–	–	2	Lassen, Plumas, Shasta, and Sierra Counties; also in Washington and Oregon	Marshes and swamps with deep water (lakes) (5,900 to 9,800 feet elevation)	None	July–August
CNPS List 3 and 4 Plants							
Bidwell's knotweed[4] *Polygonum bidwelliae*	–	–	4	Butte, Shasta, and Tehama Counties	Thin volcanic soils of openings in chaparral, oak woodland, and valley and foothill grasslands (195 to 3,940 feet elevation)	One occurrence documented in the Restoration Project area	April–June
Butte County fritillary[3] *Fritillaria eastwoodiae*	–	–	3[5]	Butte, Shasta, Tehama, and Yuba Counties	Chaparral, cismontane woodland, and lower montane conifer forest (1,640 to 4,900 feet elevation)	None	March–May
Depauperate milk-vetch[4] *Astragalus pauperculus*	–	–	4	Butte, Placer, Shasta, Tehama, and Yuba Counties	Open, vernally moist, volcanic clay soils in oak woodland and annual grassland (490 to 1,970 feet elevation)	27 occurrences documented in the Restoration Project area	March–May

Common Name/ Scientific Name	Legal Status[1] Federal	State	CNPS	Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
Henderson's bent grass[3] *Agrostis hendersonii*	–	–	3	Butte, Calaveras, Merced, and Shasta Counties; also in Oregon	Valley and foothill grasslands and vernal pools (3,000 to 3,500 feet elevation)	None	April–May
Hot rock daisy *Erigeron inornatus* var. *calidipetris*	–	–	4	Butte, Modoc, Plumas, Shasta, and Tehama Counties	Sandy, volcanic soils in lower montane conifer forest (3,600 to 4,600 feet elevation)	None	June–September
Marsh claytonia *Claytonia palustris*	–	–	4	Butte, Fresno, Plumas, Siskiyou, Tehama, and Tulare Counties	Montane marshes, meadows, springs, and stream banks (3,280 to 8,205 feet elevation)	None	June–August
Pale yellow stonecrop *Sedum laxum* ssp. *flavidum*	–	–	4	Glenn, Humboldt, Shasta, Siskiyou, Tehama, and Trinity Counties	Serpentine or volcanic outcrops in broad-leaved upland forest, chaparral, cismontane woodland, and lower montane conifer forest (2,600 to 6,500 feet elevation)	None	May–July
Sanborn's onion *Allium sanbornii* var. *sanbornii*	–	–	4	Butte, Calaveras, El Dorado, Nevada, Placer, Tehama, and Yuba Counties; also in Oregon	Gravelly areas on serpentinite substrates in chaparral, oak woodland, and lower montane coniferous forest (980 to 4,495 feet elevation)	None	May–September
Shield-bracted monkeyflower[4] *Mimulus glaucescens*	–	–	4	Butte, Colusa, Lake, and Tehama Counties	Seeps and other wet places in foothill woodland and foothill annual grassland (below 1,970 feet elevation)	15 occurrences documented in the Restoration Project area	March–May
Woolly meadowfoam[4] *Limnanthes floccosa* ssp. *floccosa*	–	–	4	Butte, Lake, Shasta, Tehama, and Trinity Counties; also in Oregon	Vernal pools, moist meadows, and other seasonally wet habitats in oak woodland and valley and foothill annual grassland (33 to 1,320 feet elevation)	15 occurrences documented in the Restoration Project area	March–June

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				

[1] Status explanation:

Federal

T = Listed as threatened under the federal Endangered Species Act.

SC = Species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.

– = No listing.

State

E = Listed as endangered under the California Endangered Species Act.

– = No listing.

CNPS

1B = List 1B species: rare, threatened, or endangered in California and elsewhere.

2 = List 2 species: rare, threatened, or endangered in California but more common elsewhere.

3 = List 3 species: plants about which more information is needed to determine their status.

4 = List 4 species: plants of limited distribution.

[2] Refers to the expected flowering period for the species. This period is considered a guide for the best time to survey for the species.

[3] Species identified in the CNDDB search (California Department of Fish and Game 2000d).

[4] Species was located during spring and summer 2000 field surveys.

[5] *Fritillaria eastwoodiae* was recently listed as a CNPS List 3 species because of taxonomic problems; however, it could possibly be relisted as a CNPS List 1B species.

Table G-3. Wildlife Survey Dates

Restoration Project Site	Survey Dates	Survey Purpose
North Fork Battle Creek		
North Battle Creek Feeder Diversion Dam	April 20, 2000 June 16, 2000	Raptor nests; special-status birds; breeding birds; California spotted owl
	April 13, 2000 May 28, 2001 August 26, 2001	Raptor nests; California spotted owl
Eagle Canyon Diversion Dam	April 20, 2000 June 15 and 16, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; bats; VELB habitat
	May 29, 2001 June 25, 2001 August 25, 2001	Raptor nests; California spotted owl
Wildcat Diversion Dam	April 20, 2000 June 16, 2000	Raptor nests; special-status birds; breeding birds
	April 12, 2001 May 28, 2001 August 25, 2001	Raptor nests; California spotted owl
South Fork Battle Creek		
Coleman Diversion Dam/ Inskip Powerhouse	April 17, 2000 June 13, 2000 July 25, 2000	Raptor nests; special-status birds; breeding birds; bats; VELB habitat
	April 12, 2001 May 28, 2001 August 26, 2001	Raptor nests; California spotted owl
Penstock Junction Box	April 17, 2000 June 13, 2000	Raptor nests; special-status birds; breeding birds
Lower Ripley Creek Feeder	April 17, 2000 June 16, 2000 July 7 and 25, 2000	Raptor nests; special-status birds; breeding birds; willow flycatcher; VELB habitat
Inskip Diversion Dam/ South Powerhouse	April 17, 2000 June 13 and 14, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; bats; VELB habitat
	May 29, 2001 June 25, 2001 August 25, 2001	Raptor nests; California spotted owl
Soap Creek Feeder	April 17, 2000 June 14, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; tailed frogs and general amphibians
South Diversion Dam	April 17, 2000 June 12 and 14, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; bats; tailed frogs and general amphibians

Table G-4. Threatened, Endangered, Candidate, and Other Special-Status Wildlife Documented or Identified as Potentially Occurring in the Restoration Project Area

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
Insects					
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT, FS	–	Streamside habitats below 3,000 feet throughout the Central Valley	Riparian and oak savanna habitats with elderberry shrubs; elderberries (the host plant)	No records from CDFG's CNDDB
Amphibians					
California red-legged frog *Rana aurora draytoni*	FT	SSC	Along the coast and coastal mountain ranges of California from Marin County to San Diego County and in the Sierra Nevada from Tehama County to Fresno County	Permanent and semipermanent aquatic habitats, such as creeks and coldwater ponds, with emergent and submergent vegetation; may estivate in rodent burrows or cracks during dry periods	No records from CDFG's CNDDB
Cascades frog *Rana cascadae*	SC, FS	SSC	In the Shasta-Trinity region, east to the Modoc Plateau and south to the Lassen area and the upper Feather River system	Seasonal and permanent ponds and streams; oviposition habitat is open, shallow water in unshaded areas	No records from CDFG's CNDDB
Foothill yellow-legged frog *Rana boylii*	SC, FS	SSC	In the Klamath, Cascade, north Coast, south Coast, Transverse, and Sierra Nevada Ranges up to approximately 6,000 feet elevation	Creeks or rivers in woodlands or forests with rock and gravel substrate and low overhanging vegetation along the edge; usually found near riffles with rocks and sunny banks nearby	No records from CDFG's CNDDB
Southern torrent (seep) salamander *Rhyacotriton variegatus* (*olympicus*)	SC	SSC	Northwestern California forests in Del Norte, Humboldt, western Siskiyou, Trinity, and Mendocino Counties; disjunct population on Pit River watershed in Shasta County	Seeps, springs, and high-gradient reaches of small forested streams; usually found in or adjacent to cool, shallow water beneath rocks or organic debris	No records from CDFG's CNDDB
Tailed frog *Ascaphus truei*	SC	SSC, FP	Northwestern California from Del Norte County south to central Sonoma County and east as far as southwest Shasta County	Cool, perennial, swiftly flowing streams in redwood, Douglas fir, and yellow pine forests; altered microclimate conditions from timber harvesting in riparian areas	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1] Federal	State	Distribution	Habitat Association	Occurrence in the Restoration Project Area
Reptiles					
Northwestern pond turtle *Clemmys marmorata marmorata*	SC, FS	SSC	From the Oregon border of Del Norte and Siskiyou Counties, south along the coast to San Francisco Bay, inland through the Sacramento Valley, and on the western slope of the Sierra Nevada	Ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation in woodlands, grasslands, and open forests	No records from CDFG's CNDDB
Birds					
American peregrine falcon *Falco peregrinus anatum*	FS	SE, FP	Permanent resident along the north and south Coast Ranges; may summer in the Cascade and Klamath Ranges and through the Sierra Nevada to Madera County; winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large prey populations	No records from CDFG's CNDDB
Bald eagle *Haliaeetus leucocephalus*	FT	SE, FP	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin; reintroduced into central coast; winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierra Nevada, and east of the Sierra Nevada south of Mono County	In western North America, nests and roosts in coniferous forests within one mile of a lake, reservoir, stream, or the ocean	One record from CDFG's CNDDB
Black swift *Cypseloides niger*	–	SSC	Breeds locally in the Sierra Nevada and Cascade Ranges and the San Gabriel, San Bernardino, and San Jacinto Mountains; and in coastal bluffs from San Mateo County south to near San Luis Obispo County	Nests in moist crevices or caves on sea cliffs above the surf, or on cliffs behind or adjacent to waterfalls in deep canyons	No records from CDFG's CNDDB
California spotted owl *Strix occidentalis occidentalis*	SC, FS	SSC	Sierra Nevada from Lassen County south to northern Kern County, and in the Transverse, Peninsular, and southern coastal mountains	Mature forest with suitable nesting trees; in southern California, in oak and oak-conifer habitats and in mature conifer forest	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
California yellow warbler *Dendroica petechia brewsteri*	–	SSC	Nests in all of California except the Central Valley, the Mojave Desert region, and high altitudes in the Sierra Nevada; winters along the Colorado River and in parts of Imperial and Riverside Counties	Nests in riparian areas dominated by willows, cottonwoods, sycamores, or alders or in mature chaparral; may also use oaks, conifers, and urban areas near streamcourses	No records from CDFG's CNDDB
Cooper's hawk[2] *Accipiter cooperii*	–	SSC	Throughout California except high altitudes in the Sierra Nevada; winters in the Central Valley, southeastern desert regions, and plains east of the Cascade Range	Nests in a wide variety of habitat types, from riparian woodlands and digger pine-oak woodlands through mixed conifer forests	No records from CDFG's CNDDB
Golden eagle *Aquila chrysaetos*	–	SSC, FP	Foothills and mountains throughout California; uncommon nonbreeding visitor to lowlands such as the Central Valley	Nests on cliffs and escarpments or in tall trees overlooking open country; forages in annual grasslands, chaparral, and oak woodlands with plentiful medium- and large-sized mammals	No records from CDFG's CNDDB
Little willow flycatcher *Empidonax traillii brewsteri*	SC, FS	SE	Summers along the western Sierra Nevada from El Dorado to Madera County, in the Cascade and northern Sierra Nevada in Trinity, Shasta, Tehama, Butte, and Plumas Counties, and along the eastern Sierra Nevada from Lassen to Inyo County	Riparian areas and large wet meadows with abundant willows; usually found in riparian habitats during migration	No records from CDFG's CNDDB
Loggerhead shrike *Lanius ludovicianus*	SC	SSC	Resident and winter visitor in lowlands and foothills throughout California; rare on coastal slope north of Mendocino County, occurring only in winter	Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches	No records from CDFG's CNDDB
Long-eared owl *Asio otus*	–	SSC	Permanent resident east of the Cascade Range from Placer County north to the Oregon border, east of the Sierra Nevada from Alpine County to Inyo County; scattered breeding populations along the coast and in southeastern California; winters throughout the Central Valley and southeastern California	Nests in abandoned crow, hawk, or magpie nests, usually in dense riparian stands of willows, cottonwoods, live oaks, or conifers	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1] Federal	State	Distribution	Habitat Association	Occurrence in the Restoration Project Area
Northern goshawk *Accipiter gentilis*	SC, FS	SSC	Permanent resident in the Klamath and Cascade Ranges, in the north Coast Ranges from Del Norte County to Mendocino County, and in the Sierra Nevada south to Kern County; winters in Modoc, Lassen, Mono, and northern Inyo Counties	Nests and roosts in older stands of red fir, Jeffrey pine, ponderosa pine, lodgepole pine, Douglas fir, and mixed conifer forests	One record from CDFG's CNDDB
Osprey[2] *Pandion haliaetus*	–	SSC	Nests along the north coast from Marin County to Del Norte County, east through the Klamath and Cascade Ranges, and in the upper Sacramento Valley; important inland breeding populations at Shasta Lake, Eagle Lake, and Lake Almanor and small numbers elsewhere south through the Sierra Nevada; winters along the coast from San Mateo County to San Diego County	Nests in snags, trees, or utility poles near the ocean, large lakes, or rivers with abundant fish populations	One record from CDFG's CNDDB
Prairie falcon *Falco mexicanus*	–	SSC	Permanent resident in the south Coast, Transverse, Peninsular, and northern Cascade Ranges, the southeastern deserts, Inyo-White Mountains, foothills surrounding the Central Valley, and in the Sierra Nevada in Modoc, Lassen, and Plumas Counties; winters in the Central Valley, along the coast from Santa Barbara County to San Diego County, and in Marin, Sonoma, Humboldt, Del Norte, and Inyo Counties	Nests on cliffs or escarpments, usually overlooking dry, open terrain or uplands	No records from CDFG's CNDDB
Purple martin *Progne subis*	–	SSC	Coastal mountains south to San Luis Obispo County, west slope of the Sierra Nevada, and northern Sierra and Cascade ranges; absent from the Central Valley except in Sacramento; isolated, local populations in southern California	Nests in abandoned woodpecker holes in oaks, cottonwoods, and other deciduous trees in a variety of wooded and riparian habitats; also nests in vertical drainage holes under elevated freeways and highway bridges	No records from CDFG's CNDDB
Sharp-shinned hawk [2] *Accipiter striatus*	–	SSC	Permanent resident in the Sierra Nevada, Cascade, Klamath, and north Coast Ranges at mid-elevations and along the coast in Marin, San Francisco, San Mateo, Santa Cruz, and Monterey Counties; winters over the rest of the state except at very high elevations	Dense-canopy ponderosa pine or mixed conifer forest and riparian habitats	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1] Federal	State	Distribution	Habitat Association	Occurrence in the Restoration Project Area
Swainson's hawk *Buteo swainsoni*	–	ST	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley; highest nesting densities occur near Davis and Woodland in Yolo County	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields	No records from CDFG's CNDDB
Vaux's swift *Chaetura vauxi*	–	SSC	Coastal belt from Del Norte County south to Santa Cruz County and in mid-elevation forests of the Sierra Nevada and Cascade Range	Nests in hollow, burned-out tree trunks in large conifers	No records from CDFG's CNDDB
Western burrowing owl *Athene cunicularia hypugea*	SC	SSC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas; rare along south coast	Level, open, dry, heavily grazed or low-stature grassland or desert vegetation with available burrows	No records from CDFG's CNDDB
White-tailed kite *Elanus leucurus*	–	FP	Lowland areas west of the Sierra Nevada from the head of the Sacramento Valley south, including coastal valleys and foothills, to western San Diego County	Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands	No records from CDFG's CNDDB
Yellow-breasted chat *Icteria virens*	–	SSC	Nests locally in coastal mountains and Sierra Nevada foothills, east of the Cascades in northern California, along the Colorado River, and very locally inland in southern California	Nests in dense riparian habitats dominated by willows, alders, Oregon ash, tall weeds, blackberry vines, and grapevines	No records from CDFG's CNDDB
Mammals					
American badger *Taxidae taxus*	–	–	Statewide except for the northwestern corner in Del Norte County and parts of Humboldt and Siskiyou Counties	Typically found in open areas with scattered shrubs and trees; also found in open forests, particularly ponderosa pine	No records from CDFG's NDDB
Fringed myotis *Myotis thysanodes*	SC	–	Throughout California except the southeastern deserts and the Central Valley	Found in a wide variety of habitats from low desert scrub to high-elevation coniferous forests; day and night roosts in caves, mines, trees, buildings, and rock crevices	No records from CDFG's CNDDB
Long-eared myotis *Myotis evotis*	SC	–	Throughout California except the southeastern deserts and the Central Valley	Occurs primarily in high-elevation coniferous forests, but also found in mixed hardwood/conifer, high desert, and humid coastal conifer habitats	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1] Federal	State	Distribution	Habitat Association	Occurrence in the Restoration Project Area
Long-legged myotis *Myotis volans*	SC	–	Mountains throughout California, including ranges in the Mojave Desert	Most common in woodlands and forests above 4,000 feet, but occurs from sea level to 11,000 feet	No records from CDFG's CNDDB
Pacific fisher *Martes pennanti pacifica*	SC, FS	SSC	Coastal mountains from Del Norte County to Sonoma County, east through the Cascades to Lassen County, and south in the Sierra Nevada to Kern County	Late-successional coniferous forests and montane riparian habitats	No records from CDFG's CNDDB
Pallid bat *Antrozous pallidus*	–	SSC	Throughout California, primarily at lower elevations and mid-elevations	Occurs in a variety of habitats from desert to coniferous forest; most closely associated with oak, yellow pine, redwood, and giant sequoia habitats in northern California; relies heavily on trees for roosts	No records from CDFG's CNDDB
Ringtail *Basariscus astutas*	–	FP	Little information on distribution and abundance; apparently occurs throughout the state except for the southern Central Valley and the Modoc Plateau	Occurs primarily in riparian habitats, but also known to occur in most forest and shrub habitats from lower elevations to mid-elevations	No records from CDFG's CNDDB
Sierra Nevada Mountain beaver *Aplodontia rufa*	–	SSC	Throughout the Klamath, Cascade, and Sierra Nevada mountains and the north Coast Ranges in Del Norte and Humboldt Counties; Sierra Nevada populations scattered and local	Slopes of ridges or gullies where there is abundant moisture, thick undergrowth, and soft soil for burrowing	No records from CDFG's CNDDB
Small-footed myotis *Myotis ciliolabrum*	SC	–	South Coast, Transverse, and Peninsular Ranges; Sierra Nevada; and the Great Basin	Open stands in forests and woodlands, as well as shrublands and desert scrub; uses caves, crevices, trees, and abandoned buildings	No records from CDFG's CNDDB
Townsend's big-eared bat *Plecotus townsendii*	SC	SSC	Throughout California, from low desert to mid-elevation montane habitats	Roosts in caves, tunnels, mines, and dark attics of abandoned buildings; buildings must offer cavelike spaces to be suitable; highly sensitive to disturbance at roost sites	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1] Federal	State	Distribution	Habitat Association	Occurrence in the Restoration Project Area
Yuma myotis *Myotis yumanensis*	SC	–	Common and widespread throughout most of California except the Colorado and Mojave Deserts	Found in a wide variety of habitats from sea level to 11,000 feet, but uncommon above 8,000 feet; optimal habitat is open forests and woodlands near water bodies	No records from CDFG's CNDDB

[1] Status Explanations:

Federal:			State:		
FE	=	Federally listed as endangered.	FP	=	State fully protected.
FS	=	U.S. Forest Service sensitive species.	SE	=	State listed as endangered.
FT	=	Federally listed as threatened.	SSC	=	Species of special concern.
SC	=	Species of concern.	ST	=	State-listed as threatened.
–	=	No listing.	–	=	No listing.

[2] This species is not considered to be a state species of special concern in the Draft List of California Bird Species of Special Concern (California Department of Fish and Game and Point Reyes 2001). This list is currently under review by the CDFG and the Point Reyes Bird Observatory Advisory Committee.

Table G-5. Quartile Analysis for Selected Representative Water Years

	Rank	Year	Exceedence	Average Flow (cfs)
Wettest Quartile	1	1983 [1]	2.78%	869.2
	2	1974	5.56%	838.2
	3	1995	8.33%	827.7
	4	1970	11.11%	719.9
	5	1982 [2]	13.89%	713.7
	6	1969	16.67%	708.9
	7	1984	19.44%	664.8
	8	1986	22.22%	642.8
Middle Quartiles	9	1971	25.00%	609.9
	10	1965	27.78%	600.0
	11	1996	30.56%	581.4
	12	1975	33.33%	573.2
	13	1978	36.11%	570.2
	14	1980	38.89%	562.3
	15	1973	41.67%	561.2
	16	1993	44.44%	558.3
	17	1967	47.22%	556.5
	18	1963	50.00%	525.5
	19	1989 [3]	52.78%	449.5
	20	1968	55.56%	421.5
	21	1972	58.33%	404.5
	22	1985	61.11%	397.2
	23	1979	63.89%	379.9
	24	1962	66.67%	377.9
	25	1987	69.44%	377.6
	26	1981	72.22%	362.2

	Rank	Year	Exceedence	Average Flow (cfs)
Driest Quartile	27	1976	75.00%	357.5
	28	1966	77.78%	349.4
	29	1988	80.56%	330.0
	30	1964	83.33%	319.0
	31	1994 [4]	86.11%	312.5
	32	1990	88.89%	307.6
	33	1991	91.67%	281.7
	34	1992	94.44%	256.3
	35	1977 [5]	97.22%	238.3

[1] Wettest water year

[2] Representative wet water year

[3] Normal or average water year

[4] Representative dry water year

[5] Driest water year

Source: U.S. Bureau of Reclamation 2001a

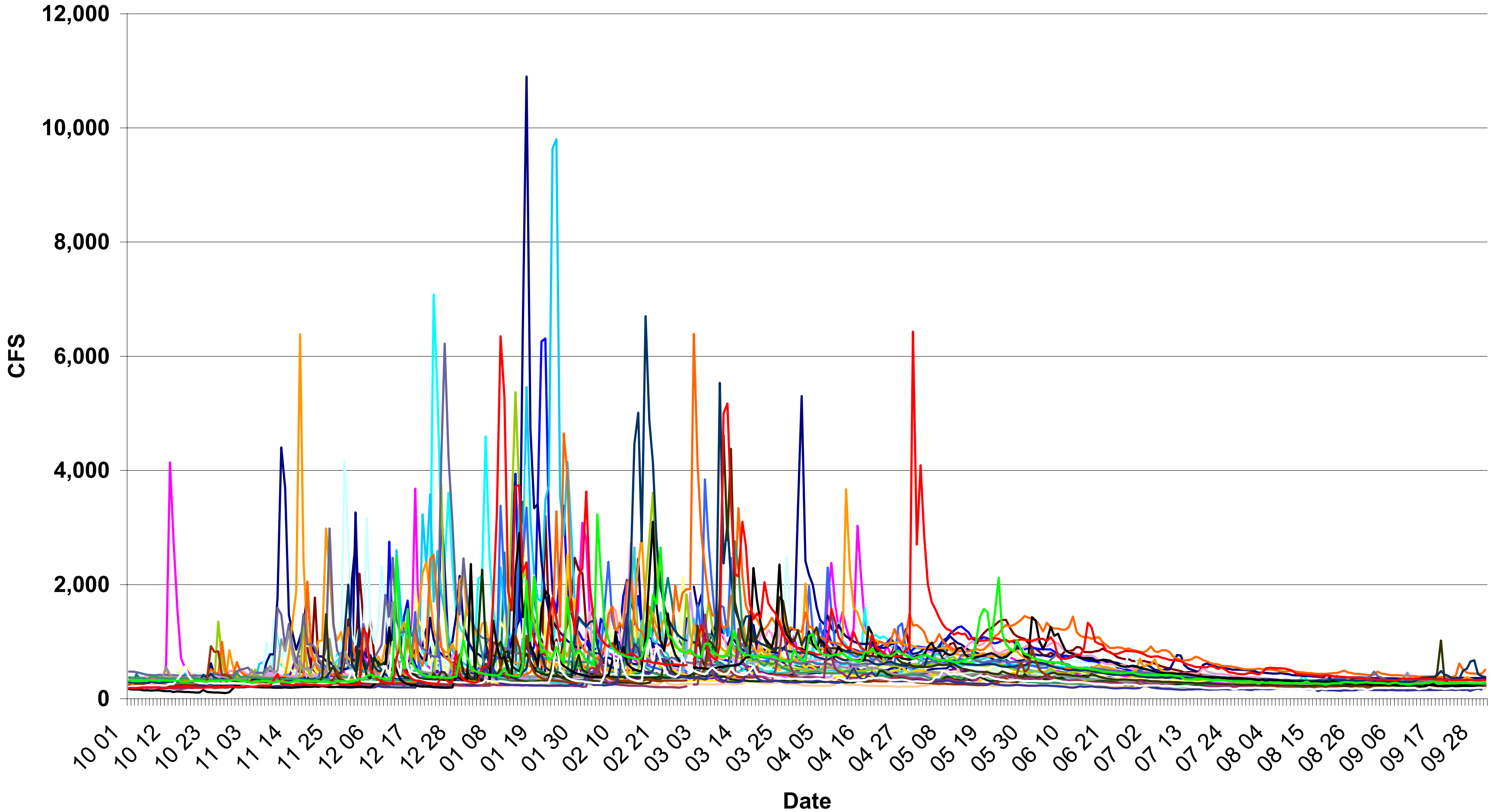


Figure G-1. Battle Creek Period of Record: 35 Water Years (1962–1996).

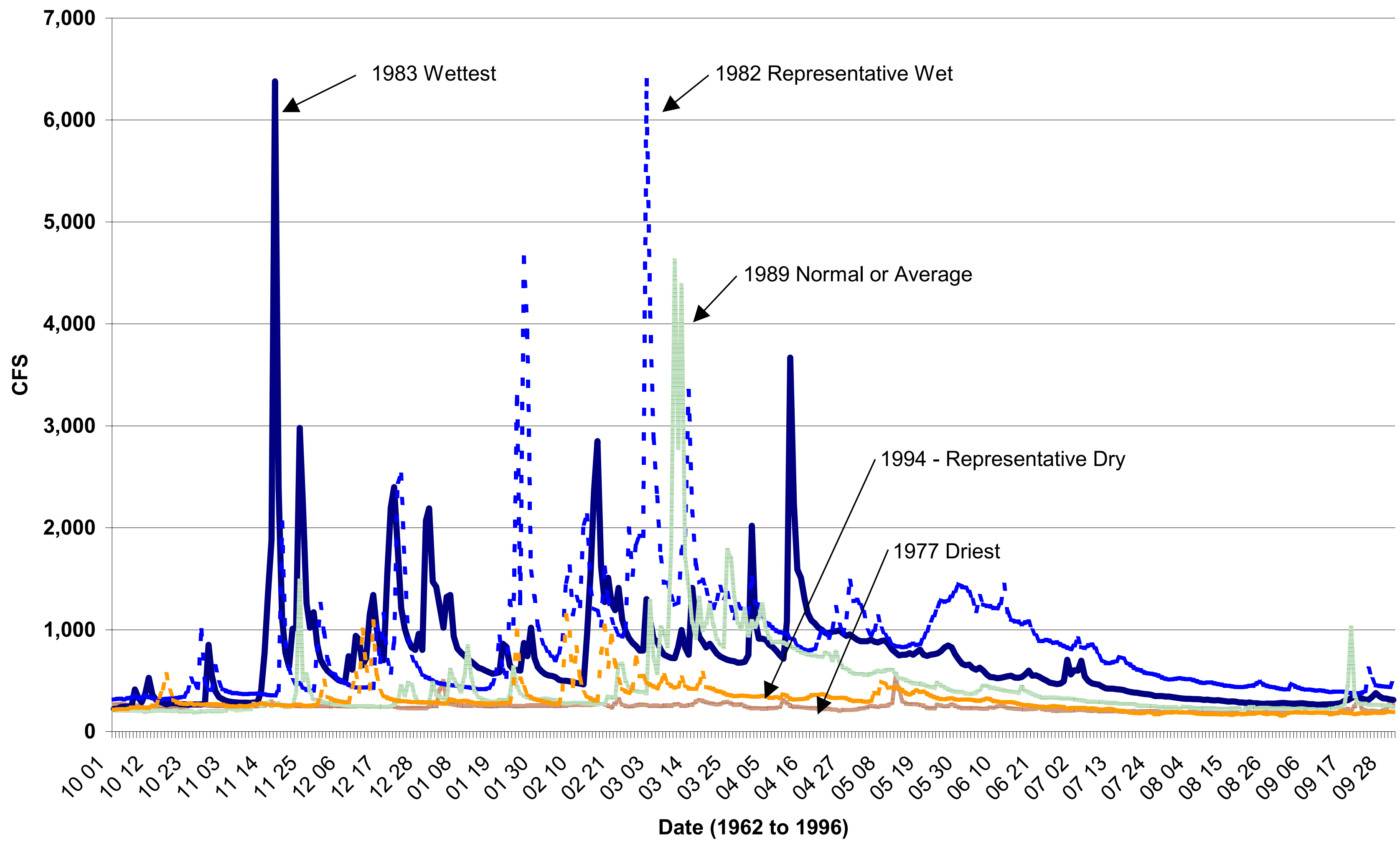


Figure G-2. Battle Creek Representative Water Years.

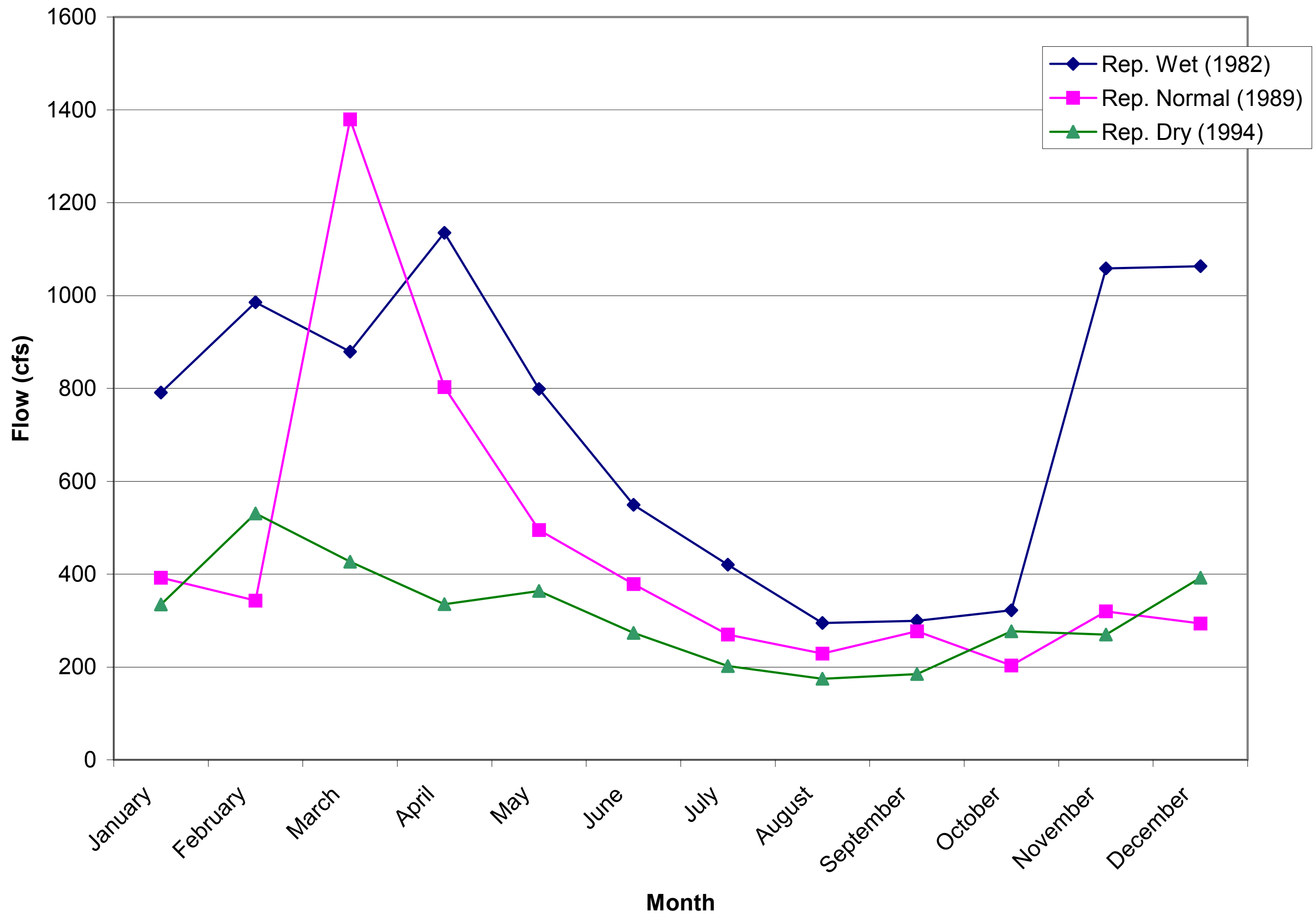


Figure G-3. Representative Water Years Selected by Ranking Yearly Average Flow

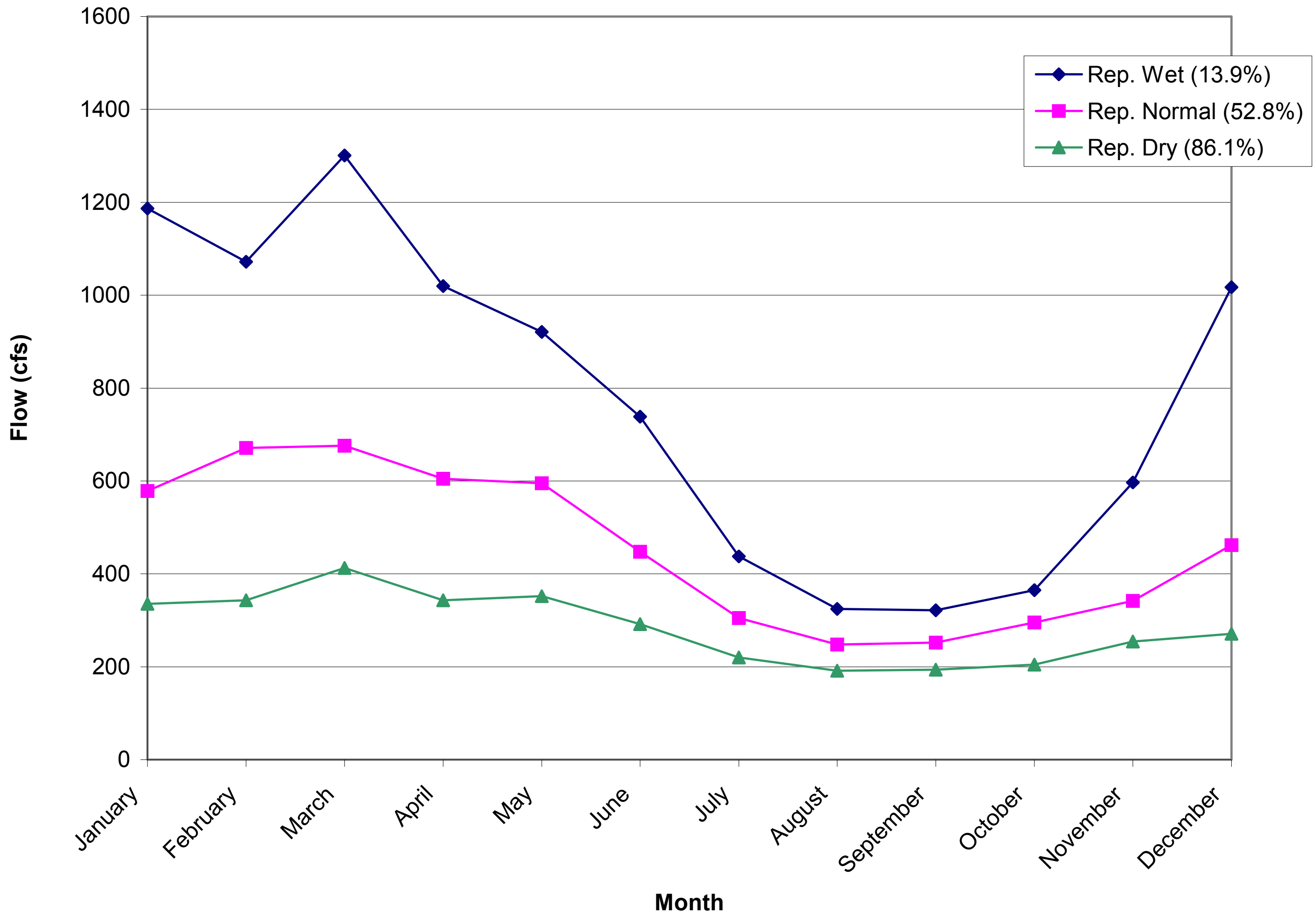


Figure G-4. Representative Water Year Composite Constructed by Ranking Monthly Average Flow.

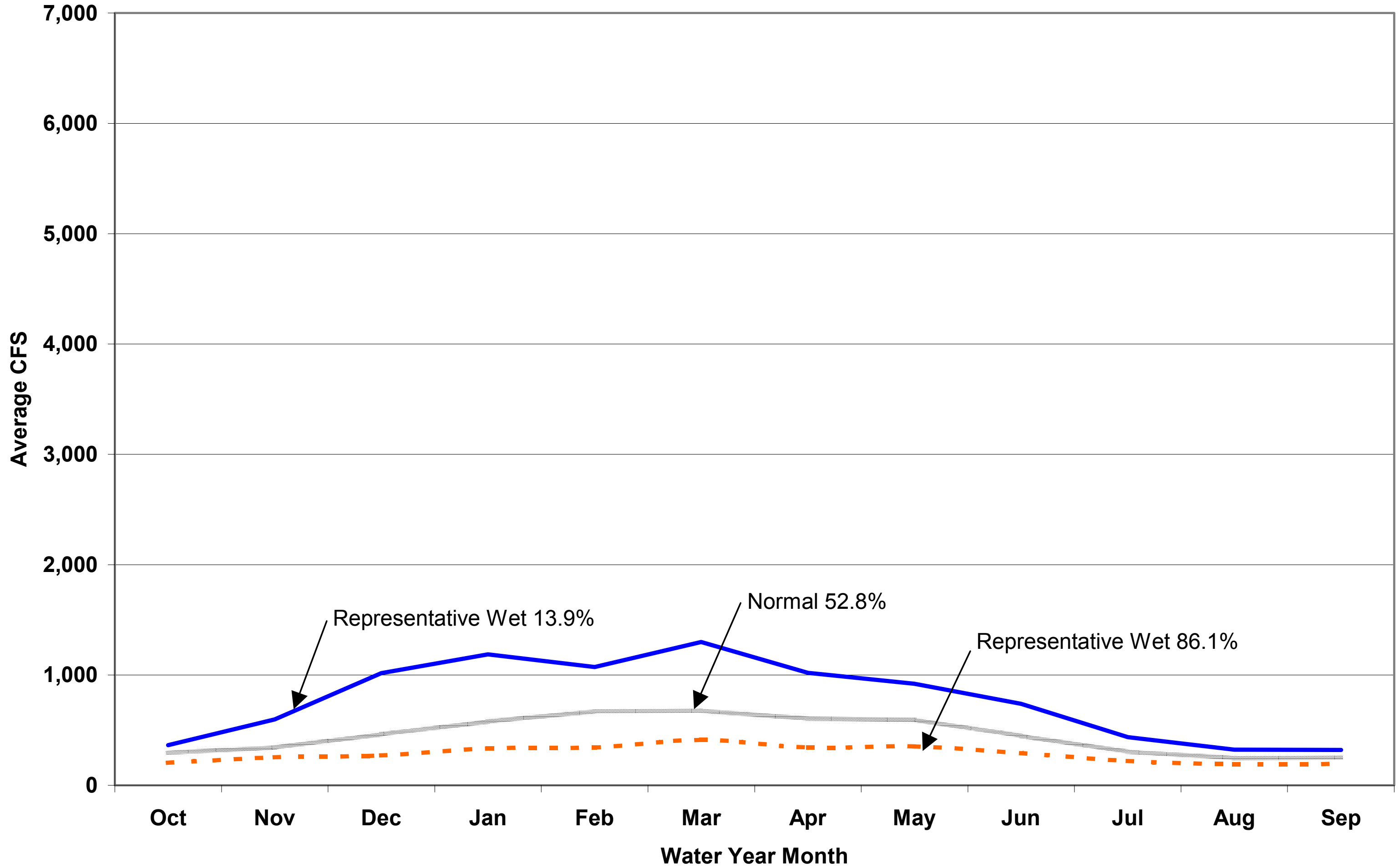


Figure G-5. Representative Synthetic Water Years.

Appendix H

Special-Status Species Requests to California Department of Fish and Game, National Marine Fisheries Service, U.S. Fish and Wildlife Service, and Response from U.S. Fish and Wildlife Service

State Water Resources Control Board

Division of Water Rights
901 P Street • Sacramento, California 95814 • (916) 657-2208
Mailing Address: P.O. Box 2000 • Sacramento, California • 95812-2000
FAX (916) 657-1485 • Web Site Address: http://www.waterrights.ca.gov

Winston H. Hickox
Secretary for Environmental Protection

Gray Davis
Governor

MAY 11 2000

Mr. Don Koch
Regional Manager
California Department of Fish and Game
601 Locust Street
Redding, CA 96001

REQUEST FOR A LIST OF STATE ENDANGERED, THREATENED, CANDIDATE AND SPECIAL STATUS SPECIES OF CONCERN IN THE BATTLE CREEK WATERSHED IN SHASTA AND TEHAMA COUNTIES

Dear Mr. Koch:

The U.S. Bureau of Reclamation (Reclamation) is proposing the Battle Creek Salmon and Steelhead Restoration Project within the Battle Creek Watershed. Reclamation and the State Water Resources Control Board (SWRCB) will be preparing an Environmental Impact Statement/ Environmental Impact Report for the proposed project. Reclamation has already submitted a species request letter to the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). The SWRCB as state lead agency is requesting from the California Department of Fish and Game a list of State-endangered, threatened, candidate, and special-status species of concern within the Battle Creek Watershed (topographic quadrangles Tuscan Buttes, Shingle Town, Manton, Hagaman Gulch, Finley Butte, and Lyonsville in Shasta and Tehama Counties). I have enclosed Figures 1 and 2, from the SWRCB's Notice of Preparation which show the project location and project features.

Please submit the species list to me via facsimile: (916) 657-1485; or by mailing the list to the following address: P.O. Box 2000, Sacramento, California 95812-2000. If you have any questions, please contact me at (916) 657-2208 or e-mail: jcanaday@waterrights.swrcb.ca.gov. Thank you in advance for your assistance.

Sincerely,

Jim Canaday
Environmental Specialist

Enclosures

cc: See Distribution List next page.

Distribution List

Mr. Harry Rectenwald
California Department of Fish and Game
601 Locust Street
Redding, CA 96001

Mr. Steve Turek
California Department of Fish and Game
601 Locust Street
Redding, CA 96001

Mr. Bart Prose
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1898

Mr. Steve Edmondson
National Marine Fisheries Service
777 Sonoma Avenue
Santa Rosa, CA 95404

Mr. Dan Free
National Marine Fisheries Service
650 Capitol Mall Boulevard, No. 6070
Sacramento, CA 95814-4706

Ms. Mary Marshall
U.S. Bureau of Reclamation
2800 Cottage Way
Sacramento, CA 95825-1898

Mr. T.J. LoVullo
Federal Energy Regulatory Commission
888 First Street, NE Mail Code 6B-02
Washington DC 20426

Ms. Angela Risdon
Pacific Gas and Electric Company
Box 770000, Mail Code NIIC
San Francisco, CA 94177

Mr. Don Wagenet
Navigant Consulting Incorporated
3100 Zinfandel Drive, Suite 600
Rancho Cordova, CA 95670-6026

Mr. Ted Beedy
Jones & Stokes
2600 V Street
Sacramento, CA 95818

Mr. Ken Bogdan
Jones & Stokes
2600 V Street
Sacramento, CA 95818

Ms. Sue Bushnell-Bergfalk
Jones & Stokes
2600 V Street
Sacramento, CA 95818

Mr. Steve Centerwall
Jones & Stokes
2600 V Street
Sacramento, CA 95818

Ms. Colleen Smith
Jones & Stokes
2600 V Street
Sacramento, CA 95818

Mr. Michael B. Ward
Terraqua Environmental Consulting
P.O. Box 85
Wauconda, WA 98859

Proposed Battle Creek Salmon and Steelhead Restoration Project

Figure 2: Project Area Limits

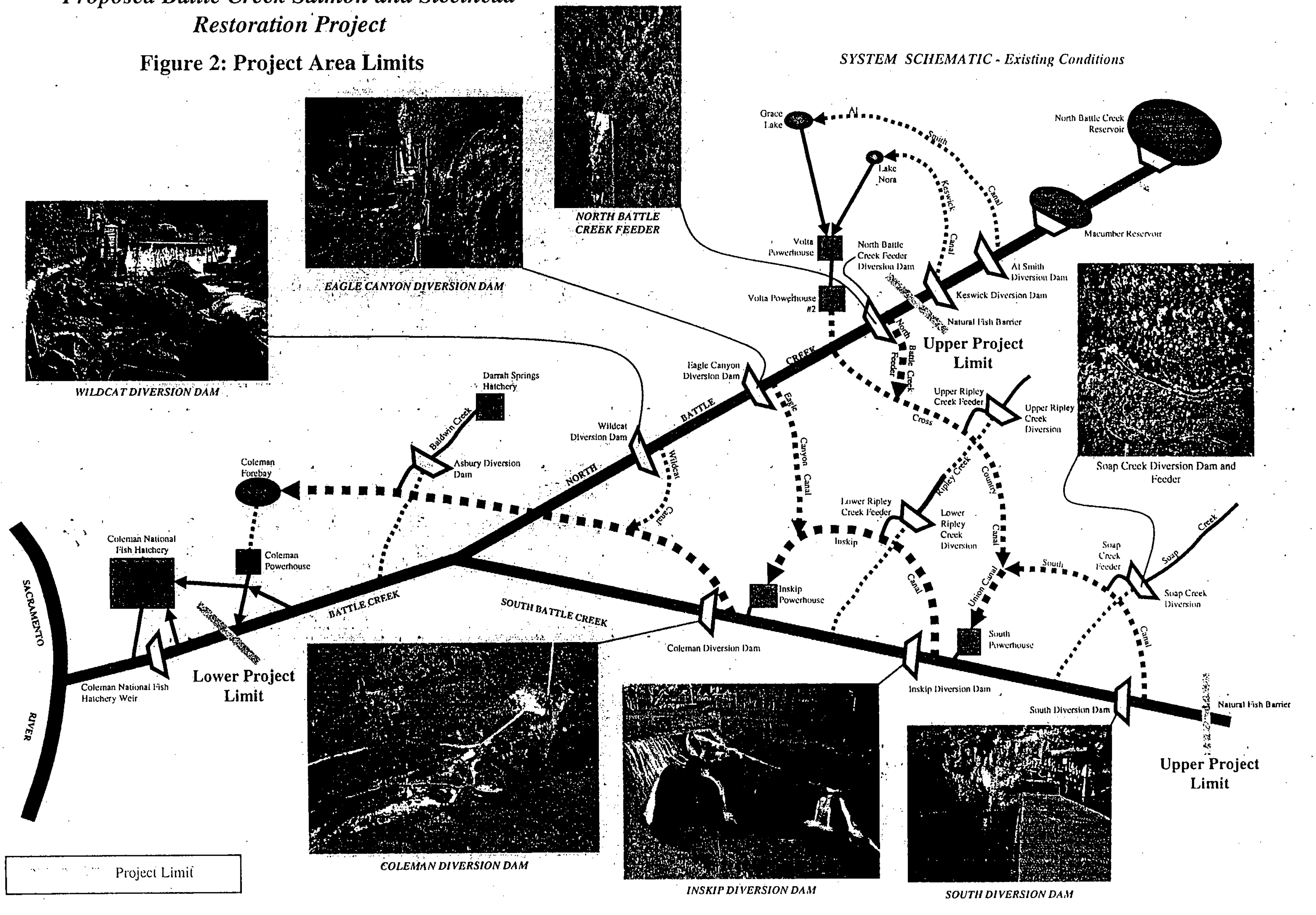
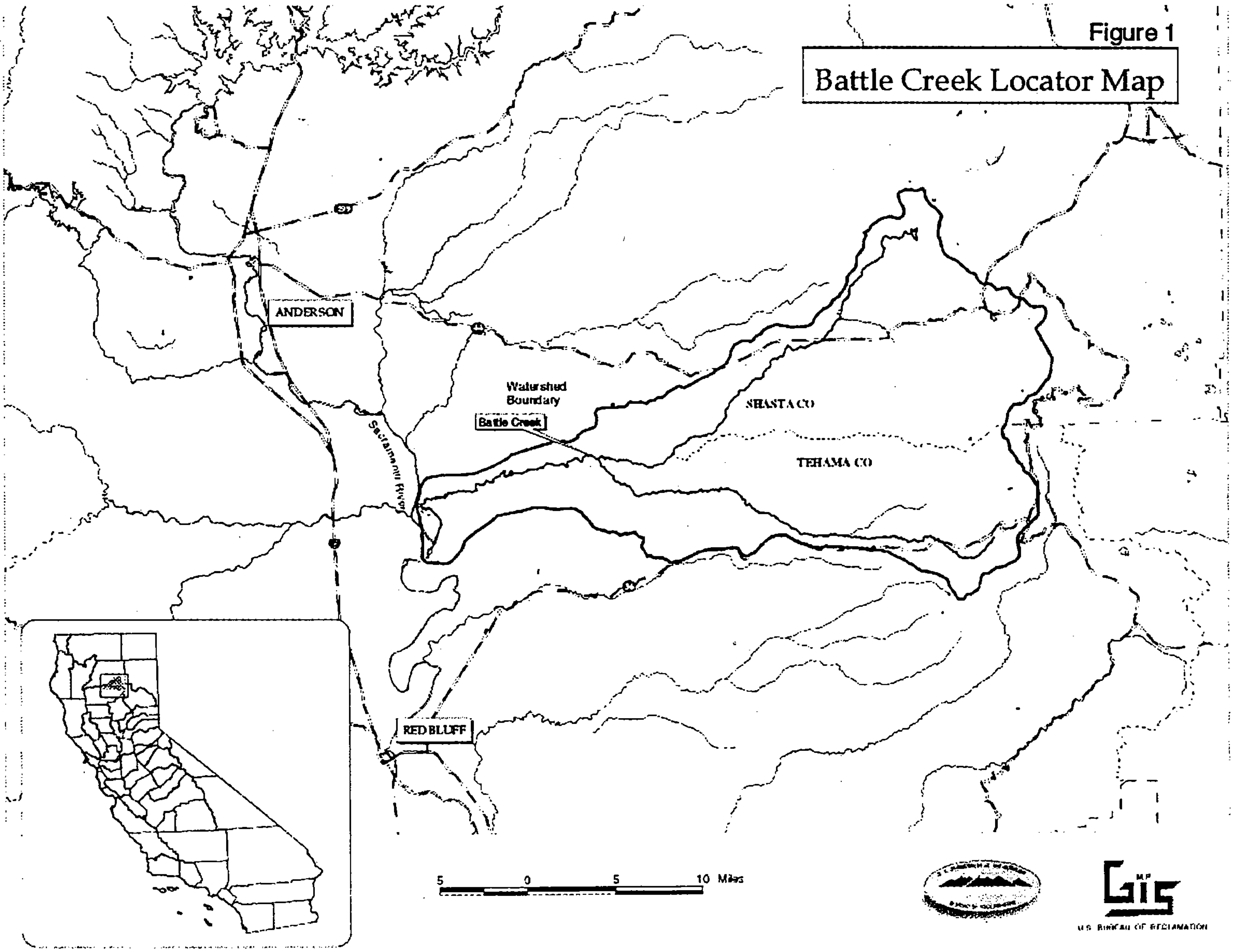


Figure 1

Battle Creek Locator Map



United States Department of the Interior

BUREAU OF RECLAMATION
Mid-Pacific Regional Office
2800 Cottage Way
Sacrame..ıto, California 95825-1898

IN REPLY
REFER TO:
MP-410
ENV-1.10

APR 1 8 2000

Mr. Jim Bybee
National Marine Fisheries Service
777 Sonoma Avenue, Suite 325
Santa Rosa CA 95404

Subject: Request for List of Federally-Endangered, Threatened, Proposed, and Candidate Species for the Battle Creek Watershed in Shasta and Tehama Counties, California

Dear Mr. Bybee:

Reclamation will be preparing an Environmental Impact Statement/Environmental Impact Report for the Battle Creek Salmon and Steelhead Restoration Project within the Battle Creek watershed. Reclamation and the State Water Resources Control Board are the Federal and State lead agencies for the proposed project. Reclamation is requesting a list of endangered, threatened, proposed, and candidate species for the Battle Creek Watershed (Tuscan Buttes, Shingle Town, Manton, Hagaman Gulch, Finley Butte, and Lyonsville topographic quadrangles in Shasta and Tehama Counties). Enclosed are Figures 1 and 2, which show the project location and project features.

Please submit the list to Ms. Mary Marshall; facsimile (916) 978-5290, mailing address: 2800 Cottage Way, Sacramento, California 95825-1898. If you have any questions, please contact Ms. Marshall at (916) 978-5248, e-mail: mmarshall@mp.usbr.gov. Thank you for your assistance.

Sincerely,

Rick Breitenbach
Acting Regional Resources Manager

Enclosures

cc: See next page

cc: Distribution list

Mr. Bart Prose
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento CA 95825-1898

Mr. T.J. LoVullo
FERC
888 First Street, N.E. Mail Code 6B-02
Washington DC 20426

Ms. Angela Risdon
Pacific Gas and Electric Company
Box 770000, Mail Code NIIC
San Francisco CA 94177

Mr. Jim Canaday
State Water Resources Control Board
PO Box 2000
Sacramento CA 95812-2000

Mr. Russ Kanz
State Water Resources Control Board
PO Box 2000
Sacramento CA 95812-2000

Mr. Steve Edmondson
National Marine Fisheries Service
777 Sonoma Avenue
Santa Rosa CA 95404

Mr. Dan Free
National Marine Fisheries Service
650 Capitol Mall Boulevard, No. 6070
Sacramento CA 95814-4706

Mr. Harry Rectenwald
California Department of Fish and Game
601 Locust Street
Redding CA 96001

Mr. Steve Turek
California Department of Fish and Game
601 Locust Street
Redding CA 96001

Navigant Consulting Incorporated
3100 Zinfandel Drive, Suite 600
Rancho Cordova CA 95670-6026

Mr. Ted Beedy
Jones & Stokes Associates Incorporated
2600 V Street
Sacramento CA 95818-1914

Ms. Colleen Smith
Jones & Stokes Associates Incorporated
2600 V Street
Sacramento CA 95818-191

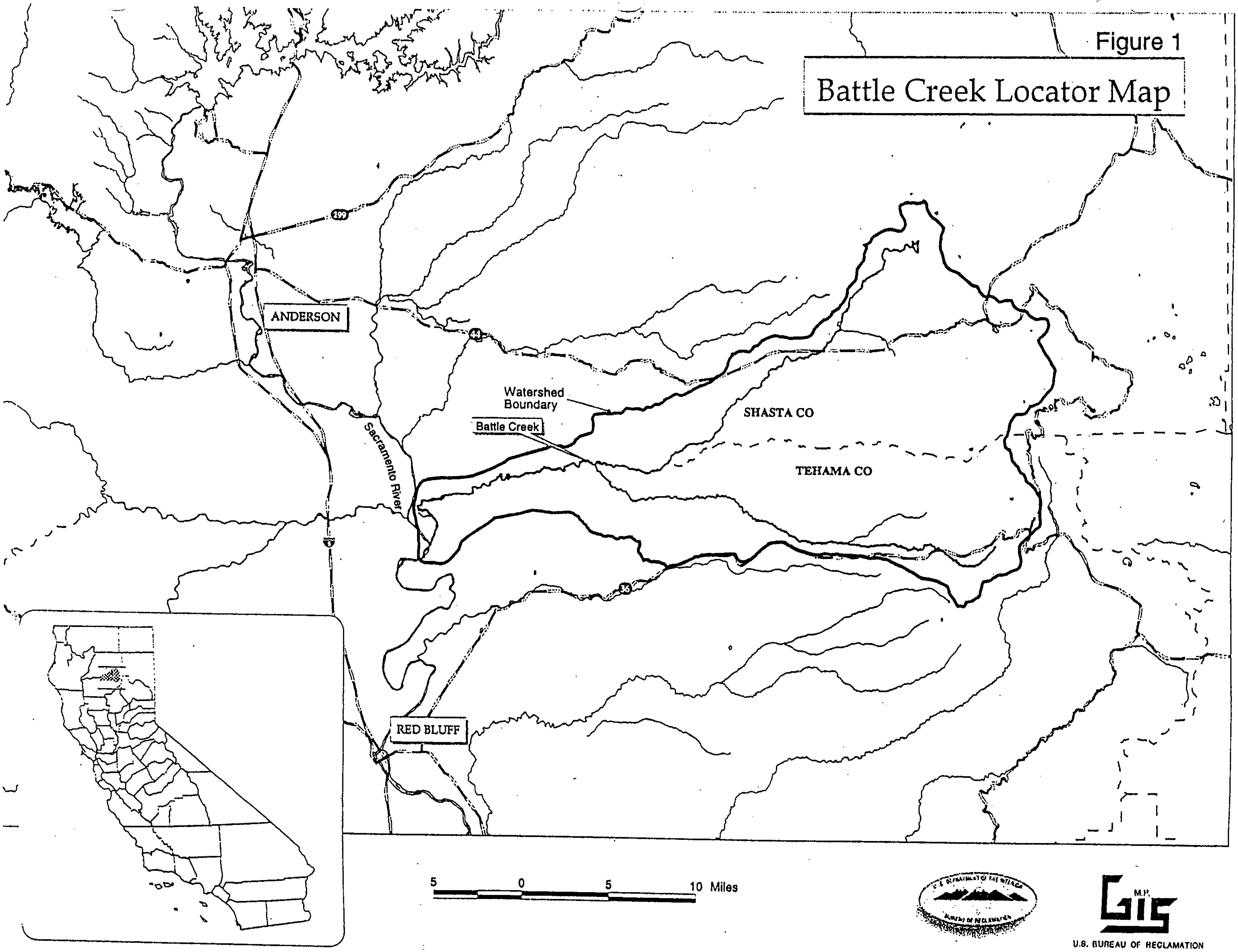
Mr. Steve Centerwall
Jones & Stokes Associates Incorporated
2600 V Street
Sacramento CA 95818-191

Mr. Ken Bogdan
Jones & Stokes Associates Incorporated
2600 V Street
Sacramento CA 95818-191

Mr. Michael B. Ward
Terraqua Environmental Consulting
PO Box 85
Wauconda WA 98859

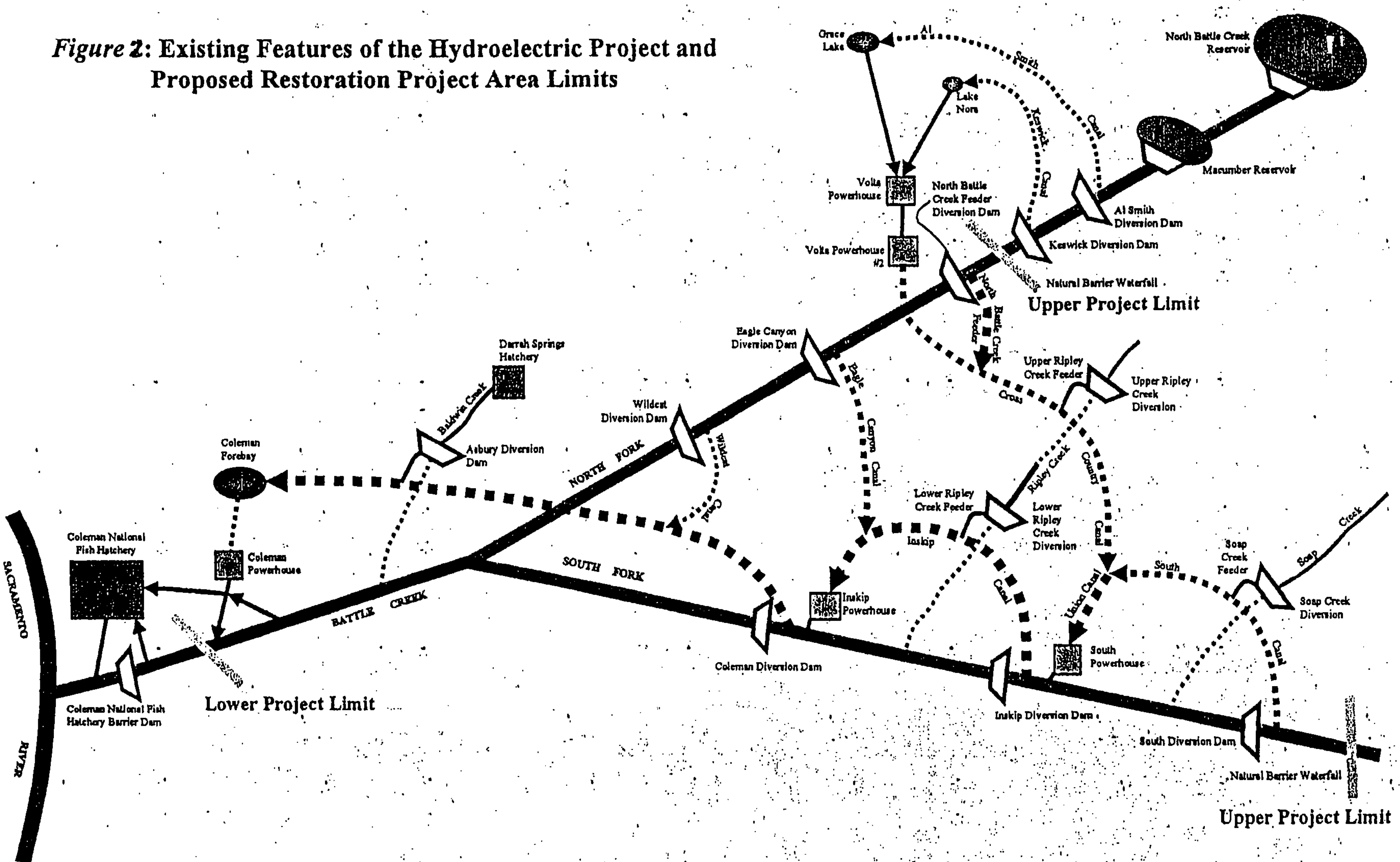
Figure 1

Battle Creek Locator Map



Proposed Battle Creek Salmon and Steelhead Restoration Project

***Figure 2*: Existing Features of the Hydroelectric Project and Proposed Restoration Project Area Limits**



United States Department of the Interior

BUREAU OF RECLAMATION
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825-1898

IN REPLY
REFER TO:
MP-410
ENV-1.10

APR 18 2000

Mr. Harry Mossman
Sacramento Field Office
US Fish and Wildlife Service
2800 Cottage Way, W-2605
Sacramento CA 95825-1846

Subject: Request for List of Federally-Endangered, Threatened, Proposed, and Candidate Species for the Battle Creek Watershed in Shasta and Tehama Counties, California

Dear Mr. Mossman:

Reclamation will be preparing an Environmental Impact Statement/Environmental Impact Report for the Battle Creek Salmon and Steelhead Restoration Project within the Battle Creek watershed. Reclamation and the State Water Resources Control Board are the Federal and State lead agencies for the proposed project. Reclamation is requesting a list of endangered, threatened, proposed, and candidate species for the Battle Creek Watershed (Tuscan Buttes, Shingle Town, Manton, Hagaman Gulch, Finley Butte, and Lyonsville topographic quadrangles in Shasta and Tehama Counties). Enclosed are Figures 1 and 2, which show the project location and project features.

Please submit the list to Ms. Mary Marshall; facsimile number (916) 978-5290, or by mailing the list to address: 2800 Cottage Way, Sacramento, California 95825-1898. If you have any questions, please contact Ms. Marshall at (916) 978-5248 (TDD 978-5608), e-mail: mmarshall@mp.usbr.gov. Thank you for your assistance.

Sincerely,

Rick Breitenbach
Acting Regional Resources Manager

Enclosures

cc: See next page

cc: Distribution list

Mr. Bart Prose
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento CA 95825-1898

Mr. T.J. LoVullo
FERC
888 First Street, N.E. Mail Code 6B-02
Washington DC 20426

Ms. Angela Risdon
Pacific Gas and Electric Company
Box 770000, Mail Code NIIC
San Francisco CA 94177

Mr. Jim Canaday
State Water Resources Control Board
PO Box 2000
Sacramento CA 95812-2000

Mr. Russ Kanz
State Water Resources Control Board
PO Box 2000
Sacramento CA 95812-2000

Mr. Steve Edmondson
National Marine Fisheries Service
777 Sonoma Avenue
Santa Rosa CA 95404

Mr. Dan Free
National Marine Fisheries Service
650 Capitol Mall Boulevard, No. 6070
Sacramento CA 95814-4706

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California Department of Fish and Game
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Redding CA 96001

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Sacramento CA 95818-191

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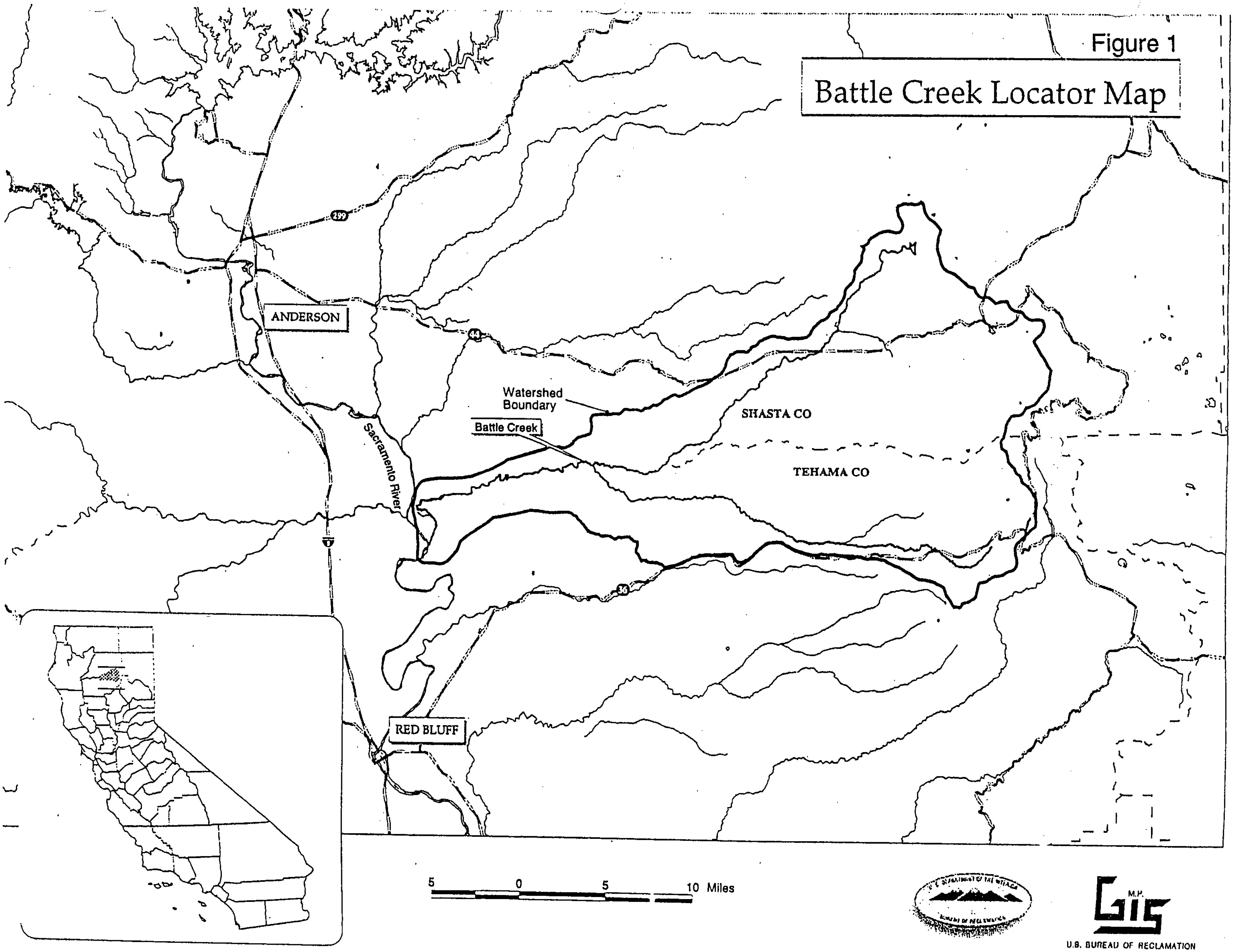
PO Box 85
Wauconda WA 98859

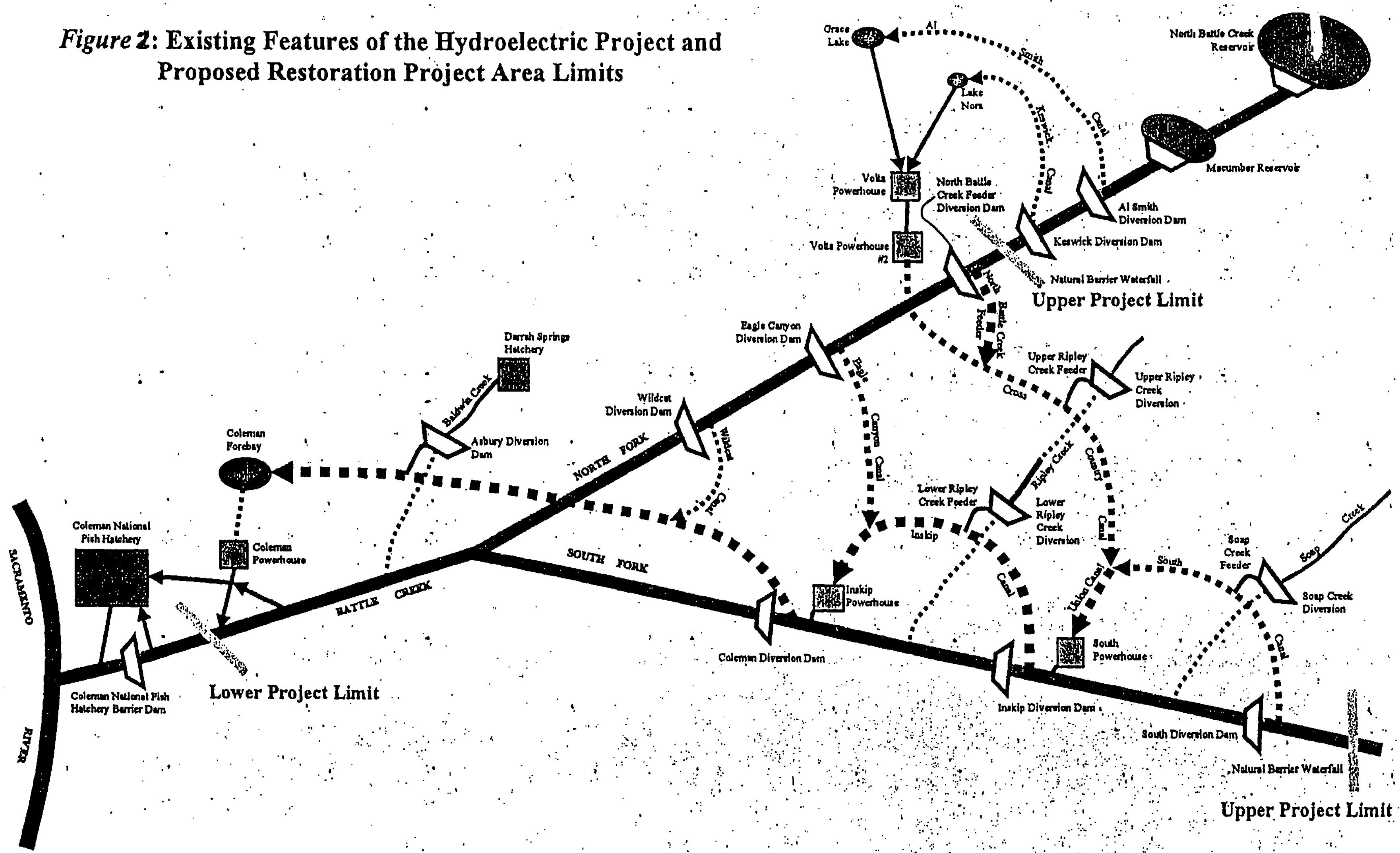
Figure 1

Battle Creek Locator Map



Proposed Battle Creek Salmon and Steelhead Restoration Project

Figure 2: **Existing Features of the Hydroelectric Project and Proposed Restoration Project Area Limits**



United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W2605
Sacramento, California 95825

BUREAU OF RECLAMATION OFFICIAL FILE COPY RECEIVED
MAY 0 3 2000

CODE	ACTION	SURNAME & DATE
410		
150	cy made	

RJK 5/3

IN REPLY REFER TO:
1-1-00-SP-1576

April 27, 2000

WU

Memorandum

To: Bureau of Reclamation, Mid-Pacific Regional Office, Sacramento, California
MP410 (Mary Marshall)

From: Chief, Endangered Species Division, Sacramento Fish and Wildlife Office, Fish and Wildlife Service, Sacramento, California

Subject: Species List for Battle Creek Watershed in Shasta and Tehama Counties, California

We are sending the enclosed list in response to your letter dated April 18, 2000, requesting information about endangered and threatened species (Enclosure A). These lists fulfill the requirement of the Fish and Wildlife Service (Service) to provide species lists under section 7(c) of the Endangered Species Act of 1973, as amended (Act).

The Service used the information in your letter to locate the proposed project on a U.S. Geological Survey (USGS) 7.5 minute quadrangle map. The animal species on the Enclosure A quad list are those species we believe may occur within, *or be affected by projects within*, the following USGS quads, where your project is planned: 626C, Lyonsville; 627A, Manton; 627B, Shingletown; 627D, Finley Butte; 628A, Tuscan Buttes NE; and 645D, Hagaman Gulch.

Any plants on the quad list are ones *that have actually been observed* in that quad. Plants may occur in a quad without having been observed there. Therefore we have included a species list for the whole county in which your project occurs. We recommend that you survey for any relevant plants shown on this list.

Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.

NOTICE: IF YOU DETACH ENCLOSURE PLEASE INSERT
CODE NO.
INITIAL
DATE

ENV 2.00
CUP
6232
37449

If a species has been listed as threatened or endangered by the State of California, but not by us nor by the National Marine Fisheries Service, it will appear on your list as a Species of Concern. *However you must contact the California Department of Fish and Game for official information about these species.* Call (916) 322-2493 or write Marketing Manager, California Department of Fish and Game, Natural Diversity Data Base, 1416 Ninth Street, Sacramento, California 95814.

Some of the species listed in Attachment A may not be affected by the proposed action. A trained biologist or botanist, familiar with the habitat requirements of the listed species, should determine whether these species or habitats suitable for them may be affected. For plants, we recommend using the enclosed Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Species (Enclosure C).

Some pertinent information concerning the distribution, life history, habitat requirements, and published references for the listed species is available upon request. This information may be helpful in preparing the biological assessment for this project, if one is required. Please see Attachment B for a discussion of the responsibilities Federal agencies have under section 7(c) of the Act and the conditions under which a biological assessment must be prepared by the lead Federal agency or its designated non-Federal representative.

Formal consultation, under 50 CFR § 402.14, should be initiated if you determine that a listed species may be affected by the proposed project. If you determine that a proposed species may be adversely affected, you should consider requesting a conference with our office under 50 CFR § 402.10. Informal consultation may be utilized prior to a written request for formal consultation to exchange information and resolve conflicts with respect to a listed species. If a biological assessment is required, and it is not initiated within 90 days of your receipt of this letter, you should informally verify the accuracy of this list with our office.

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as *critical habitat*. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal. Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, this will be noted on the species list. Maps and boundary descriptions of the critical habitat may be found in the *Federal Register*. The information is also reprinted in the *Code of Federal Regulations* (50 **CFR** 17.95).

Candidate species are being reviewed for possible listing. Contact our office if your biological assessment reveals any candidate species that might be adversely affected. Although they currently have no protection under the Endangered Species Act, one or more of them could be proposed and listed before your project is completed. By considering them from the beginning, you could avoid problems later.

Your list may contain a section called *Species of Concern.* This term includes former *category 2 candidate species* and other plants and animals of concern to the Service and other Federal, State and private conservation agencies and organizations. Some of these species may become candidate species in the future.

If the proposed project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by the U.S. Army Corps of Engineers (Corps), a Corps permit will be required, under section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act. Impacts to wetland habitats require site specific mitigation and monitoring. You may request a copy of the Service's General Mitigation and Monitoring Guidelines or submit a detailed description of the proposed impacts for specific comments and recommendations. If you have any questions regarding wetlands, contact Mark Littlefield at (916) 414-6580.

We appreciate your concern for endangered species. Please contact Harry Mossman, Biological Technician, at (916) 414-6650, if you have any questions about the attached list or your responsibilities under the Endangered Species Act. For the fastest response to species list requests, address them to the attention of Mr. Mossman at this address. You may fax requests to him at 414-6712 or 6713.

Sincerely,

fn Karen J. Miller

Attachments

ATTACHMENT A

Endangered and Threatened Species that May Occur in
or be Affected by Projects in the Selected Quads Listed Below
Reference File No. 1-1-00-SP-1576

EIR/EIS for Battle Creek Restoration, Shasta and Tehama Counties, California

April 26, 2000

QUAD : 626C LYONSVILLE

Listed Species

Birds

bald eagle, *Haliaeetus leucocephalus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

spotted bat, *Euderma maculatum* (SC)

California wolverine, *Gulo gulo luteus* (CA)

Sierra Nevada snowshoe hare, *Lepus americanus tahoensis* (SC)

Pacific fisher, *Martes pennanti pacifica* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

California spotted owl, *Strix occidentalis occidentalis* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

QUAD : 627A MANTON

Listed Species

Birds

bald eagle, *Haliaeetus leucocephalus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Plants

Butte fritillary, *Fritillaria eastwoodiae* (SC)

Ahart's whitlow-wort, *Paronychia ahartii* (SC)

QUAD : 627B SHINGLETOWN

Listed Species

Birds

bald eagle, *Haliaeetus leucocephalus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

Butte fritillary, *Fritillaria eastwoodiae* (SC)

QUAD : 627D FINLEY BUTTE

Listed Species

Birds

bald eagle, *Haliaeetus leucocephalus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

QUAD : 628A TUSCAN BUTTES NE

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

vernal pool tadpole shrimp, *Lepidurus packardi* (E)

Plants

slender Orcutt grass, *Orcuttia tenuis* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

Birds

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

bank swallow, *Riparia riparia* (CA)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

river lamprey, *Lampetra ayresi* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)

Sacramento anthicid beetle, *Anthicus sacramento* (SC)

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

valley sagittaria, *Sagittaria sanfordii* (SC)

QUAD : 645D HAGAMAN GULCH

Listed Species

Birds

bald eagle, *Haliaeetus leucocephalus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

spotted bat, *Euderma maculatum* (SC)

California wolverine, *Gulo gulo luteus* (CA)

Pacific fisher, *Martes pennanti pacifica* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

Sierra Nevada red fox, *Vulpes vulpes necator* (CA)

Birds

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

silky cryptantha, *Cryptantha crinita* (SC)

Butte fritillary, *Fritillaria eastwoodiae* (SC)

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	May be endangered or threatened. Not enough biological information has been gathered to support listing at this time.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
(*)	*Extirpated*	Possibly extirpated from this quad.
(**)	*Extinct*	Possibly extinct.
	Critical Habitat	Area essential to the conservation of a species.

Attachment B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a) Consultation/Conference

Requires: (1) federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; (2) Consultation with FWS when a federal action may affect a listed endangered or threatened species to insure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the federal agency after determining the action may affect a listed species; and (3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment-Major Construction Activity[1]

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat is present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirement; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, and problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

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[1]A construction project (or other undertaking having similar physical impacts) which is a major federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2]"Effects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

Attachment C

GUIDELINES FOR CONDUCTING AND REPORTING BOTANICAL INVENTORIES FOR FEDERALLY LISTED, PROPOSED AND CANDIDATE PLANTS

(September 23, 1996)

These guidelines describe protocols for conducting botanical inventories for federally listed, proposed and candidate plants, and describe minimum standards for reporting results. The Service will use, in part, the information outlined below in determining whether the project under consideration may affect any listed, proposed or candidate plants, and in determining the direct, indirect, and cumulative effects.

Field inventories should be conducted in a manner that will locate listed, proposed, or candidate species (target species) that may be present. The entire project area requires a botanical inventory, except developed agricultural lands. The field investigator(s) should:

1. Conduct inventories at the appropriate times of year when target species are present and identifiable. Inventories will include all potential habitats. Multiple site visits during a field season may be necessary to make observations during the appropriate phenological stage of all target species.

2. If available, use a regional or local reference population to obtain a visual image of the target species and associated habitat(s). If access to reference populations(s) is not available, investigators should study specimens from local herbaria.

3. List every species observed and compile a comprehensive list of vascular plants for the entire project site. Vascular plants need to be identified to a taxonomic level which allows rarity to be determined.

4. Report results of botanical field inventories that include:

    a. a description of the biological setting, including plant community, topography, soils, potential habitat of target species, and an evaluation of environmental conditions, such as timing or quantity of rainfall, which may influence the performance and expression of target species

    b. a map of project location showing scale, orientation, project boundaries, parcel size, and map quadrangle name

    c. survey dates and survey methodology(ies)

    d. if a reference population is available, provide a written narrative describing the target species reference population(s) used, and date(s) when observations were made

    e. a comprehensive list of all vascular plants occurring on the project site for each habitat type

    f. current and historic land uses of the habitat(s) and degree of site alteration

g. presence of target species off-site on adjacent parcels, if known.

h. an assessment of the biological significance or ecological quality of the project site in a local and regional context

5. If target species is(are) found, report results that additionally include:

   a. a map showing federally listed, proposed and candidate species distribution as they relate to the proposed project

   b. if target species is (are) associated with wetlands, a description of the direction and integrity of flow of surface hydrology. If target species is (are) affected by adjacent off-site hydrological influences, describe these factors.

   c. the target species phenology and microhabitat, an estimate of the number of individuals of each target species per unit area; identify areas of high, medium and low density of target species over the project site, and provide acres of occupied habitat of target species. Investigators could provide color slides, photos or color copies of photos of target species or representative habitats to support information or descriptions contained in reports.

   d. the degree of impact(s), if any, of the proposed project as it relates to the potential unoccupied habitat of target habitat.

6. Document findings of target species by completing California Native Species Field Survey Form(s) and submit form(s) to the Natural Diversity Data Base. Documentation of determinations and/or voucher specimens may be useful in cases of taxonomic ambiguities, habitat or range extensions.

7. Report as an addendum to the original survey, any change in abundance and distribution of target plants in subsequent years. Project sites with inventories older than 3 years from the current date of project proposal submission will likely need additional survey. Investigators need to assess whether an additional survey(s) is (are) needed.

8. Adverse conditions may prevent investigator(s) from determining presence or identifying some target species in potential habitat(s) of target species. Disease, drought, predation, or herbivory may preclude the presence or identification of target species in any year. An additional botanical inventory(ies) in a subsequent year(s) may be required if adverse conditions occur in a potential habitat(s). Investigator(s) may need to discuss such conditions.

9. Guidance from California Department of Fish and Game (CDFG) regarding plant and plant community surveys can be found in Guidelines for Assessing the Effects of Proposed Developments on Rare and Endangered Plants and Plant Communities, 1984. Please contact the CDFG Regional Office for questions regarding the CDFG guidelines and for assistance in determining any applicable State regulatory requirements.

Endangered and Threatened Species that May Occur in or be Affected by
Projects in the Area of the Following California Counties
Reference File No. 1-1-00-sp-1576
April 26, 2000

SHASTA COUNTY

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)
bald eagle, *Haliaeetus leucocephalus* (T)
Critical habitat, northern spotted owl, *Strix occidentalis caurina* (T)
northern spotted owl, *Strix occidentalis caurina* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)
winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)
delta smelt, *Hypomesus transpacificus* (T)
Central Valley steelhead, *Oncorhynchus mykiss* (T)
Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)
Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool tadpole shrimp, *Lepidurus packardi* (E)
Shasta crayfish, *Pacifastacus fortis* (E)
vernal pool fairy shrimp, *Branchinecta lynchi* (T)
valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Plants

Greene's tuctoria, *Tuctoria greenei* (E)
slender Orcutt grass, *Orcuttia tenuis* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

McCloud River redband trout, *Oncorhynchus (=Salmo) mykiss ssp.* (C)
Klamath Mts. Province steelhead, *Oncorhynchus mykiss* (C)
Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

California wolverine, *Gulo gulo luteus* (CA)

- pygmy rabbit, *Brachylagus idahoensis* (SC)
- pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)
- Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)
- spotted bat, *Euderma maculatum* (SC)
- Sierra Nevada snowshoe hare, *Lepus americanus tahoensis* (SC)
- American (=pine) marten, *Martes americana* (SC)
- Pacific fisher, *Martes pennanti pacifica* (SC)
- small-footed myotis bat, *Myotis ciliolabrum* (SC)
- long-eared myotis bat, *Myotis evotis* (SC)
- fringed myotis bat, *Myotis thysanodes* (SC)
- long-legged myotis bat, *Myotis volans* (SC)
- Yuma myotis bat, *Myotis yumanensis* (SC)
- San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

- little willow flycatcher, *Empidonax traillii brewsteri* (CA)
- greater sandhill crane, *Grus canadensis tabida* (CA)
- bank swallow, *Riparia riparia* (CA)
- American peregrine falcon, *Falco peregrinus anatum* (D)
- northern goshawk, *Accipiter gentilis* (SC)
- tricolored blackbird, *Agelaius tricolor* (SC)
- grasshopper sparrow, *Ammodramus savannarum* (SC)
- Bell's sage sparrow, *Amphispiza belli belli* (SC)
- short-eared owl, *Asio flammeus* (SC)
- western burrowing owl, *Athene cunicularia hypugea* (SC)
- American bittern, *Botaurus lentiginosus* (SC)
- ferruginous hawk, *Buteo regalis* (SC)
- Lawrence's goldfinch, *Carduelis lawrencei* (SC)
- Vaux's swift, *Chaetura vauxi* (SC)
- black tern, *Chlidonias niger* (SC)
- lark sparrow, *Chondestes grammacus* (SC)
- olive-sided flycatcher, *Contopus cooperi* (SC)
- black swift, *Cypseloides niger* (SC)
- hermit warbler, *Dendroica occidentalis* (SC)
- common loon, *Gavia immer* (SC)
- loggerhead shrike, *Lanius ludovicianus* (SC)
- Lewis' woodpecker, *Melanerpes lewis* (SC)
- long-billed curlew, *Numenius americanus* (SC)
- white-faced ibis, *Plegadis chihi* (SC)
- rufous hummingbird, *Selasphorus rufus* (SC)
- red-breasted sapsucker, *Sphyrapicus ruber* (SC)

Brewer's sparrow, *Spizella breweri* (SC)
California spotted owl, *Strix occidentalis occidentalis* (SC)
Bewick's wren, *Thryomanes bewickii* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)
California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

Shasta salamander, *Hydromantes shastae* (CA)
tailed frog, *Ascaphus truei* (SC)
foothill yellow-legged frog, *Rana boylii* (SC)
Cascades frog, *Rana cascadae* (SC)
western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

rough sculpin, *Cottus asperrimus* (CA)
green sturgeon, *Acipenser medirostris* (SC)
river lamprey, *Lampetra ayresi* (SC)
Pit roach, *Lavinia symmetricus mitrulus* (SC)
longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Trinity (=California) bristlesnail, *Monadenia setosa* (CA)
Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)
Sacramento anthicid beetle, *Anthicus sacramento* (SC)
confusion caddisfly, *Cryptochia shasta* (SC)
King's Creek ecclisomyian caddisfly, *Ecclisomyia bilera* (SC)
California linderiella fairy shrimp, *Linderiella occidentalis* (SC)
Shasta sideband snail, *Monadenia troglodytes* (SC)
Siskiyou ground beetle, *Nebria gebleri siskiyouensis* (SC)
Trinity Alps ground beetle, *Nebria sahlbergii triad* (SC)
King's Creek parapsyche caddisfly, *Parapsyche extensa* (SC)
Castle Crags rhyacophilan caddisfly, *Rhyacophila lineata* (SC)
bilobed rhyacophilan caddisfly, *Rhyacophila mosana* (SC)

Plants

Klamath manzanita, *Arctostaphylos klamathensis* (SC)
Suksdorf's milk-vetch, *Astragalus pulsiferae var. suksdorfii* (SC)
long-haired star-tulip, *Calochortus longebarbatus var. longebarbatus* (SC)
Wilkins' harebell, *Campanula wilkinsiana* (SC)
arid northern clarkia, *Clarkia borealis ssp. arida* (SC)
silky cryptantha, *Cryptantha crinita* (SC)
clustered lady's-slipper, *Cypripedium fasciculatum* (SC)

Oregon fireweed, *Epilobium oreganum* (SC)
Butte fritillary, *Fritillaria eastwoodiae* (SC)
Howell's lewisia, *Lewisia cotyledon var. howellii* (SC)
Bellinger's meadowfoam, *Limnanthes floccosa ssp. bellingeriana* (SC)
Stebbins' madia, *Madia stebbinsii* (SC)
The Lassics sandwort, *Minuartia decumbens* (SC)
Ahart's whitlow-wort, *Paronychia ahartii* (SC)
thread-leaved penstemon, *Penstemon filiformis* (SC)
Trinity (Scott Mountain) phacelia, *Phacelia dalesiana* (SC)
Devil's Garden pogogyne, *Pogogyne floribunda* (SC)
Howell's alkali grass, *Puccinellia howellii* (SC)
valley sagittaria, *Sagittaria sanfordii* (SC)
Canyon Creek stonecrop, *Sedum paradisum* (SC)
Butte County (western) catchfly, *Silene occidentalis ssp. longistipitata* (SC)
Mt. Lassen smelowskia, *Smelowskia ovalis ssp. congesta* (SC)
Pit River jewelflower, *Streptanthus sp. nov. /ined. (Shasta Co.)* (SC)

TEHAMA COUNTY

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)
bald eagle, *Haliaeetus leucocephalus* (T)
Critical habitat, northern spotted owl, *Strix occidentalis caurina* (T)
northern spotted owl, *Strix occidentalis caurina* (T)

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)
winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)
delta smelt, *Hypomesus transpacificus* (T)
Central Valley steelhead, *Oncorhynchus mykiss* (T)
Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)
Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

Conservancy fairy shrimp, *Branchinecta conservatio* (E)
vernal pool tadpole shrimp, *Lepidurus packardi* (E)
vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Plants

hairy Orcutt grass, *Orcuttia pilosa* (E)

Greene's tuctoria, *Tuctoria greenei* (E)

Hoover's spurge, *Chamaesyce hooveri* (T)

slender Orcutt grass, *Orcuttia tenuis* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Fish

Klamath Mts. Province steelhead, *Oncorhynchus mykiss* (C)

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

California wolverine, *Gulo gulo luteus* (CA)

Sierra Nevada red fox, *Vulpes vulpes necator* (CA)

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

spotted bat, *Euderma maculatum* (SC)

Sierra Nevada snowshoe hare, *Lepus americanus tahoensis* (SC)

Pacific fisher, *Martes pennanti pacifica* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

Swainson's hawk, *Buteo Swainsoni* (CA)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

greater sandhill crane, *Grus canadensis tabida* (CA)

bank swallow, *Riparia riparia* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

northern goshawk, *Accipiter gentilis* (SC)

tricolored blackbird, *Agelaius tricolor* (SC)

grasshopper sparrow, *Ammodramus savannarum* (SC)

Bell's sage sparrow, *Amphispiza belli belli* (SC)

short-eared owl, *Asio flammeus* (SC)

western burrowing owl, *Athene cunicularia hypugea* (SC)
American bittern, *Botaurus lentiginosus* (SC)
ferruginous hawk, *Buteo regalis* (SC)
Lawrence's goldfinch, *Carduelis lawrencei* (SC)
Vaux's swift, *Chaetura vauxi* (SC)
black tern, *Chlidonias niger* (SC)
lark sparrow, *Chondestes grammacus* (SC)
black swift, *Cypseloides niger* (SC)
hermit warbler, *Dendroica occidentalis* (SC)
white-tailed (=black shouldered) kite, *Elanus leucurus* (SC)
loggerhead shrike, *Lanius ludovicianus* (SC)
Lewis' woodpecker, *Melanerpes lewis* (SC)
long-billed curlew, *Numenius americanus* (SC)
white-faced ibis, *Plegadis chihi* (SC)
rufous hummingbird, *Selasphorus rufus* (SC)
Brewer's sparrow, *Spizella breweri* (SC)
California spotted owl, *Strix occidentalis occidentalis* (SC)
Bewick's wren, *Thryomanes bewickii* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)
California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

tailed frog, *Ascaphus truei* (SC)
foothill yellow-legged frog, *Rana boylii* (SC)
mountain yellow-legged frog, *Rana muscosa* (SC)
western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)
river lamprey, *Lampetra ayresi* (SC)
longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)
Sacramento anthicid beetle, *Anthicus sacramento* (SC)
Leech's skyline diving beetle, *Hydroporus leechi* (SC)
California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

Indian Valley brodiaea, *Brodiaea coronaria ssp. rosea* (CA)
upswept moonwort, *Botrychium ascendens* (SC)
scalloped moonwort, *Botrychium crenulatum* (SC)

Wilkins' harebell, *Campanula wilkinsiana* (SC)
silky cryptantha, *Cryptantha crinita* (SC)
clustered lady's-slipper, *Cypripedium fasciculatum* (SC)
Oregon fireweed, *Epilobium oreganum* (SC)
Brandegee's woolly-star, *Eriastrum brandegeae* (SC)
Butte fritillary, *Fritillaria eastwoodiae* (SC)
adobe lily, *Fritillaria pluriflora* (SC)
Tehama dwarf-flax, *Hesperolinon tehamense* (SC)
legenere, *Legenere limosa* (SC)
Mt. Tedoc linanthus, *Linanthus nuttallii ssp. howellii* (SC)
red-flowered lotus, *Lotus rubriflorus* (SC)
Anthony Peak lupine, *Lupinus antoninus* (SC)
Stebbins' madia, *Madia stebbinsii* (SC)
The Lassics sandwort, *Minuartia decumbens* (SC)
Ahart's whitlow-wort, *Paronychia ahartii* (SC)
valley sagittaria, *Sagittaria sanfordii* (SC)
Tracy's sanicle, *Sanicula tracyi* (SC)
Butte County (western) catchfly, *Silene occidentalis ssp. longistipitata* (SC)

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	Other species of concern to the Service.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
*	*Extirpated*	Possibly extirpated from the area.
**	*Extinct*	Possibly extinct
	Critical Habitat	Area essential to the conservation of a species.

Appendix I

Common and Scientific Names for Plant and Wildlife Species Mentioned in the Battle Creek Salmon and Steelhead Restoration Project Environmental Impact Statement/ Environmental Impact Report

Appendix I

Common and Scientific Names for Plant and Wildlife Species Mentioned in the Battle Creek Salmon and Steelhead Restoration Project Environmental Impact Statement/ Environmental Impact Report

Plants

Common Name	Scientific Name
Adobe-lily	*Fritillaria puriflora*
Ahart's paronychia	*Paronychia ahartii*
Annual agoseris	*Agoseris heterophylla*
Annual fescues	*Vulpia* sp.
Annual hairgrass	*Deschampsia danthoinoides*
Aster	*Aster* sp.
Bedstraws	*Galium* sp.
Bidwell's knotweed	*Polygonum bidwelliae*
Big manzanita	*Arctostaphylos manzanita*
Big-leaf maple	*Acer macrophyllum*
Big-scale balsamroot	*Balsamorhiza macrolepis* var. *macrolepis*
Birch-leaved mountain-mahogany	*Cercocarpus betuloides*
Black oak	*Quercus kelloggii*
Blackberry	*Rubus* sp.
Blue dicks	*Dichelostemma* sp.
Blue elderberry	*Sambucus cerulea* var. *cerulea*
Blue oak	*Quercus douglasii*
Boggs Lake hedge-hyssop	*Gratiola heterosepala*
Bracken fern	*Pteridium aquilinum*

Plants

Common Name	Scientific Name
Brandegee's eriastrum	*Eriastrum brandegeae*
Brownbells	*Fritillaria micrantha*
Buckbrush	*Ceanothus cuneatus* var. *cuneatus*
Butte County fritillary	*Fritillaria eastwoodiae*
California bay laurel	*Umbellularia californica*
California buckeye	*Aesculus californica*
California melic grass	*Melica californica*
California wild grape	*Vitis californica*
California yerba-santa	*Eriodictyon californicum*
Canyon Creek stonecrop	*Sedum paradisum*
Canyon live oak	*Quercus chrysolepis*
Checkered fritillary	*Fritillaria affinis*
Chinese tree-of-heaven	*Ailanthus altissima*
Cocklebur	*Xanthium strumarium*
Coffeeberry	*Rhamnus tomentella*
Cowbag clover	*Trifolium depauperatum*
Coyote thistle	*Eryngium castrense*
Curly dock	*Rumex crispus*
Depauperate milk-vetch	*Astragalus pauperculus*
Dimorphic snapdragon	*Antirrhinum subcordatum*
Dogwood	*Cornus sessilis*
Douglas fir	*Pseudotsuga menziesii*
Downy navarretia	*Navarretia pubescens*
Dwarf downingia	*Downingia pusilla*
Dwarf stonecrop	*Parvisedum pumilum*
Eel-grass pondweed	*Potamogeton zosteriformis*
Elderberry	*Sambucus* spp.
Erect plantain	*Plantago erecta*
Fig	*Ficus carica*
Filago	*Filago* sp.
Filarees	*Erodium* sp.
Fitch's spikeweed	*Hemizonia fitchii*

Plants

Common Name	Scientific Name
Four-angled spikerush	*Eleocharis quadrangularis*
Fremont's goldfields	*Lasthenia fremontii*
Goldenroc	*Solidago* sp.
Goldfields	*Lasthenia* sp.
Grass nuts	*Triteleia* sp.
Gray pine	*Pinus sabiniana*
Green-leaved manzanita	*Arctostaphylos patula*
Hedgehog dogtail	*Cynosurus echinatus*
Henderson's bent grass	*Agrostis hendersonii*
Himalayan blackberry	*Rubus discolor*
Hot rock daisy	*Erigeron inornatus* var. *calidipetris*
Hyssop loosestrife	*Lythrum hyssopifolium*
Incense cedar	*Calocedrus decurrens*
Indian-pink	*Silene californica*
Interior live oak	*Quercus wislizenii* var. *wislizenii*
Italian rye-grass	*Lolium multiflorum*
Klamath weed	*Hypericum perforatum*
Legenere	*Legenere limosa*
Lemonadeberry	*Rhus trilobata*
Lesser quaking-grass	*Briza minor*
Liverworts	Hepaticopsida
Long-beaked hawkbit	*Leontodon taraxacoides*
Lowland shooting star	*Dodecatheon clevelandii*
Manroot	*Marah fabaceus*
Manzanitas	*Arctostaphylos* sp.
Marigold navarretia	*Navarretia tagetina*
Marsh claytonia	*Claytonia palustris*
Marsh skullcap	*Scutellaria galericulata*
Mediterranean barley	*Hordeum marinum* ssp. *gussoneanum*
Medusahead	*Taeniatherum caput-medusae*
Miner's lettuce	*Claytonia perfoliata*
Mistletoe	*Phoradendron* sp./*Viscum* sp.

Plants

Common Name	Scientific Name
Monkeyflower	*Mimulus guttatus*
Mountain brome	*Bromus marginatus*
Narrow-leaved cattail	*Typha angustifolia*
Needlegrass	*Achnatherum* sp.
Nitgrass	*Gastridium ventricosum*
Obtuse starwort	*Stellaria obtusa*
Orchard grass	*Dactylis glomerata*
Oregon ash	*Fraxinus latifolia*
Pacific sanicle	*Sanicula crassicaulis*
Pacific yew	*Taxus brevifolia*
Pale yellow stonecrop	*Sedum laxum* ssp. *flavidum*
Parish's spike-rush	*Eleocharis parishii*
Pipevine	*Aristolochia californica*
Poison oak	*Toxicodendron diversilobum*
Ponderosa pine	*Pinus ponderosa*
Popcorn-flowers	*Plagiobothrys* sp.
Prickly lettuce	*Lactuca serriola*
Puttyroots	*Plectritis* sp.
Q-tips	*Micropus californicus*
Red Bluff dwarf rush	*Juncus leiospermus* var. *leiospermus*
Red brome	*Bromus madritensis*
Red-flowered lotus	*Lotus rubriflorus*
Redberry	*Rhamnus crocea*
Redbud	*Cercis occidentalis*
Ripgut brome	*Bromus diandrus*
Rush	*Juncus effusus*
Sanborn's onion	*Allium sanbornii* var. *sanbornii*
Sanford's arrowhead	*Sagittaria sanfordii*
Sanicle	*Sanicula* sp.
Saxifrage	*Saxifraga californica*
Scotch broom	*Cytisus scoparius*
Scrub oak	*Quercus berberidifolia*

Plants

Common Name	Scientific Name
Sedge	*Carex* sp.
Shield-bracted monkeyflower	*Mimulus glaucescens*
Silky cryptantha	*Cryptantha crinita*
Silver hairgrass	*Aira caryophyllea*
Slender Orcutt grass	*Orcuttia tenuis*
Snub pea	*Lathyrus sulphureus*
Soaproots	*Chlorogalum* sp.
Soft chess	*Bromus hordaeaceus*
Star-thistle	*Centaurea* sp.
Sword ferns	*Polystichum* sp.
Tarweed	*Hemizonia* sp.
Tidy-tips	*Layia fremontii*
Toad rush	*Juncus bufonius* var. *bufonius*
Tomcat clover	*Trifolium willdenovii*
Toyon	*Heteromeles arbutifolia*
Valley oak	*Quercus lobata*
Vetch	*Vicia* sp.
Water bulrush	*Scripus subterminalis*
Water starwort	*Callitriche* sp.
Watercress	*Rorippa nasturtium-aquaticum*
Western buttercup	*Ranunculus occidentalis*
Western compion	*Silene occidentalis* ssp. *longistipitata*
Western spicebush	*Calycanthus occidentalis*
Western sycamore	*Platanus racemosa*
White alder	*Alnus rhombifolia*
White mulberry	*Morus alba*
White-leaved manzanita	*Arctostaphylos viscida*
White-stemmed pondweed	*Potamogeton praelongus*
White-tipped clover	*Trifolium variegatum*
Wild iris	*Iris* sp.
Wild oats	*Avena* sp.
Willows	*Salix exigua, S. laevigata, S. lasiolepis*

Plants

Common Name	Scientific Name
Woodland strawberry	*Fragaria vesca*
Woolly marbles	*Psilocarphus* sp.
Woolly meadowfoam	*Limnanthes flocossa* ssp. *flocossa*
Yellow star-thistle	*Centaurea solstitialis*
Yellowcarpet	*Blennosperma nanum*

Animals

Common Name	Scientific Name
Insect	
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
Amphibians	
California newt	*Taricha torosa*
California slender salamander	*Batrachoseps attenuatus*
California red-legged frog	*Rana aurora draytoni*
Cascades frog	*Rana cascadae*
Foothill yellow-legged frog	*Rana boylii*
Sierra Nevada salamander	*Ensatina eschscholtzi*
Southern torrent (seep) salamander	*Rhyacotriton variegates (olympicus)*
Tailed frog	*Ascaphus truei*
Reptiles	
Common kingsnake	*Lampropeltis getulus*
Garter snake	*Thamnophis* sp.
Gopher snake	*Pituophis melanoleucus*
Northern alligator lizard	*Gerrhonotus coeruleus*
Northwestern pond turtle	*Clemmys marmorata marmorata*
Ring-necked snake	*Diadophis punctatis*
Southwestern pond turtle	*Clemmys marmorata pallida*
Western fence lizard	*Sceloporus occidentalis*
Western rattlesnake	*Crotalus viridis*
Birds	
Acorn woodpecker	*Melanerpes formicivorus*

Animals

Common Name	Scientific Name
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American dipper	*Cinclus mexicanus*
American kestrel	*Falco sparverius*
American peregrine falcon	*Falco peregrinus anatum*
American pipit	*Anthus rubescens*
American robin	*Turdus migratorius*
American wigeon	*Anas americana*
Anna's hummingbird	*Calypte anna*
Ash-throated flycatcher	*Myiarchis cinerascens*
Bald eagle	*Haliaeetus leucocephalus*
Band-tailed pigeon	*Columba fasciata*
Barn owl	*Tyto alba*
Barn swallow	*Hirundo rustica*
Belted kingfisher	*Ceryle alcyon*
Bewick's wren	*Thryomanes bewickii*
Black phoebe	*Sayornis nigricans*
Black swift	*Cypseloides niger*
Black-headed grosbeak	*Pheuticus melanocephalus*
Black-necked stilt	*Himantopus mexicanus*
Black-throated gray warbler	*Dendroica nigrescens*
Blue-gray gnatcatcher	*Polioptila caerulea*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown creeper	*Certhia americana*
Brown-headed cowbird	*Molothrus ater*
Bullock's oriole	*Icterus bullockii*
Bushtit	*Psaltriparus minimus*
California quail	*Callipepla californica*
California spotted owl	*Strix occidentalis occidentalis*
California thrasher	*Toxostoma redivivum*
California towhee	*Pipilo crissalis*
California yellow warbler	*Dendroica petechia brewsteri*

Animals

Common Name	Scientific Name
Cassin's vireo	*Vireo cassinii*
Chipping sparrow	*Spizella passerina*
Cinnamon teal	*Anas cyanoptera*
Common merganser	*Mergus merganser*
Common nighthawk	*Chordeiles minor*
Common poorwill	*Phalaenoptilus nuttallii*
Common raven	*Corvus corax*
Common snipe	*Gallinago gallinago*
Cooper's hawk	*Accipiter cooperi*
Dark-eyed junco	*Junco hyemalis*
Downy woodpecker	*Picoides pubescens*
Ferruginous hawk	*Buteo regalis*
Fox sparrow	*Passerella iliaca*
Gadwall	*Anas strepera*
Golden eagle	*Aquila chrysaetos*
Golden-crowned kinglet	*Regulus satrapa*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Great blue heron	*Ardea herodias*
Great egret	*Ardea alba*
Great horned owl	*Bubo virginianus*
Greater roadrunner	*Geococcyx californicus*
Greater yellowlegs	*Tringa melanoleuca*
Green heron	*Butorides virescens*
Green-winged teal	*Anas crecca*
Hairy woodpecker	*Picoides villosus*
Hermit thrush	*Catharus guttatus*
Hermit warbler	*Dendroica occidentalis*
Horned lark	*Eremophila alpestris*
House finch	*Carpodacus mexicanus*
House wren	*Troglodytes aedon*
Hutton's vireo	*Vireo huttoni*
Killdeer	*Charadrius vociferus*

Animals

Common Name	Scientific Name
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Lesser goldfinch	*Carduelis psaltria*
Little willow flycatcher	*Empidonax traillii brewsteri*
Loggerhead shrike	*Lanius ludovicianus*
Long-eared owl	*Asio otus*
Macgillivray's warbler	*Oporornis tolmiei*
Mallard	*Anas platyrhynchos*
Merlin	*Falco columbarius*
Mountain quail	*Oreortyx pictus*
Mourning dove	*Zenaida macroura*
Nashville warbler	*Vermivora ruficapilla*
Northern flicker	*Colaptes auratus*
Northern goshawk	*Accipiter gentilis*
Northern harrier	*Circus cyaneus*
Northern pygmy-owl	*Glaucidium gnoma*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Nuttall's woodpecker	*Picoides nuttallii*
Oak titmouse	*Baeolophus inornatus*
Olive-sided flycatcher	*Contopus cooperi*
Orange-crowned warbler	*Vermivora celata*
Osprey	*Pandion haliaetus*
Pacific-slope flycatcher	*Empidonax difficilis*
Phainopepla	*Phainopepla nitens*
Pied-billed grebe	*Podilymbus podiceps*
Pileated woodpecker	*Drycopus pileatus*
Pine siskin	*Carduelis pinus*
Prairie falcon	*Falco mexicanus*
Purple finch	*Carpodacus purpureus*
Purple martin	*Progne subis*
Red-breasted nuthatch	*Sitta canadensis*
Red-breasted sapsucker	*Sphyrapicus ruber*

Animals

Common Name	Scientific Name
Red-tailed hawk	*Buteo jamaicensis*
Ring-necked duck	*Aythya collaris*
Rough-legged hawk	*Buteo lagopus*
Rufous-crowned sparrow	*Aimophila ruficeps*
Savannah sparrow	*Passerculus sandwichensis*
Sharp-shinned hawk	*Accipiter striatus*
Song sparrow	*Melospiza melodia*
Spotted towhee	*Pipilo maculatus*
Steller's jay	*Cyanositta stelleri*
Swainson’s hawk	*Buteo swainsoni*
Tree swallow	*Tachycineta bicolor*
Turkey vulture	*Cathartes aura*
Vaux's swift	*Chaetura vauxi*
Vesper sparrow	*Pooecetes gramineus*
Violet-green swallow	*Tachycineta thalassina*
Warbling vireo	*Vireo gilvus*
Western bluebird	*Sialia mexicana*
Western burrowing owl	*Athene cunicularia hypugea*
Western kingbird	*Tyrannus verticalis*
Western meadowlark	*Sturnella neglecta*
Western screech owl	*Otus kennicottii*
Western scrub jay	*Aphelocoma californica*
Western tanager	*Piranga ludoviciana*
Western wood-pewee	*Contopus sordidulus*
White-breasted nuthatch	*Sitta carolinensis*
White-crowned sparrow	*Zonotrichia leucophrys*
White-tailed kite	*Elanus leucurus*
Willow flycatcher	*Empidonax traillii*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wood duck	*Aix sponsa*
Wrentit	*Chamaea fasciata*

Animals

Common Name	Scientific Name
Yellow warbler	*Dendroica petechia*
Yellow-breasted chat	*Icteria virens*
Mammals	
American badger	*Taxidae taxus*
Big brown bat	*Eptesicus fuscus*
Black-tailed deer	*Odocoileus hemionus*
Black-tailed hare	*Lepus californicus*
Bobcat	*Lynx rufus*
Brush rabbit	*Silvilagus bachmani*
California ground squirrel	*Spermophylla beecheyi*
Coyote	*Canis latrans*
Deer mouse	*Peromyscus maniculatus*
Dusky-footed woodrat	*Neotoma fuscipes*
Fringed myotis	*Myotis thysanodes*
Gray fox	*Urocyon cinereoargenteus*
Long-eared myotis	*Myotis evotis*
Long-legged myotis	*Myotis volans*
Northern flying squirrels	*Glaucomys sabrinus*
Pacific fisher	*Martes pennanti pacifica*
Pallid bat	*Antrozous pallidus*
Raccoon	*Procyon lotor*
Ringtail	*Bassariscus astutus*
Sierra Nevada Mountain beaver	*Aplodontia rufa*
Small-footed myotis	*Myotis ciliolabrum*
Spotted bat	*Euderma maculatum*
Striped skunk	*Mephitis mephitis*
Townsend’s big-eared bat	*Plecotus townsendii*
Western gray squirrel	*Sciurus griseus*
Yuma myotis	*Myotis yumanensis*

Appendix J
Special-Status Wildlife Descriptions

Appendix J
Special-Status Wildlife Descriptions

Wildlife surveys were performed in the Battle Creek Salmon and Steelhead Resotration Project (Restoration Project) area in 2000 and 2001. Detailed biological survey results are discussed in Volumes I and II of the *Biological Survey Summary Report for the Battle Creek Salmon and Steelhead Restoration Project* (Summary Report) (Jones & Stokes 2001a, 2001b). The following 13 special-status animals or their potential habitats were documented during field surveys:

- Valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*)
- Northwestern pond turtle (*Clemmys marmorata marmorata*)
- Foothill yellow-legged frog (*Rana boylii*)
- Osprey (*Pandion haliaetus*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Sharp-shinned hawk (*Accipiter striatus*)
- Cooper's hawk (*Accipter cooperii*)
- Golden eagle (*Aquila chrysaetos*)
- American peregrine falcon (*Falco peregrinus anatum*)
- California spotted owl (*Strix occidentalis occidentalis*)
- Vaux's swift (*Chaetura vauxi*)
- Willow flycatcher (*Empidonax traillii*)
- Yellow-breasted chat (*Icteria virens*)

The legal status for each species is provided in Table J-1. The occurrences of special-status wildlife documented during field surveys are recorded in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b) and their locations are shown in Maps WL-1 through WL-9 in Volume II of the Summary Report (Jones & Stokes 2001b). A description of each special-status species follows, with information on its legal status, distribution, habitat association, reasons for decline, and occurrence in the Restoration Project area.

Table J-1. Special-Status Wildlife Species Detected in the Restoration Project Area

Common Name	Scientific Name	Legal Status
Listed Species		
Valley elderberry longhorn beetle[1]	*Desmocerus californicus dimorphus*	Federally listed threatened species
Bald eagle	*Haliaeetus leucocephalus*	Federally listed threatened species State-listed endangered species
American peregrine falcon	*Falco peregrinus anatum*	State fully protected
Willow flycatcher (nesting)	*Empidonax traillii*	State-listed endangered species (all subspecies)
Little willow flycatcher	*Empidonax traillii brewsteri*	Federal species of concern
Sensitive Species and Species of Special Concern		
Amphibians and Reptiles		
Foothill yellow-legged frog	*Rana boylii*	Federal species of concern, State species of special concern
Northwestern pond turtle	*Clemmys marmorata marmorata*	Federal species of concern; State species of special concern
Birds		
Osprey[2]	*Pandion haliaetus*	State species of special concern
Sharp-shinned hawk[2]	*Accipiter striatus*	State species of special concern
Cooper's hawk[2]	*Accipiter cooperii*	State species of special concern
Golden eagle	*Aquila chrysaetos*	State species of special concern State fully protected
California spotted owl	*Strix occidentalis occidentalis*	Federal species of concern, State species of special concern
Vaux's swift	*Chaetura vauxi*	State species of special concern
Yellow-breasted chat	*Icteria virens*	State species of special concern
Bats[3]		
Fringed myotis	*Myotis thysanodes*	Federal species of concern
Long-eared myotis	*Myotis evotis*	Federal species of concern
Small-footed myotis	*Myotis ciliolabrum*	Federal species of concern
Long-legged myotis	*Myotis volans*	Federal species of concern
Yuma myotis	*Myotis yumanensis*	Federal species of concern

Common Name	Scientific Name	Legal Status
Pallid bat	*Antrozous pallidus*	State species of special concern
Townsend's big-eared bat	*Plecotus townsendii*	Federal species of concern State species of special concern

[1] The valley elderberry longhorn beetle is Federally listed as threatened. Although the species was not observed, blue elderberry shrubs that provide potential habitat for the beetle were identified during the field investigations.

[2] This species is not considered to be a state species of special concern in the Draft List of California Bird Species of Special Concern (CDFG and Point Reyes Bird Observatory 2001). This list is currently under review by the California Department of Fish and Game and the Point Reyes Bird Observatory Advisory Committee.

[3] Many unidentified bats were seen at dusk during the wildlife surveys. The species listed here could potentially occur in the Restoration Project area.

Valley Elderberry Longhorn Beetle

Legal Status

The VELB is Federally listed as threatened (45 FR 52803, August 8, 1980); it is not listed by the state. The U.S. Fish and Wildlife Service (USFWS) developed a recovery plan in 1984 (U.S. Fish and Wildlife Service 1984a) with the interim objectives of protecting three known localities, surveying riparian areas in the Central Valley to detect other VELB populations, and protecting the riparian habitats within the VELB's historical distribution. As more information becomes available, USFWS will determine the number of sites and populations of VELB required before it considers delisting the species (U.S. Fish and Wildlife Service 1984a).

Description

The VELB is a medium-sized beetle (0.8 inch long) in the long-horned wood-boring family Cerambycidae. The Latin term *dimorphus* in the beetle's scientific name (*Desmocerus californicus dimorphus*) refers to differences in appearance by gender. The forewings of the female are dark metallic green with red margins, whereas those of the male are primarily red with dark green spots.

The VELB's life history characteristics are assumed to follow a sequence of events similar to those of related taxa (U.S. Fish and Wildlife Service 1984a). Females deposit eggs in crevices in the bark of living blue elderberry shrubs, primarily in valley foothill riparian habitats. Presumably, the eggs hatch shortly after they are laid and larvae bore into the pith of the trunk or stem. When larvae are ready to pupate, they work their way through the pith of the shrub, open an emergence hole through the bark, and return to the pith for pupation. Adults exit through the emergence holes and can be found on elderberry foliage, flowers, or stems or on adjacent vegetation. The entire life cycle of the VELB is thought to take two years from the time eggs are laid and hatch until adults emerge and die (U.S. Fish and Wildlife Service 1984a).

The presence of exit holes in blue elderberry stems is an indication of previous VELB use. The distinctive oval exit holes are approximately 0.25 inch in diameter and can be found from a few inches above the ground to about 10 feet up on stems ranging from 1 to 8 inches in diameter (Barr 1991).

Distribution

Information on the historical distribution and abundance of VELB is scarce. The VELB may have always been a rare species; however, the substantial reduction in Central Valley riparian vegetation in the past 100 years probably has further reduced the beetle's range and isolated the remaining populations (U.S. Fish and Wildlife Service 1984a).

In 1984, the VELB was known to occur in only three Central Valley drainages: the Merced River, Putah Creek, and the American River (U.S. Fish and Wildlife Service 1984a). However, additional field surveys in subsequent years detected new locations of VELB along the Yuba, American, Cosumnes, Sacramento, Mokelumne, Calaveras, San Joaquin, Tuolumne, Stanislaus, and Merced Rivers (Barr 1991).

The current range of the VELB extends from the northern end of the Central Valley at Redding to the Bakersfield area. In the foothills of the Sierra Nevada, adult beetles have been found in elevations up to 2,220 feet and exit holes in elevations up to 2,940 feet. Along the Coast Ranges, adult beetles have been found up to 500 feet elevation, and exit holes have been detected up to 730 feet elevation (Barr 1991).

Habitat Association

The beetle's entire life cycle is associated with blue elderberry shrubs in creeks and riparian areas connected to California's Central Valley and in the surrounding foothills up to 3,000 feet in elevation in the east and the entire watershed to the west (U.S. Fish and Wildlife Service 1984a).

Reasons for Decline

Although its historical distribution is unknown, the extensive loss of riparian forests in the Central Valley during the past 100 years probably resulted in a decrease and fragmentation of the VELB's range (U.S. Fish and Wildlife Service 1984a; Barr 1991). Insecticide from cultivated fields and orchards adjacent to blue elderberry shrubs could affect VELB populations if it drifts when adults are present on the shrubs (Barr 1991). Herbicide drift from agricultural fields and orchards could also negatively affect blue elderberry shrubs and reduce VELB habitat.

Occurrence in the Restoration Project Area

There are no known VELB occurrences in the Restoration Project area, and no VELB were observed during field surveys; however, numerous elderberry plants that provide habitat for the beetle were found during field surveys. Many had stems greater than 1 inch diameter, which could provide habitat for the larval stage. Wherever possible, stems were surveyed for exit holes. A few stems with *possible* VELB exit holes were found in two separate large clusters of elderberry bushes located on the South Powerhouse alternative access road. However, the holes were old, and it cannot be determined whether they were made by emerging VELB; other wood-boring insects and woodpeckers could make similar-sized holes. Information on each elderberry occurrence and the presence or absence of exit holes in stems is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b).

Northwestern Pond Turtle

Legal Status

The northwestern pond turtle is designated as a species of concern by Region 1 of the USFWS and as a species of special concern by the California Department of Fish and Game (CDFG). The species currently receives no statutory protection under the California Endangered Species Act (CESA) (Fish and Game Code §§2050-2068) or the Federal Endangered Species Act (ESA) (16 USC 1531-1544).

Description

The northwestern pond turtle is an aquatic turtle of medium size (up to 7 inches long). It is the only native turtle in northern California and is unlikely to be misidentified. The carapace is olive brown to blackish, often with darker spots or lines radiating out from the centers of the shields on the plastron. The newly hatched young are 1 inch long, with the tail nearly as long as the shell. These turtles are dietary generalists that feed primarily on small aquatic invertebrates, such as crustaceans and insects, but they also will feed on carrion. Frogs, small fish, and ducklings have been reported prey items, but it is unknown if they were captured while alive or taken as carrion (Holland 1994).

Distribution

The northwestern pond turtle is endemic to the Pacific Northwest. Two subspecies of western pond turtle are currently recognized, the northwestern and southwestern pond turtles. The former is found in northern California from the Oregon border south to the American River and the latter in the coastal areas south of San Francisco. The two subspecies intergrade in the Central and San Joaquin Valleys, but not within the Restoration Project area. It has been suggested that a third undescribed subspecies occurs near the Columbia River Gorge and that the three forms may actually represent different species (Holland 1994). Genetic studies are currently under way to resolve this question.

Movements of up to 3 miles across terrestrial habitats have been documented in all size classes of northwestern pond turtles. Reasons for such movements are generally unknown, but the movements may be responses to environmental stress, such as drought, or regular movements among a series of ponds (Holland 1994). Male and female home ranges have been estimated at approximately 2.5 and 0.6 acre, respectively (Bury 1972).

Habitat Association

The northwestern pond turtle inhabits a wide range of freshwater or brackish rivers, streams, lakes, ponds, and permanent or ephemeral wetlands and is often seen basking on logs, rocks, and mud banks. The species typically occurs in slow-moving streams, pools, and ponds. In most cases, emergent basking sites, such as rocks, logs, or vegetation, are present. Although northwestern pond turtles are occasionally observed in reservoirs, abandoned gravel pits, stock ponds, and sewage treatment plants, most such sightings are of displaced individuals and do not represent viable populations (Holland 1994; Jennings and Hayes 1994).

The species typically nests on gentle slopes in compact soils with a large proportion of silt or clay. Vegetation is usually sparse and consists of grass or forbs. Nests can be from about 10 feet to more than 1,300 feet away from aquatic habitats (Holland 1994). Rathbun et al. (1992) recommended a 1,600-foot buffer zone around aquatic habitats to protect nesting habitat.

The characteristics of overwintering habitat and terrestrial habitats used at other times of the year are highly variable. The presence of a duff layer seems to be a general characteristic of such habitats. The species sometimes overwinters in aquatic environments, such as on mud bottoms, beneath undercut banks or logs, or in areas of emergent vegetation. Movement between overwintering sites does occur, and turtles have been observed swimming under ice in water with temperatures as low as 34ºF (Holland 1994).

Northwestern pond turtles may be either largely inactive during the winter or active throughout the year, depending on location and environmental conditions.

In some areas, turtles overwinter communally in either aquatic or terrestrial sites. Terrestrial overwintering sites may be up to about 1,600 feet from aquatic habitats and usually consist of burrows in leaf litter or soil (Holland 1994; Jennings and Hayes 1994).

Reasons for Decline

Holland (1994) estimated a 96 percent to 98 percent decline in northwestern pond turtle populations in Oregon, but specific causes were not identified. Habitat destruction from agricultural activities, urbanization, and flood control and water diversion projects are considered primary causes of population decline (Jennings et al. 1992). Jennings and Hayes (1994) hypothesized that observed changes in age-class distribution suggest a lack of recruitment that may indicate that the destruction of nesting habitat is a significant factor in declines. They identified agricultural or livestock activity as probable causes. However, introduced exotic fish and bullfrogs that prey on young turtles may also be causing decreases in recruitment. In addition, disease and mortality from ingestion of baited hooks could be contributing factors. Although logging activities can affect the quality of aquatic habitats, no evidence exists to suggest that timber harvesting has contributed to regional or statewide population declines.

Occurrence in the Restoration Project Area

One adult was found in Ripley Creek, just upstream of the Lower Ripley Creek Feeder Dam. The turtles are likely to occur elsewhere in both forks of Battle Creek, but no turtles were found during field surveys. Information on this single observation and its potential for occurrence elsewhere in the Restoration Project area is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b).

Foothill Yellow-Legged Frog

Legal Status

The foothill yellow-legged frog has been designated as a California species of special concern by the CDFG and as a Federal species of concern. The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

The foothill yellow-legged frog is easily distinguished from the rare, Federally listed red-legged frog by the color of its legs. The foothill yellow-legged frog rarely gives its guttural croaking mating call so, unlike the common bullfrog and tree frogs, it is usually not found by its voice. This frog breeds after the winter river levels have dropped in mid-March to May. It can be distinguished from the mountain yellow-legged frog by its snout, which has a triangular buff-colored patch, and the absence of a dark mask.

Distribution

The foothill yellow-legged frog historically occurred in most Pacific drainages from the Oregon border to the San Gabriel River drainage in Los Angeles County (Jennings and Hayes 1994). Its current distribution is the Coast Ranges and the Transverse Mountains in Los Angeles County. This species is also found along the western side of the Sierra Nevada and in most of northern California west of the Cascade crest (Zeiner et al. 1988).

Habitat Association

Habitat requirements for the foothill yellow-legged frog include shallow, flowing streams with at least cobble-sized substrate. It is believed that this substrate provides necessary refuge for larval and juvenile stages (Jennings and Hayes 1994). In the warmer part of this species' range, individuals may remain active year-round; in colder areas, individuals may become inactive or hibernate (Zeiner et al. 1988).

Reasons for Decline

Introduced predatory aquatic species such as fish and bullfrogs, poorly timed water releases from reservoirs, and decreased water flows that have forced adults to move into permanent pools where they are more susceptible to predation have contributed to the decline of this species throughout much of its range (Jennings and Hayes 1994).

Occurrence in the Restoration Project Area

Adult foothill yellow-legged frogs were found at the Lower Ripley Creek Feeder Dam and the Soap Creek Feeder. Juveniles were found at South Powerhouse, South Diversion Dam, and in the Soap Creek Feeder, and many tadpoles were found in the creek adjacent to the South Powerhouse. Information on each foothill yellow-legged frog observation is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b).

Osprey

Legal Status

The osprey is a California species of special concern. This species is not considered to be a state species of special concern in the *Draft List of California Bird Species of Special Concern* (CDFG and Point Reyes Bird Observatory 2001), which is currently under review by the CDFG and the Point Reyes Bird Observatory Advisory Committee. The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

The osprey is a very large raptor with bowed and angled wings in flight that give it a characteristic profile. Ospreys are largely white below and brown above. They often perch prominently close to water bodies. The osprey is not closely related to any other raptor and is placed in its own subfamily.

Distribution

In the western hemisphere, ospreys breed in the United States, Canada, and Mexico. While a portion of their population migrates to spend the winter in Mexico south to the Amazon Basin, some birds winter in California, especially along the coast. Often seen during migration soaring at great heights, ospreys are widely distributed throughout most of the world.

Historically, ospreys bred along the entire length of California, with population centers along the north inxterior, Channel Islands, and north, central, and south coasts (Grinnell 1915). Within this range, the distribution was spotty, as evidenced by the rarity of ospreys in the San Francisco Bay area (Grinnell and Wythe 1927). By the 1940s, Grinnell and Miller (1944) reported declines and range contraction, particularly in the southern half of the state, including the Channel Islands and the central and south coasts, and along the Sacramento and San Joaquin Rivers.

Currently, the osprey breeds in northern California from the Cascade Range south to Lake Tahoe and along the north coast south to Marin County. Regular breeding sites include Shasta Lake, Eagle Lake, Lake Almanor, Lake Oroville, New Bullards Bar Reservoir, Camanche Reservoir, other inland lakes and reservoirs, and river systems (e.g., the Pit River, Sacramento River, Yuba River, and Cache Creek) (Zeiner et al. 1990b). Ospreys winter in small numbers along the entire coast and large inland bodies of water, such as the Feather River, Putah and Cache Creeks, American River, Camanche Reservoir, Turlock Reservoir, New Melones Reservoir, and Lake San Antonio (Roberson 1985).

Habitat Association

The osprey is associated strictly with large, fish-bearing waters primarily in ponderosa pine and mixed conifer habitats. Nests are platforms of sticks constructed on the top of large snags, in dead-topped trees, on cliffs, or on human-made structures in open forest habitats. The location of nests requires tall, open-branched “pilot trees” nearby where the osprey can land before approaching the nest and where young osprey can practice flying. The osprey preys mainly on fish and, therefore, requires open waters for foraging (Zeiner et al. 1990b).

Reasons for Decline

Factors leading to the decline of osprey populations include pesticide contamination, nest-tree removal, degradation of the environmental quality of rivers and lakes, boating and other human disturbances in nesting areas, and illegal shooting (Henny et al. 1978). Osprey populations declined through the 1960s, especially in the eastern United States, because of eggshell thinning caused by pesticide contamination (Henny and Ogden 1970), which led to reproductive failure (Garber 1972); however, reproductive success has increased since the early 1970s (Airola and Shubert 1981).

Occurrence in the Restoration Project Area

One active osprey nest was found in the 2000 breeding season in a large ponderosa pine on the south bank of the South Fork Battle Creek approximately 1.3 miles downstream of the South Diversion Dam and 0.7 mile north of the access road. This nest was not active in 2001, and no breeding ospreys were observed that year. One osprey was observed foraging along South Fork Battle Creek. Information on both osprey observations is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b).

Bald Eagle

Legal Status

The bald eagle is federally listed as threatened and state listed as endangered and is protected under the federal Bald and Golden Eagle Protection Act (16 USC 668-668d).

Description

The sharp contrast between the adult bald eagle's distinctive white-feathered head and tail and its dark brown body and wings make this species clearly identifiable. The heads and tails of younger birds are mostly brown, and these birds are often mistaken for golden eagles. When fully grown, bald eagles measure 2.5 to 3.5 feet long, with a wingspan of more than 6.5 feet. Females typically are larger than males. Bald eagles tend to be more vocal than most raptors and emit a variety of high-pitched calls (Thelander 1994).

Distribution

Bald eagles winter throughout most of California at lakes, reservoirs, river systems, and some rangelands and coastal wetlands (Zeiner et al. 1990b). Almost half of the state's population winters in the Klamath Basin, but this species is also an uncommon visitor to the Central Valley. The breeding range of bald eagles is primarily in mountainous habitats near reservoirs, lakes, and rivers in the northwest corner of the state (California Department of Fish and Game 1989). Fish constitute most of the bald eagle's diet, but wintering birds frequent Central Valley wetlands in search of dead and dying waterfowl and other water birds.

Habitat Association

Bald eagle nesting territories are associated primarily with young or mature forests of varying canopy closure of ponderosa and mixed conifer types, but can be found in all forest types from blue oak savanna to lodgepole pine types (Verner and Boss 1980). Bald eagles usually nest in overstory ponderosa or sugar pine with foliage shading the nests, within 0.5 mile of a large body of water and with low human disturbance (Verner and Boss 1980). Total canopy closure in stands that support bald eagle nests is usually less than 40 percent (Verner and Boss 1980).

Reasons for Decline

Historically, bald eagle populations have declined as a result of eggshell-thinning from the ingestion of dichlorodiphenyltrichloroethane (DDT), shooting, and disturbance of nest sites. However, because of their protection under the CESA, the Federal ESA, and the Bald and Golden Eagle Protection Act, their populations have recovered across most of North America and they may soon be delisted from the Federal list.

Occurrence in the Restoration Project Area

Bald eagles hunt for fish within the Restoration Project area; however, no active or inactive nest sites were identified. Bald eagles likely nest outside the Restoration Project area. Adults were seen flying high over both forks of Battle Creek on several occasions during the spring field surveys. An adult bald eagle was observed flying over the Eagle Canyon Diversion Dam site in mid-June 2000, and in mid-April 2001, an adult was seen flying high about 1 mile east of Wildcat Diversion Dam. An immature bald eagle was observed at Coleman Diversion Dam in mid-June 2000. Information on the adult bald eagle observations is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b).

Sharp-Shinned Hawk

Legal Status

The sharp-shinned hawk is designated as a species of special concern by the CDFG. This species is not considered to be a state species of special concern in the *Draft List of California Bird Species of Special Concern* (California Department of Fish and Game and Point Reyes Bird Observatory 2001), which is currently under review by the CDFG and the Point Reyes Bird Observatory Advisory Committee. The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

The sharp-shinned hawk is the smallest North American member of the genus *Accipiter*, a group of forest-dwelling hawks with short, rounded wings and a long tail that enables them to maneuver in forested habitat. Of the three species of *Accipiter* in North America, the sharp-shinned hawk is the most specialized in hunting avian prey; birds commonly make up more than 90 percent of the sharp-shinned hawk's diet during the breeding season (Johnsgard 1990). They can be distinguished from the larger Cooper's hawk by their straight rather than rounded tail tips, their short undertail coverts, and their smaller heads and shorter necks.

Distribution

Found throughout North America, sharp-shinned hawks nest primarily in heavily forested locations with little human disturbance. In California, nest sites are found almost exclusively in forests in the northern Coast Ranges, the Sierra Nevada, and the Cascades. In California, they are rare breeders, primarily in the conifer forests of the Sierra Nevada, the coastal forests of northern California

(Verner and Boss 1980), and, in small numbers, the mountain ranges of southern California (Garrett and Dunn 1981). During migration periods and in the winter, however, they are fairly common in most habitats (Grinnell and Miller 1944).

Habitat Association

Sharp-shinned hawks typically nest in montane settings with dense, relatively young, even-aged conifer stands or deciduous riparian habitats (Reynolds et al. 1982; Moore and Henny 1983; Johnsgard 1990). Nests are usually situated on moderately steep, north-facing slopes near water in stands with a high foliage density and often near forest openings or edges (Reynolds et al. 1982; Johnsgard 1990). Estimates of breeding season home ranges vary from 150 to 1,000 acres (Johnsgard 1990). Reynolds et al. (1982) recommended retaining 9-acre buffer zones around active nests, an area large enough to encompass nearby prey-plucking posts. During migration, sharp-shinned hawks can be found in all habitats, but during the winter, they are most frequently found in a variety of forest types, riparian woodlands, and suburban areas with an abundance of prey (small passerine birds).

Reasons for Decline

Sharp-shinned hawks may have never been abundant in California during the breeding season (Grinnell and Miller 1944; Remsen 1978). A possible decline noted in California during the DDT era (Remsen 1978) coincided with declines in eastern populations and probably was attributable to DDT and other pesticides (Bednarz et al. 1990). However, the population status in California is unknown. Timber harvesting has also been suggested as a potential threat to the species population (Remsen 1978).

Occurrence in the Restoration Project Area

Several individuals were seen during spring and fall migration (April and September) at various locations along access roads and Restoration Project sites. Their specific occurrence during migration is unpredictable but is often tied to local, ephemeral concentrations of prey (small passerine birds). No individuals were observed during the breeding season (June and July); therefore, they are not likely to nest in the Restoration Project area. Information on each sharp-shinned hawk observation has not been presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b) because the individuals observed on access roads and Restoration Project sites were spring and fall migrants and were not nesting in the Restoration Project area.

Cooper's Hawk

Legal Status

The Cooper's hawk is designated as a state species of special concern by the CDFG. This species is not considered to be a state species of special concern in the *Draft List of California Bird Species of Special Concern* (California Department of Fish and Game and Point Reyes Bird Observatory 2001), which is currently under review by the CDFG and the Point Reyes Bird Observatory Advisory Committee. The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

This medium-sized *Accipiter* is larger than the sharp-shinned hawk. Its rounded tail, longer undertail coverts, and larger head and neck help in its identification. Cooper's hawks are smaller than northern goshawks, and adults are easily identified by the reddish barring on their underparts and their lack of a white eye stripe. Immature Cooper's hawks are much more similar to northern goshawks, but often have straight, even white barring on the tail and are smaller and not as broad-winged. Cooper's hawks can be found in a variety of habitats and elevations; however, they are not as closely tied to montane coniferous forests as are sharp-shinned hawks or northern goshawks.

Distribution

The historical range of the Cooper's hawk is similar to its current range, although the species is less common in the Central Valley than it was historically. Cooper's hawks are found throughout most of the United States, southern Canada, and northern Mexico. Northern populations are said to be migratory and southern populations, resident; however, some southern populations apparently migrate as well (Rosenfield and Bielefeldt 1993). Cooper's hawks breed throughout most of California in a variety of woodland habitats (Grinnell and Miller 1944; Garrett and Dunn 1981). They are uncommon breeders in much of California; the highest densities probably occur in the foothill oak woodlands of the Sierra Nevada and Transverse Ranges (Asay 1987). Cooper's hawks are found in greater numbers during migration and winter, when they can be found in all habitats throughout California (Grinnell and Miller 1944).

Habitat Association

The Cooper's hawk nests in deciduous, conifer, and mixed woodlands (Garrett and Dunn 1981), but will also nest in urban areas and seems to tolerate human disturbance near the nest (Palmer 1988). The hawks nest and forage near open water or riparian vegetation. Prey comprises small birds, a variety of small mammals, reptiles, and amphibians (Zeiner et al. 1990b). The species usually breeds after two years (Rosenfield 1982; Henny et al. 1985; Asay 1987), and pairs generally return to the same territory year after year and will often build a new nest in the vicinity of the existing one (Reynolds and Wright 1978).

Reasons for Decline

The decline of eastern United States populations of Cooper's hawk is attributed to pesticide contamination. Declines in the West are less documented, but in California, they have been attributed to destruction of habitat, particularly of lowland riparian areas (Remsen 1978). Pesticides may also play a role in declines in western populations.

Occurrence in the Restoration Project Area

An immature Cooper's hawk was seen during field surveys performed in July 2000 and was probably dispersing from its natal territory. An adult Cooper's hawk was seen in April 2001 on the road to South Diversion Dam and was probably a migrating bird not breeding locally. Information on these Cooper's hawk observations have not been presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b) because neither is considered to signify breeding within the Restoration Project area.

Golden Eagle

Legal Status

The golden eagle is designated as a species of special concern by the CDFG, is a fully protected species under the California Fish and Game Code, and is protected under the federal Bald and Golden Eagle Protection Act (16 USC 668-668d).

Description

One of the largest raptors in North America, the golden eagle is named for the golden crown and nape found on the adults. Immature golden eagles can be distinguished from immature bald eagles by their smaller bill and the fact that they are white only on the bases of their primaries and tail feathers.

Distribution

Golden eagles are found throughout western North America, and a few migrate through and winter in parts of the eastern United States. The golden eagle is a permanent resident throughout California, except in the center of the Central Valley, although it winters in this area (Zeiner et al. 1990b). Golden eagle populations have declined near human population centers, but overall its population appears stable (Remsen 1978).

Habitat Association

Golden eagles are closely tied to open range, including blue oak savanna. This species avoids dense coastal and montane coniferous forests (Small 1994). It breeds from late January through August, peaking from March though July. Nests are most frequently placed on cliff ledges, but may be placed on trees large enough to support their weight. Golden eagles often maintain alternative nest sites and old nests are often reused (Zeiner et al. 1990b). The golden eagle needs open areas for hunting. Its diet consists mostly of rabbits and rodents, but also includes other mammals, reptiles, birds, and some carrion (Zeiner et al. 1990b).

Reasons for Decline

Golden eagles have declined as a result of shooting, poisoning, and disturbance of nest sites (Remsen 1978).

Occurrence in the Restoration Project Area

Golden eagles were seen flying overhead at North Battle Creek Feeder Dam and the South Powerhouse. An immature bird was seen perched on a ledge in the headwaters of Soap Creek above the South Diversion Dam access road. Old, unoccupied nests were found at the headwaters of Soap Creek Feeder and at the South Powerhouse. The eagles sighted may have nested in the region, but because their home range is very large, observations of pairs of golden eagles at a site do not necessarily indicate local nesting. Information on each golden eagle observation is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b). In mid-April 2001, one adult golden eagle was seen circling very high over North Battle Creek, and two birds were observed in courtship display over crags at South Diversion Dam.

American Peregrine Falcon

Legal Status

The American peregrine falcon is state-listed as endangered under the CESA and is currently fully protected under the California Fish and Game Code. The peregrine falcon was formerly listed as Federally endangered, but the population has recently recovered to the extent that it was delisted in August 1999 (64 FR 46541-46558, August 25, 1999).

Description

A large and powerful predator, the peregrine falcon is the fastest bird in North America, capable of reaching speeds up to 200 mph in a dive. The adult male is blue-gray on the back, with a streaked breast. The crown and nape are black, with a black wedge that extends below the eyes, forming a distinctive helmeted appearance.

Distribution

Historically, resident American peregrine falcons occurred throughout most of California (California Department of Fish and Game 1980; U.S. Fish and Wildlife Service 1982). The population increased during winter, when migrating birds arrived from the north. Peregrine falcons nested throughout the state, with breeding pairs concentrated along the coast and around the Channel Islands. Interior nesting locations included Tule Lake in Siskiyou County, Mono Lake in Mono County, and the inner Coast Ranges in Kern County (Grinnell and Miller 1944). The population of California peregrine falcons began to seriously decline in the 1950s. Based on a conservative historical estimate, there were 100 pairs breeding in California before 1947. By 1969, fewer than 10 nesting sites were believed to be active (Herman et al. 1970). In 1970, only two nesting pairs were confirmed, with probably fewer than five nesting pairs statewide (Herman 1971). In 1992, there were approximately 140 breeding pairs of American peregrine falcons in California, primarily in mountains of the central and northern Coast Ranges and the Cascade Range (California Department of Fish and Game 1997).

Habitat Association

American peregrine falcons nest on protected ledges of high cliffs, primarily in woodland, forest, and coastal habitats (California Department of Fish and Game 1980; U.S. Fish and Wildlife Service 1982). They have been known to nest at elevations as high as 10,000 feet, but most occupied nest sites are below 4,000 feet (Shimamoto and Airola 1981). Falcons prefer to nest near marshes, lakes, and rivers that support an abundance of birds, but they may travel several miles from their nesting grounds to forage on pigeons, shorebirds, waterfowl, and songbirds (Grinnell and Miller 1944; California Department of Fish and Game 1980). Coastal and inland marsh habitats are especially important in fall and winter, when they attract large concentrations of water birds (California Department of Fish and Game 1980).

Reasons for Decline

The widespread use of organochloride pesticides, especially DDT, was a primary cause of the decline in peregrine falcon populations (U.S. Fish and Wildlife Service 1982). High levels of these pesticides and their metabolites (i.e., by-products of organic decompositions) have been found in the tissues of peregrine falcons, leading to thin eggshells, aberrant reproductive behavior, and reproductive failure. Other causes of decline include illegal shooting, illegal falconry activities, and habitat destruction (California Department of Fish and Game 1980).

Occurrence in the Restoration Project Area

One adult peregrine falcon was observed circling high over the road at South Diversion Dam during raptor surveys on April 13, 2001.

California Spotted Owl

Legal Status

The California spotted owl is a Federal and state species of special concern. On October 12, 2000, the California spotted owl was proposed to be Federally listed as a threatened species (65 FR 60605–60607). However, until the USFWS makes the proposed listing final, the California spotted owl is still considered a Federal species of concern and a state species of special concern. Because the California spotted owl is proposed as a Federally listed threatened species, the USFWS requires that it be treated as a listed species by other Federal agencies. The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

The spotted owl is a large nocturnal bird, overall brown in color, with irregular white spots on the back, head, and underparts. It is smaller than the great horned owl, lacks ear tufts, and has dark brown eyes. The closely related barred owl is slightly larger, with horizontal bars across the chest instead of spots. The California spotted owl is one of three subspecies of the spotted owl (American Ornithologists' Union 1957) and is paler in color with larger spots than the similar, federally threatened northern spotted owl, which also occurs in California. Females typically are larger than males. Spotted owls are vocal; both male and female frequently utter a distinctive four-note call during the breeding season.

Distribution

California spotted owls occur on the western side of the Sierra Nevada from the southern Cascade Range south to Kern County, in the southern part of the Coast Range, and in mountain ranges of southern California south to Baja California (Gutiérrez et al. 1995; Verner et al. 1992b).

Habitat Association

The California spotted owl occurs in coniferous, hardwood, and mixed forests and is strongly associated with forests that have complex, multilayered structure, large-diameter trees, and high canopy closure (Bias and Gutiérrez 1992; Gutiérrez et al. 1995). Nests are placed in tree cavities or abandoned nests of other animals within areas of dense old-growth forest with more than 75 percent canopy closure (Bias and Gutiérrez 1992). Roosting sites have similar characteristics. California spotted owls forage in a wider variety of forest types, including more open forests with canopy cover as low as 40 percent (Verner et al. 1992b). In the Sierra Nevada, spotted owls prey largely on northern flying squirrels and dusky-footed woodrats, but a variety of other prey items are taken, including birds, mammals, insects, and reptiles.

Reasons for Decline

The status of the Sierra Nevada population of the California spotted owl is uncertain. Although short-term declines have been reported, data are lacking to demonstrate long-term population trends (Verner et al. 1992b). Key habitat requirements are declining as a result of logging, particularly the selective removal of large-diameter conifers (Verner et al. 1992a). In southern California, habitat for the spotted owls is decreasing because of urban expansion, rural development, and increasing water extraction, and owl populations are declining (LaHaye et al. 1992; Verner et al. 1992a).

Occurrence in the Restoration Project Area

Suitable nesting and roosting habitat occurs in dense forest with large trees on lower canyon slopes, and suitable foraging habitat occurs more widely throughout the Restoration Project area. The California spotted owl is not known to breed within the Restoration Project area, and to date, no California spotted owls have been observed within the Restoration Project area. Surveys in the 2001 breeding season are the first year of a two-year survey following the USFWS-endorsed *Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls* (U.S. Fish and Wildlife Service 1992). According to USFWS representatives, the survey protocol for the California spotted owl will be similar to the survey protocol for northern spotted owl.

Vaux's Swift

Legal Status

Vaux's swift is designated as a species of special concern by the CDFG (Remsen 1978). The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

Vaux's swift is a migratory, insectivorous bird that nests and roosts in large hollow trees and snags. As with other swifts, this species forages in the air over forest canopy, grasslands, and water. Vaux's swift can be readily distinguished from the larger white-throated swift by its lack of obvious white on the throat and flanks and from the larger black swift by its squared-off tail, pale brown throat and rump, and narrower wings. Vaux's swift can be readily distinguished from the many species of swallows by its overall dark brown plumage, cigar-shaped body, and twittering wing beats.

Distribution

In California, the species occurs during the breeding season primarily in the narrow redwood-forested coastal zone from the Oregon border south to Santa Cruz County. The species also occurs across the northern portion of the state and in the Sierra Nevada, although apparently at much lower densities (Bull and Collins 1993; Sterling and Paton 1996).

Habitat Association

In California, Vaux's swifts appear to prefer redwood and Douglas fir forest types (Sterling and Paton 1996), constructing their nests in large hollow trees and snags and burned-out hollows (Bull and Cooper 1991; Bull and Collins 1993). Several investigators have reported an association between the presence of Vaux's swift and old- growth forests (Manuwal and Huff 1987; Lundquist and Mariani 1991; Bull and Hohmann 1993; Sterling and Paton 1996). However, age and structural characteristics of forest stands may not in themselves be as critical to swifts (Bull 1991) as the need for suitable nest and roost trees. Nest and roost trees are more likely to occur in old-growth forests because of the large size and decay conditions of the trees (Bull and Hohmann 1993; Bull and Collins 1993).

Nest trees tend to be large, averaging 32 inches in diameter at breast height in one study (Bull and Hohmann 1993). However, Bull and Hohmann (1993) also reported limited use of residual snags in second-growth forests, and Dawson (1923) and others (cited in Sterling and Paton 1996) described nests in residual snags in old burns and clear-cuts. These findings suggest that retained hollowed trees and snags could continue to provide habitat in regeneration areas. Lundquist and Mariani (1991) recommend retention of snags greater than 30 inches in diameter at breast height. Vaux's swifts forage on insects and spiders, usually above the canopy, water, and grasslands, but may also take prey near branches inside the canopy (Bull and Collins 1993).

Reasons for Decline

Populations of Vaux's swift declined in Oregon and Washington during the 1980s (the percentages of annual change were –8 percent in Oregon and –11 percent in Washington) (Bull and Collins 1993). Corresponding data for California are lacking (Sterling and Paton 1996). The removal of large snags and hollow trees generally associated with late seral-stage forests probably has contributed to population declines (Bull and Collins 1993).

Occurrence in the Restoration Project Area

An individual was sighted flying over blue oak savanna just outside the Restoration Project area on June 13, 2000, and a pair was observed at the Lower Ripley Creek Feeder on July 25, 2000. Although the nest location is unknown, these birds are probably nesting in a large snag somewhere in the canyon of either South Fork or North Fork Battle Creek at a higher elevation outside the Restoration Project area. Information on Vaux's swift has not been provided in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b) because it is not known to nest in the Restoration Project area or at the elevation and habitat in California where the swift was observed (Sterling and Paton 1996). Furthermore, the pair of Vaux's swift observed at the Lower Ripley Creek Feeder in late July 2000 is best interpreted as birds dispersing from their breeding territory.

Willow Flycatcher

Legal Status

The willow flycatcher is state-listed as endangered. One subspecies occurring in California, the southwestern willow flycatcher (*Empidonax traillii extimus*), is Federally listed as endangered.

Description

The willow flycatcher is in the genus *Empidonax*, a group of small, dull-plumaged flycatchers. It can be distinguished from other members of its genus by its loud song, “fitz-bew,” and by its lack of a white eye ring. The species includes four or five subspecies, three of which breed in California: *extimus* (southwestern) in southern California, *brewsteri* (little) in the Sierra Nevada, and *adastus* east of the Sierra Nevada (Sedgwick 2000). The willow flycatchers seen in the Restoration Project area are likely to be *brewsteri*, based on range, although *adastus* could also occur in migration.

The willow flycatcher differs from the similar western wood-pewee in its song and “whit” call note; its habit of flicking its tail (shared by other *Empidonax* species); its lack of dark coloring or vested look on its breast; and its brighter yellow belly, longer tail, paler and greener head and back, and broader, more prominent white wing-bars.

Distribution

Historically, the little willow flycatcher was a common nesting species in the Sierra Nevada, Central Valley, and the central and northern Coast Ranges. Now it is found only in isolated populations in mountain meadow systems in the Sierra Nevada and the Cascade Range (Harris et al. 1988; California Department of Fish and Game 1997).

Habitat Association

The little willow flycatcher breeds and forages almost exclusively in wet mountain meadow systems with standing water for at least part of the breeding season (May to July) and with ample numbers of willow and other associated trees and shrubs (Harris et al. 1987). It arrives on the breeding grounds in May and June and departs for South America in August (Harris et al. 1988; Zeiner et al. 1990b).

Reasons for Decline

This species has declined for a variety of reasons, including nest parasitism by brown-headed cowbirds, loss and degradation of riparian and meadow habitats, and disturbance of nest sites by cattle (Zeiner et al. 1990b; California Department of Fish and Game 1997).

Occurrence in the Restoration Project Area

During 2000, willow flycatchers were seen at Eagle Canyon Diversion Dam and in the riparian habitat at the Lower Ripley Creek Feeder during their peak spring migration period. Although birds were observed singing in appropriate nesting habitat, they are presumed to have been migrants because follow-up searches of these sites in July did not detect nesting willow flycatchers. Information on both willow flycatcher occurrences is presented in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b).

Yellow-Breasted Chat

Legal Status

The yellow-breasted chat is designated as a species of special concern by the CDFG. The species currently receives no statutory protection under the CESA or the Federal ESA.

Description

The yellow-breasted chat is the largest of the New World warblers. It has a very large head with bright white “spectacles,” bright yellow breast, white belly, and undertail coverts. The head, back, and wings are medium gray. Throughout the year, the yellow-breasted chat feeds on insects and spiders, berries, and other fruits.

Distribution

The yellow-breasted chat was once common throughout riparian woodland and scrub habitats in California. It is now an uncommon breeder along the coast of

California and in the foothills of the central and southern Sierra Nevada, and breeding populations have declined over much of its former range in southern California (Garrett and Dunn 1981). It is increasingly rare in the Sacramento Valley and rare in the San Joaquin Valley and Mojave Desert (Garrett and Dunn 1981; Small 1994). The mid-elevation western slope of the northern Sierra Nevada is one of the strongholds for this species in California. Yellow-breasted chats are fairly common throughout the riparian habitats in the Restoration Project vicinity.

The breeding season for the yellow-breasted chat is from early May to early August, peaking in June. A migratory species, the yellow-breasted chat leaves for wintering grounds in Mexico and Guatemala in September and returns in April (Dunn and Garrett 1997).

Habitat Association

Although generally associated with riparian habitats, chats in the foothills of the Sierra Nevada are very closely tied to blackberry brambles for cover and for foraging (fruit). Yellow-breasted chats build nests in dense riparian habitats, often consisting of willow thickets and tangles of California wild grape and blackberry brambles (Grinnell and Miller 1944; Dunn and Garrett 1997).

Reasons for Decline

The loss and fragmentation of riparian habitats are major causes of the decline of the yellow-breasted chat (Garrett and Dunn 1981; Dunn and Garrett 1997). Brood parasitism by the brown-headed cowbird has caused the decline of this species, even in areas with intact riparian habitat (Remsen 1978).

Occurrence in the Restoration Project Area

Yellow-breasted chats were found at four riparian sites that had blackberry brambles and riparian scrub: the Darrah Springs Feeder, Coleman Diversion Dam/Inskip Powerhouse, Lower Ripley Creek Feeder, and Inskip Diversion Dam/South Powerhouse. Information on the yellow-breasted chat occurrences at Darrah Springs and Coleman Diversion Dam/Inskip Powerhouse are in Table II-3 in Volume II of the Summary Report (Jones & Stokes 2001b). The occurrences at the Lower Ripley Creek Feeder and Inskip Diversion Dam/South Powerhouse have not been provided in Volume II because the chats observed at these sites were migrants and do not nest in the area.

Special-Status Bats

Numerous bats were observed foraging over the Restoration Project area during the field surveys, and roosting bats were observed in abandoned tunnels near the South Powerhouse and at Inskip Diversion Dam. None was identified by species, but the following species have potential to occur in the Restoration Project area based on their habitats and geographic range:

- Fringed myotis (*Myotis thysanodes*)
- Long-eared myotis (*Myotis evotis*)
- Small-footed myotis (*Myotis leibii*)
- Long-legged myotis (*Myotis volans*)
- Yuma myotis (*Myotis yumanensis*)
- Pallid bat (*Antrozous pallidus*)
- Townsend's big-eared bat (*Plecotus townsendii*)

All of these species are considered Federal species of concern, and known roosting sites in abandoned tunnels should be protected with a steel mesh or bat door that permits access by bats but not by humans or predators.

Appendix K

Development and Assumptions of the Battle Creek Hydrology and Hydroelectric Power Model

Appendix K
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Purpose of the Monthly Hydrology and Hydroelectric Power Model

The purpose of this monthly hydrology and hydroelectric power model is to determine the relative value of the Battle Creek Hydroelectric Project to Pacific Gas & Electric Company (PG&E) under different restoration alternatives that have different stream flow targets and diversion capacities at the eight existing diversion dams. In order to identify relative hydroelectric power values, the monthly diversions must be calculated for a range of Battle Creek flows that are representative of the likely future flows. This appendix documents the hydrology and hydroelectric power diversion flow assumptions that allow the monthly flows in each reach of Battle Creek to be estimated.

Monthly Hydrology

The fist step in the monthly hydrology model is to estimate the natural or unimpaired flows (i.e., no upstream diversions) at each diversion dam location. The North Fork Battle Creek has five diversion dams. The two upstream diversions at Al Smith Dam and Keswick Dam are upstream of the potential restoration area and are considered in the model to be a single diversion located at Keswick Dam. These diversions are for the Volta power plants and have a combined capacity of 128 cubic feet per second (cfs). The existing Federal Energy Regulatory Commission (FERC) instream flow requirement below Keswick Dam is 3 cfs. Table K-1 provides a summary of the diversion dam locations (river mile) with the upstream watershed area and the approximate elevation and capacity of the diversion.

Several water stage gages are present throughout the Battle Creek watershed. Some of the gaged flow data are reported to the U.S. Geological Survey (USGS). These USGS records are available from 1983 to the present, but only relatively low flows are reported to demonstrate compliance with the FERC requirements.

Higher flows passing the diversion dams are not reported to USGS. The USGS records include flows at each of the five hydroelectric power plants (i.e., Volta 1 and Volta 2, South, Inskip, Coleman). PG&E maintains additional gages within their canal system to let them know how much water is being diverted at each of the eight diversion dams. The data from these diversion gages is proprietary information that PG&E is not required to make public. They have provided these diversion records from recent years to assist in verifying the hydrology model assumptions.

Initial efforts to model the hydrology of the watershed attempted to use data from all of the reported PG&E gauges. However, the measured flows at the USGS gage below Coleman National Fish Hatchery are the best source of flow data for the entire Battle Creek watershed. Daily measurements are available at this gauge (with no missing data) for the period from October 1, 1961, through September 30, 2002. Using the watershed area-flow method, the total flow measured at the base of the watershed is apportioned to points throughout the watershed based on the percentage of total drainage area at the point being estimated. For example, the total drainage area at the base of the watershed (Coleman National Fish Hatchery) is 357 square miles, and the total drainage area at the Eagle Canyon Diversion Dam on the North Fork is 186 square miles. Thus, under the area-flow method, 52 percent of the measured daily flow at Coleman National Fish Hatchery is the assumed flow at the Eagle Canyon Diversion Dam under natural unimpaired conditions (with no upstream diversions for hydroelectric power).

The Resource Agencies thought that the area-flow method would be appropriate for the restoration alternative assessments. The PG&E records from recent years (Water Years [WY] 1998–2002) have been used to confirm the area-flow estimates. Discussion with PG&E staff about the specific hydrology of the watershed did, however, help refine the area method modeling. In particular, the existence of volcanic soils and fractured geology throughout the watershed provides a nearly constant base flow at several major springs. The area-flow method assumes uniform runoff across the entire watershed. In order to increase the accuracy of the model, the flows from the major springs was estimated and the area-flow method used to estimate the remainder of the flow.

With the assistance of PG&E and California Department of Fish and Game staff familiar with the watershed, estimates of major spring flows were made. It was assumed that these springs had a constant flow all times of the year. The area-flow method was then used to apportion the remaining measured flows (i.e., total flow at Coleman National Fish Hatchery less the sum of all estimated spring flows) to points in the watershed that correspond to diversion facilities. Using this adjusted area-flow method, the model can estimate the monthly average unimpaired flow at each diversion point on the North Fork and South Fork of Battle Creek.

The monthly model uses the full range of measured monthly flows at the USGS gage below the Coleman Hatchery from the 1963 to 1993 period. The monthly flows are ranked from smallest to largest and the percentile values (i.e., minimum, 10 percent, 20 percent, 30 percent... maximum) monthly flow values are determined. Table K-2 gives the monthly flow values for Battle Creek obtained form the 1963 to 1993 flow record. The model uses the 10 percent, 30 percent, 50 percent, 70 percent, and 90 percent monthly flow values to approximate the full range of future likely flows. Each of these five flow values is assumed to be representative of flows expected in about 20 percent of the future years. The 10 percent flow values are representative of the lowest flows that would be exceeded in 80 percent of the future years. Table K-2 indicates that the 10 percent flow value for January would be 345 cfs. This value is used to represent the lowest 20 percent of the future January flows.

Calculated North Fork Battle Creek Flows and Diversions

The hydrology model calculates all flows and diversions for each month for the five representative total Battle Creek monthly flows. This provides a description of the range of flows likely in each reach or diversion canal under each of the restoration alternatives. Table K-3 shows an example of the calculations for the North Fork Battle Creek assuming the 10 percent monthly flow values under the No Action Alternative (all diversions with FERC flows). The upstream flows at Keswick are estimated as a spring flow of 20 cfs and with 22.5 percent of the non-spring Coleman National Fish Hatchery flow. The total Battle Creek Spring flow is estimated to be 65 cfs. The January flow at Keswick Dam is calculated to be 83 cfs. The minimum FERC flow at Keswick Dam is 3 cfs, and so the calculated diversion to the Volta power plants for January is 80 cfs. A portion of this would actually have been diverted at the Al Smith diversion.

The next diversion dam is the North Battle Creek Feeder Diversion Dam. There are relatively large streams (Bailey Creek and Rock Creek) that join the North Fork just upstream of the dam. The North Battle Creek Feeder diversion capacity is 50 cfs. The estimated flow at the feeder in January is 49 cfs, and the calculated diversion to the Cross Country Canal and the South Powerhouse is 46 cfs, leaving the required FERC flow of 3 cfs below North Battle Creek Feeder. Because the North Battle Creek Feeder canal and the Volta 2 tailrace (with a pipeline across the North Fork) both flow into the Cross Country Canal with a total capacity of 150 cfs, only the water needed to fill the Cross Country Canal is diverted at North Battle Creek Feeder Diversion Dam. In January, with a Volta 2 powerhouse flow of only 80 cfs, the full diversion capacity of 50 cfs would have been diverted if the flow at the diversion dam had been slightly higher. For January, the Cross Country Canal flow is calculated to be 126 cfs (i.e., 80 cfs from the Volta powerhouse plus 46 cfs from the North Battle Creek Feeder Diversion Dam).

The next diversion dam is the Eagle Canyon Diversion Dam. The diversion capacity is 64 cfs. There are 5 cfs of springs assumed between North Battle Creek Feeder and Eagle Canyon Diversion Dams. The calculated January flow is

46 cfs, largely from Digger Creek that joins North Fork Battle Creek just upstream of Eagle Canyon Diversion Dam. The Eagle Canal flows to the Inskip powerhouse, and the diversion is calculated to be 43 cfs, leaving the required FERC flow of 3 cfs below the Eagle Canyon Diversion Dam.

The last diversion dam on the North Fork Battle Creek is the Wildcat Diversion Dam. The total upstream spring flow is assumed to be 35 cfs and the watershed fraction is 53 percent of the total Battle Creek watershed flow. There are an assumed 10 cfs of springs between Eagle Canyon and Wildcat Diversion Dams. Some of this spring flow is currently flowing into the Eagle Canyon Canal, so the assumed springs at Eagle Canyon Diversion Dam should perhaps be increased to reflect this diversion under the No Action Alternative. For most of the Action Alternatives (all except the No Dam Removal Alternative), Wildcat Diversion Dam would be removed and the Wildcat diversions would be eliminated.

The calculation results shown in Table K-3 indicate that the flows in the North Fork Battle Creek would be only 3 cfs throughout the year if the 10 percent monthly values were to occur each month for the entire year. This simply indicates that the hydroelectric power diversion capacities were designed to allow the diversion of the entire North Fork flows during low flow conditions.

Calculated South Fork Battle Creek Flows and Diversions

Table K-4 gives the monthly model calculations for the South Fork Battle Creek flows and diversions for the No Action Alternative (all diversions with FERC flows) for the 10 percent monthly Battle Creek flows. The first diversion is at the South Diversion Dam. There are no upstream springs and the watershed fraction is 19 percent. The January flow at South Diversion Dam is 53 cfs. The required FERC flow is 5 cfs, so the maximum diversion in January is 48 cfs. The South Diversion Dam diversion capacity is 100 cfs, but this includes the 10 cfs assumed spring flow from Soap Creek that can be diverted into the South Canal. The South Canal and Cross Country Canal join to form Union Canal that flows to the South Powerhouse penstock with a capacity of 222 cfs. Because the Cross Country Canal flow is 125 cfs and the Soap Creek Feeder diversion is 10 cfs, the diversion at South Diversion Dam could be 87 cfs to fill the South Powerhouse capacity. But the available water at South Diversion Dam limits the January diversion to 48 cfs. The South Powerhouse flow is therefore 183 cfs in January.

The next diversion dam is Inskip Diversion Dam. The upstream watershed is 88 square miles, representing a flow of about 25% of Battle Creek non-spring flow. The calculated flow at Inskip Diversion Dam in January is 204 cfs, which includes the South Diversion Dam flow of 5 cfs, the South Powerhouse discharge of 183 cfs (entering just upstream from Inskip Dam), and 16 cfs from several creeks (including Soap Creek) that enter the South Fork between South Diversion Dam and Inskip Diversion Dam. The required FERC flow is 5 cfs and the Inskip diversion capacity is 199 cfs. The Inskip Canal is assumed to pick up any Ripley Creek spring flow (assumed to be 5 cfs) and will join with the Eagle Canyon Canal to flow into the Inskip Powerhouse Penstock with a capacity of 283 cfs. The Eagle Canyon Canal flow for January is 43 cfs, so the possible January diversion at Inskip Diversion Dam would be 235 cfs. The available water at Inskip Diversion Dam limits the diversion to 199 cfs, so the total Inskip Powerhouse flow is 247 cfs.

The last diversion dam on South Fork Battle Creek is Coleman Diversion Dam. The upstream watershed is 102 square miles, representing about 29 percent of the non-spring Battle Creek flow. The calculated flow at the Coleman Diversion Dam is 258 cfs in January. This includes the 247 cfs discharged from Inskip Powerhouse just upstream of Coleman Diversion Dam, the 5 cfs released from Inskip Diversion Dam, and local inflows of 6 cfs. The required FERC flow is 5 cfs, and the Coleman Diversion Dam is 253 cfs.

There are two diversions on Baldwin Creek that increase the Coleman Canal flow. The Pacific Power diversion has a capacity of 15 cfs and the Asbury dam and pump has a capacity of 35 cfs. Baldwin Creek flow is estimated from the watershed to be about 4 percent of the non-spring Battle Creek Flow and includes Darrah Springs that supply the Darrah Springs Hatchery with a constant assumed flow of 15 cfs. Wildcat Canal with a capacity of 18 cfs also joins the Coleman Canal. The Coleman powerhouse flow in January is therefore 291 cfs, including the 253 cfs diversion at Coleman Diversion Dam, 26 cfs from Baldwin Creek, and 12 cfs from Wildcat Diversion Dam on the North Fork Battle Creek.

The calculated January flow below the confluence of North Fork and South Fork is 8 cfs, representing the required FERC flows from Wildcat and Coleman Diversion Dams. The Coleman Powerhouse flow increases Battle Creek flow to 299 cfs. The Battle Creek flow at the Coleman National Fish Hatchery was 345 cfs in January. The missing flow is about 14 percent of the non-spring Battle Creek flow that is not accounted for by the 53 percent of the watershed at Wildcat Diversion Dam, the 29 percent of the watershed at Coleman Diversion Dam and the 4 percent of the watershed in Baldwin Creek. It is possible that slightly more of the watershed flow enters Battle Creek upstream of the confluence, but this area-flow method with a constant spring flow of 65 cfs provides a reasonable method for estimating the likely flows at each upstream dam.

Estimating Hydroelectric Power Production

Monthly diversions at each diversion dam are calculated from the total available flow at that diversion, the required in stream flow below the diversion, and the capacity of the conveyance and generation facilities that the diversion must pass through. The upstream diversions on the North Fork Battle Creek (Al Smith and Keswick) are assumed to be operated to capacity. The sequential diversions on the North Fork are also maximized subject to available water and canal capacities. The South Fork diversions are then limited by available water or remaining powerhouse capacities.

The Battle Creek power plants are operated as run-of-the-river facilities generating electricity 24 hours per day because there are no storage facilities available for peaking power generation. Each hydroelectric powerhouse has an assumed capacity. The energy production is calculated with the simple equation that estimates the daily energy:

Energy (KWh) = 2.0 x flow (cfs) x Head (feet) x Efficiency

The head and efficiency at each powerhouse can be multiplied together to give the effective head. The efficiencies are generally about 80 percent. The Volta 1 and Volta 2 powerhouses are operated in series and the total effective head is used. The Volta powerhouses have a combined effective head of 1,100 feet. The megawatt hours (MWh) production at each plant for each month is calculated from the number of days in the month. For example, for the No Action Alternative at 10 percent flows, the January production at the Volta powerhouses was 5,441 MWh, South Powerhouse produced 4,145 MWh, Inskip Powerhouse produced 4,728 MWh and Coleman Powerhouse produced 7,226 MWh. The combined January energy production was 21,345 MWh, which, with an assumed price of $35/MWh, would represent an energy value of about $750,000 for the month.

Conclusions

The monthly flow and diversion model is an important tool for evaluating the flows and energy production for the alternative restoration water management actions. The results for each restoration alternative can be reviewed in Appendix L, “Results from the Monthly Flow and Diversion Model.”

Table K-1. Battle Creek Stream and Diversion Data

Battle Creek Location	Battle Creek Reach	River Mile	Elevation (feet)	Diversion Capacity (cfs)
Confluence with Sacramento River	BC	0.0		--
Coleman National Fish Hatchery Weir	BC	7.5		--
Coleman Powerhouse Tailrace	BC	8.0	490	--
North Fork and South Fork Confluence	BC	17.1	830	--
Wildcat Diversion Dam	NFBC	2.8	1070	18
Eagle Canyon Diversion Dam	NFBC	5.4		64
Digger Creek	NFBC	5.5	1470	--
North Battle Creek Feeder Diversion Dam	NFBC	9.6		50
Bailey Creek	NFBC	9.8	2110	--
Fish Blockage	NFBC	14.5		--
Keswick Diversion Dam	NFBC	15.1	3650	128 (with Al Smith Diversion)
Coleman Diversion Dam	SFBC	2.5	1000	340
Ripley Creek	SFBC			--
Inskip Diversion Dam	SFBC	8.0	1415	220
Soap Creek	SFBC			--
South Diversion Dam	SFBC	14.4	2030	100
Fish Blockage	SFBC			--

Notes:

BC Mainstem Battle Creek

NFBC North Fork Battle Creek

SFBC South Fork Battle Creek

Table K-2. Cumulative Percentiles of Historic Monthly Flow in Battle Creek below Coleman National Fish Hatchery (cfs) for the 1963–1993 Period of Record

Percentile	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TAF/yr
0%	234	260	266	231	266	207	168	160	154	139	205	224	173
10%	345	340	345	343	331	292	220	191	203	205	255	259	223
20%	399	391	441	436	375	300	224	210	216	222	263	311	253
30%	445	508	529	476	396	317	250	229	231	250	295	344	273
40%	458	538	593	515	462	367	265	238	245	275	339	405	292
50%	579	635	676	605	595	448	305	248	252	296	366	462	380
60%	788	708	741	659	651	489	346	253	276	318	415	538	405
70%	864	845	833	729	744	521	384	291	279	327	438	583	415
80%	983	939	879	894	799	641	404	295	294	362	467	792	465
90%	1,187	1,072	1,301	1,020	851	739	438	325	322	391	765	1,041	517
100%	2,434	1,919	1,802	1,135	1,070	1,074	666	461	423	589	1,058	1,602	629

Note: Average Flow = 501 cfs

Table K-3. Example Monthly Calculations of North Fork Battle Creek Flows and Diversions for No Action Alternative for 10% Monthly Flows (cfs)

		Location on Battle Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Watershed (mile^2)	357	Battle Creek at Coleman National Fish Hatchery Flow	345	340	345	343	331	292	220	191	203	205	255	259
		Total Springs	65	65	65	65	65	65	65	65	65	65	65	65
Watershed (mile^2)	80	Keswick Springs	20	20	20	20	20	20	20	20	20	20	20	20
Fraction of Watershed	0.224	Estimate of Flow at Keswick Diversion Dam	83	82	83	82	80	71	55	48	51	51	62	63
Diversion Capacity	128	Estimate of Volta Diversions	80	79	80	79	77	68	52	45	48	48	59	60
		Instream Flow Target	3	3	3	3	3	3	3	3	3	3	3	3
		Flow Below Keswick Dam	3	3	3	3	3	3	3	3	3	3	3	3
Watershed (mile^2)	133	Upstream Springs	20	20	20	20	20	20	20	20	20	20	20	20
Fraction of Watershed	0.372	Estimate of Flow at North Battle Creek Feeder Diversion Dam	49	48	49	48	47	41	30	26	28	24	35	36
Diversion Capacity	50	Estimate of North Battle Creek Feeder Diversion	46	45	46	45	44	38	27	23	25	21	32	33
		Instream Flow Target	3	3	3	3	3	3	3	3	3	3	3	3
		Flow Below North Battle Creek Feeder Diversion Dam	3	3	3	3	3	3	3	3	3	3	3	3
Watershed (mile^2)	186	Upstream Springs	25	25	25	25	25	25	25	25	25	25	25	25

		Location on Battle Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fraction of Watershed	0.521	Estimate of Flow at Eagle Canyon Diversion Dam	46	45	45	45	43	38	27	23	24	29	32	33
Diversion Capacity	64	Estimate of Eagle Canyon Diversion	43	42	42	42	40	35	24	20	21	26	29	30
		Instream Flow Target	3	3	3	3	3	3	3	3	3	3	3	3
		Flow Below Eagle Canyon Diversion Dam	3	3	3	3	3	3	3	3	3	3	3	3
Watershed ($mile^2$)	189	Upstream Springs	35	35	35	35	35	35	35	35	35	35	35	35
Fraction of Watershed	0.529	Estimate of Flow at Wildcat Diversion Dam	15	15	15	15	15	15	14	14	14	14	15	15
Diversion Capacity	18	Estimate of Wildcat Diversion	12	12	12	12	12	12	11	11	11	11	12	12
		Instream Flow Target	3	3	3	3	3	3	3	3	3	3	3	3
		Flow Below Wildcat Diversion Dam	3	3	3	3	3	3	3	3	3	3	3	3

Table K-4. Example Monthly Calculations of South Fork Battle Creek Flows and Diversions for No Action Alternative for 10% Monthly Flows (cfs)

		Location on Battle Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Watershed (mile^2)	67													
Fraction of Watershed	0.188	Estimate of Flow at South Diversion Dam	53	52	53	52	50	43	29	24	26	26	36	36
Diversion Capacity	100	Estimate of South Dam Diversion	48	47	48	47	45	38	24	19	21	21	31	31
		Instream Flow Target	5	5	5	5	5	5	5	5	5	5	5	5
		Flow Below South Diversion Dam	5	5	5	5	5	5	5	5	5	5	5	5
		Estimate of Flow at Soap Creek Feeder	10	10	10	10	10	10	10	10	10	10	10	10
Diversion Capacity	10	Estimate of Soap Creek Feeder Diversion	10	10	10	10	10	10	10	10	10	10	10	10
		Instream Flow Target	0	0	0	0	0	0	0	0	0	0	0	0
		Flow Below Soap Creek Feeder	0	0	0	0	0	0	0	0	0	0	0	0
Diversion Capacity	150	Estimate of Cross-Country Canal Flow	125	123	125	125	120	106	79	68	73	69	92	93
Diversion Capacity	120	Estimate of South Canal Flow	58	57	58	57	55	48	34	29	31	31	41	41
Diversion Capacity	222	Estimate of South Powerhouse Flow	183	180	183	182	175	153	113	97	104	100	132	135
Diversion Capacity	0	South Powerhouse Connector	0	0	0	0	0	0	0	0	0	0	0	0

		Location on Battle Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Watershed (mile^2)	88													
Fraction of Watershed	0.284	Estimate of Flow at Inskip Diversion Dam	204	201	204	203	195	171	127	109	117	113	148	151
Diversion Capacity	220	Estimate of Inskip Diversion	199	196	199	198	190	166	122	104	112	108	143	146
		Instream Flow Target	5	5	5	5	5	5	5	5	5	5	5	5
		Flow Below Inskip Diversion Dam	5	5	5	5	5	5	5	5	5	5	5	5
		Estimate of Flow at Ripley Creek Feeder	5	5	5	5	5	5	5	5	5	5	5	5
Diversion Capacity	5	Estimate of Lower Ripley Creek Feeder Diversion	5	5	5	5	5	5	5	5	5	5	5	5
		Instream Flow Target	0	0	0	0	0	0	0	0	0	0	0	0
		Flow Below Ripley Creek Feeder	0	0	0	0	0	0	0	0	0	0	0	0
Diversion Capacity	283	Estimate of Inskip Powerhouse Flow	247	243	246	245	236	206	151	129	138	139	177	180
Diversion Capacity	0	Inskip Powerhouse Connector	0	0	0	0	0	0	0	0	0	0	0	0
Watershed (mile^2)	102													
Fraction of Watershed	0.286	Estimate of Flow at Coleman Diversion Dam	258	254	258	256	246	215	157	134	144	145	185	188
Diversion Capacity	340	Estimate of Coleman Diversion	253	249	253	251	241	210	152	129	139	140	180	183

		Location on Battle Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Instream Flow Target	5	5	5	5	5	5	5	5	5	5	5	5
		Flow Below Coleman Diversion Dam	5	5	5	5	5	5	5	5	5	5	5	5
Watershed ($mile^2$)	14	Upstream Springs	15	15	15	15	15	15	15	15	15	15	15	15
Fraction of Watershed	0.039	Estimate of Baldwin Creek Flow	26	26	26	26	25	24	21	20	20	20	22	23
Diversion Capacity	15	Estimate of Pacific Power Diversion	15	15	15	15	15	15	15	15	15	15	15	15
Diversion Capacity	35	Asbury Pipe Pumping	11	11	11	11	10	9	6	5	5	5	7	8
		Instream Flow Target	0	0	0	0	0	0	0	0	0	0	0	0
		Baldwin Creek Flow	0	0	0	0	0	0	0	0	0	0	0	0
		Flow Below Confluence	8	8	8	8	8	8	8	8	8	8	8	8
Diversion Capacity	380	Estimate of Coleman Powerhouse Flow	291	287	291	289	279	246	185	160	170	171	214	217

Appendix L

Results from Monthly Flow and Power Generation Model

Appendix L

Results from Monthly Flow and Power Generation Model

This appendix presents the results of monthly flow and diversion calculations for each alternative. The assumptions and an example calculation is presented in Appendix K, "Development and Assumptions of the Battle Creek Hydrology and Hydroelectric Power Model".

Table L-1. Calculated Battle Creek Flows for Alternative: No Action (FERC Flows) (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Keswick Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	3	3	3	3	3	3	3	3	3	3	3	3
50%	7	20	29	13	11	3	3	3	3	3	3	3
70%	71	67	64	41	44	3	3	3	3	3	3	8
90%	143	118	169	106	68	43	3	3	3	3	49	111
Below North Battle Creek Feeder Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	15	39	47	27	6	3	3	3	3	3	3	3
50%	65	86	102	75	71	17	3	3	3	3	3	22
70%	171	164	160	121	127	44	4	3	3	3	13	67
90%	292	249	334	229	167	125	13	3	3	3	135	237
Below Eagle Canyon Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	9	42	53	25	3	3	3	3	3	3	3	3
50%	79	108	129	92	87	10	3	3	3	3	3	18
70%	227	218	211	157	165	49	3	3	3	3	5	81
90%	396	336	455	309	221	162	5	3	3	3	176	319
Below Wildcat Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	4	37	49	20	3	3	3	3	3	3	3	3
50%	75	104	126	89	84	6	3	3	3	3	3	13
70%	225	216	209	154	162	44	3	3	3	3	3	77
90%	397	336	457	308	219	159	3	3	3	3	173	319
Above South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below South Diversion Dam												
10%	5	5	5	5	5	5	5	5	5	5	5	5
30%	9	21	25	15	5	5	5	5	5	5	5	5
50%	35	45	53	39	38	10	5	5	5	5	5	13
70%	88	85	82	63	66	24	5	5	5	5	8	35
90%	149	127	170	118	86	65	8	5	5	5	70	121
Below Inskip Diversion Dam												
10%	5	5	5	5	5	5	5	5	5	5	5	5
30%	54	72	78	63	25	5	5	5	5	5	5	5
50%	92	108	120	99	97	55	5	5	5	5	9	59
70%	173	168	164	134	139	76	19	5	5	5	52	93
90%	265	232	297	217	169	137	52	5	5	21	145	223
Below Coleman Diversion Dam												
10%	5	5	5	5	5	5	5	5	5	5	5	5
30%	5	21	28	11	5	5	5	5	5	5	5	5
50%	44	62	76	52	49	5	5	5	5	5	5	6
70%	137	131	127	93	98	25	5	5	5	5	5	45
90%	233	200	265	185	133	96	5	5	5	5	105	191
Below Confluence of North Fork and South Fork Battle Creek												
10%	8	8	8	8	8	8	8	8	8	8	8	8
30%	9	58	77	31	8	8	8	8	8	8	8	8
50%	119	167	202	141	133	11	8	8	8	8	8	19
70%	362	346	336	247	260	70	8	8	8	8	8	122
90%	638	540	735	496	352	255	8	8	8	8	278	513
Below Coleman National Fish Hatchery												
10%	345	340	345	343	331	292	220	191	203	205	255	259
30%	445	508	529	476	396	317	250	229	231	250	295	344
50%	579	635	676	605	595	448	305	248	252	296	366	462
70%	864	845	833	729	744	521	384	291	279	327	438	583
90%	1187	1072	1301	1020	851	739	438	325	322	391	765	1041

Table L-2. Calculated Battle Creek Diversions for Alternative: No action (FERC Flows) (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta 2 Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	109	91	73	58	54	54	58	68	80
50%	128	128	128	128	128	103	71	58	59	69	84	106
70%	128	128	128	128	128	119	89	68	65	76	100	128
90%	128	128	128	128	128	128	100	75	75	90	128	128
North Battle Creek Feeder Diversion												
10%	46	45	46	45	44	38	27	23	25	21	32	33
30%	48	34	29	41	50	41	32	28	29	27	38	46
50%	22	22	22	22	22	47	40	31	32	34	49	44
70%	22	22	22	22	22	31	50	38	36	39	50	22
90%	22	22	22	22	22	22	50	43	42	48	22	22
Eagle Canyon Diversion												
10%	43	42	42	42	40	35	24	20	21	26	29	30
30%	64	64	64	64	53	38	28	25	26	33	35	42
50%	64	64	64	64	64	64	37	28	29	39	46	64
70%	64	64	64	64	64	64	50	34	33	44	64	64
90%	64	64	64	64	64	64	64	40	39	54	64	64
Wildcat Diversion												
10%	12	12	12	12	12	12	11	11	11	11	12	12
30%	18	18	18	18	13	12	11	11	11	11	12	12
50%	18	18	18	18	18	18	12	11	11	12	12	18
70%	18	18	18	18	18	18	13	12	12	12	15	18
90%	18	18	18	18	18	18	15	12	12	13	18	18
South Canal Diversion												
10%	48	47	48	47	45	38	24	19	21	21	31	31
30%	62	62	62	62	57	42	30	26	26	30	38	48
50%	62	62	62	62	62	62	40	29	30	38	52	62
70%	62	62	62	62	62	62	55	37	35	44	62	62
90%	62	62	62	62	62	62	62	44	43	56	62	62
South Connector												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Inskip Diversion												
10%	210	207	210	209	201	175	128	109	117	114	151	153
30%	214	214	214	214	220	191	147	134	135	143	177	209
50%	214	214	214	214	214	214	184	146	149	174	220	214
70%	214	214	214	214	214	214	220	174	166	194	214	214
90%	214	214	214	214	214	214	214	197	195	220	214	214
Inskip Connector												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Coleman Diversion												
10%	253	249	253	251	241	210	152	129	139	140	180	183
30%	328	330	329	331	294	230	176	159	161	176	212	252
50%	327	325	323	326	326	329	221	175	178	213	270	332
70%	316	317	317	321	321	329	285	209	199	238	326	327
90%	312	312	312	312	316	321	326	237	234	290	320	312
South Powerhouse Flow												
10%	183	180	183	182	175	153	113	97	104	100	132	135
30%	222	222	222	222	208	167	130	118	119	125	155	183
50%	222	222	222	222	222	222	161	129	131	151	195	222
70%	222	222	222	222	222	222	204	153	146	169	222	222
90%	222	222	222	222	222	222	222	172	170	204	222	222

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inskip Powerhouse Flow												
10%	258	253	257	256	246	215	157	134	143	144	185	188
30%	283	283	283	283	278	235	181	164	166	181	217	257
50%	283	283	283	283	283	283	225	179	183	218	271	283
70%	283	283	283	283	283	283	275	214	204	243	283	283
90%	283	283	283	283	283	283	283	241	239	279	283	283
Coleman Powerhouse Flow												
10%	291	287	291	289	279	246	185	160	170	171	214	217
30%	375	380	380	380	335	267	210	192	194	210	248	291
50%	380	380	380	380	380	376	257	208	212	249	309	380
70%	380	380	380	380	380	380	325	245	234	275	370	380
90%	380	380	380	380	380	380	370	274	271	330	380	380

Table L-3. Calculated Battle Creek Hydro Power Production for Alternative: No Action (FERC Flows) (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta Powerhouse (MWh)												
10%	5441	4841	5430	5232	5220	4477	3531	3087	3168	3294	3926	4116
30%	6958	7159	8255	7199	6214	4847	3982	3665	3581	3982	4519	5426
50%	8730	7885	8730	8448	8730	6783	4829	3954	3892	4690	5575	7224
70%	8730	7885	8730	8448	8730	7868	6038	4609	4278	5156	6630	8730
90%	8730	7885	8730	8448	8730	8448	6852	5128	4918	6138	8448	8730
South Powerhouse (MWh)												
10%	4145	3682	4135	3983	3961	3357	2560	2192	2270	2269	2899	3045
30%	5024	4538	5024	4862	4714	3663	2934	2671	2613	2839	3391	4132
50%	5024	4538	5024	4862	5024	4862	3637	2911	2871	3427	4267	5024
70%	5024	4538	5024	4862	5024	4862	4607	3454	3192	3813	4862	5024
90%	5024	4538	5024	4862	5024	4862	5024	3885	3722	4628	4862	5024
Inskip Powerhouse (MWh)												
10%	4728	4199	4717	4543	4514	3813	2881	2452	2547	2652	3280	3447
30%	5194	4691	5194	5026	5107	4171	3317	3011	2946	3317	3853	4713
50%	5194	4691	5194	5026	5194	5026	4136	3290	3247	4001	4808	5194
70%	5194	4691	5194	5026	5194	5026	5044	3924	3621	4452	5026	5194
90%	5194	4691	5194	5026	5194	5026	5194	4425	4239	5112	5026	5194
Coleman Powerhouse (MWh)												
10%	7226	6424	7210	6946	6918	5900	4578	3962	4084	4249	5135	5389
30%	9309	8512	9424	9120	8296	6412	5203	4764	4657	5202	5957	7205
50%	9424	8512	9424	9120	9424	9035	6377	5164	5088	6184	7421	9424
70%	9424	8512	9424	9120	9424	9120	8053	6073	5624	6830	8883	9424
90%	9424	8512	9424	9120	9424	9120	9182	6791	6510	8191	9120	9424

System Total Annual (MWh)

10%	20,2052
30%	24,6792
50%	28,0533
70%	29,7611
90%	31,1415

Table L-4. Calculated Battle Creek Flows for Alternative: Five Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Keswick Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	3	3	3	3	3	3	3	3	3	3	3	3
50%	7	20	29	13	11	3	3	3	3	3	3	3
70%	71	67	64	41	44	3	3	3	3	3	3	8
90%	143	118	169	106	68	43	3	3	3	3	49	111
Below North Battle Creek Feeder Diversion Dam												
10%	49	48	49	48	47	41	30	26	28	24	35	36
30%	63	73	76	67	47	44	35	31	32	30	41	49
50%	87	88	102	75	71	47	43	34	35	37	47	66
70%	171	164	160	121	127	47	47	41	39	42	47	88
90%	292	249	334	229	167	125	47	46	45	47	135	237
Below Eagle Canyon Diversion Dam												
10%	46	46	46	46	35	35	35	35	35	35	35	46
30%	57	76	82	65	35	35	35	35	35	35	35	46
50%	101	110	129	92	87	41	35	35	35	35	35	62
70%	227	218	211	157	165	52	35	35	35	35	39	102
90%	396	336	455	309	221	162	39	35	35	37	176	319
Below Wildcat Diversion Dam												
10%	58	58	58	58	47	47	46	46	46	46	47	58
30%	70	89	96	78	48	47	46	46	46	46	47	58
50%	115	124	144	107	102	54	47	46	46	47	47	75
70%	243	234	227	172	180	65	48	47	47	47	52	116
90%	415	354	475	326	237	177	52	47	47	49	191	337
Above South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183
Below Inskip Diversion Dam												
10%	86	86	86	61	40	40	40	40	40	40	40	65
30%	86	86	86	61	40	40	40	40	40	40	40	86
50%	86	101	115	94	92	40	40	40	40	40	40	86
70%	168	163	159	129	134	68	40	40	40	40	40	86
90%	260	227	292	212	164	132	40	40	40	40	140	218
Below Coleman Diversion Dam												
10%	92	92	92	67	46	45	45	45	45	45	45	70
30%	92	92	92	67	46	46	45	45	45	45	45	92
50%	92	107	121	100	98	46	45	45	45	45	46	92
70%	174	169	166	136	140	73	46	45	45	46	46	92
90%	267	234	299	219	171	139	46	46	46	46	146	225
Below Confluence of North Fork and South Fork Battle Creek												
10%	155	155	155	130	98	97	97	96	96	96	97	133
30%	167	186	193	150	98	98	97	97	97	97	97	155
50%	212	236	270	212	204	105	97	97	97	97	98	172
70%	423	408	398	313	325	144	98	97	97	98	103	213
90%	690	593	787	550	413	321	103	98	98	100	343	567
Below Coleman National Fish Hatchery												
10%	345	340	345	343	331	292	220	191	203	205	255	259
30%	445	508	529	476	396	317	250	229	231	250	295	344
50%	579	635	676	605	595	448	305	248	252	296	366	462
70%	864	845	833	729	744	521	384	291	279	327	438	583
90%	1187	1072	1301	1020	851	739	438	325	322	391	765	1041

Table L-5. Calculated Battle Creek Diversions for Alternative: Five Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta 2 Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	109	91	73	58	54	54	58	68	80
50%	128	128	128	128	128	103	71	58	59	69	84	106
70%	128	128	128	128	128	119	89	68	65	76	100	128
90%	128	128	128	128	128	128	100	75	75	90	128	128
North Battle Creek Feeder Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	1	9	0	0	0	0	0	0	0
50%	0	20	22	22	22	17	0	0	0	0	5	0
70%	22	22	22	22	22	28	7	0	0	0	15	1
90%	22	22	22	22	22	22	15	0	0	4	22	22
Eagle Canyon Diversion												
10%	45	44	45	45	52	40	19	10	14	15	29	19
30%	64	64	64	64	62	48	28	22	22	28	41	45
50%	64	64	64	64	64	64	44	27	29	42	58	64
70%	64	64	64	64	64	64	60	40	36	51	64	64
90%	64	64	64	64	64	64	64	50	49	64	64	64
Wildcat Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Canal Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Connector												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	110	100	73	58	54	54	58	68	80
50%	128	148	150	150	150	120	71	58	59	69	89	106
70%	150	150	150	150	150	147	96	68	65	76	116	129
90%	150	150	150	150	150	150	116	75	75	94	150	150
Inskip Diversion												
10%	4	2	3	28	45	34	14	6	9	10	24	0
30%	32	50	56	66	64	42	22	17	17	22	35	3
50%	70	71	69	69	69	79	38	22	23	36	56	37
70%	69	69	69	69	69	72	61	34	31	44	76	71
90%	69	69	69	69	69	69	76	44	43	63	69	69
Inskip Connector												
10%	129	124	128	152	174	143	85	62	71	72	113	80
30%	198	230	241	240	226	163	109	92	94	109	145	128
50%	262	283	283	283	283	262	153	107	111	146	202	207
70%	283	283	283	283	283	283	217	142	132	171	256	264
90%	283	283	283	283	283	283	256	169	167	221	283	283
Coleman Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	110	100	73	58	54	54	58	68	80
50%	128	148	150	150	150	120	71	58	59	69	89	106
70%	150	150	150	150	150	147	96	68	65	76	116	129
90%	150	150	150	150	150	150	116	75	75	94	150	150

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inskip Powerhouse Flow												
10%	129	124	128	152	174	143	85	62	71	72	113	80
30%	198	230	241	240	226	163	109	92	94	109	145	128
50%	262	283	283	283	283	262	153	107	111	146	202	207
70%	283	283	283	283	283	283	217	142	132	171	256	264
90%	283	283	283	283	283	283	256	169	167	221	283	283
Coleman Powerhouse Flow												
10%	150	145	149	173	194	162	101	77	87	88	130	97
30%	223	257	269	266	249	183	126	108	110	126	164	149
50%	292	315	317	314	314	287	173	124	128	165	224	232
70%	324	323	323	319	319	311	240	161	150	191	280	294
90%	333	332	333	330	324	319	280	189	187	243	320	331

Table L-6. Calculated Battle Creek Hydro Power Production for Alternative: Five Dam Removal

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta Powerhouse (MWh)												
10%	5441	4841	5430	5232	5220	4477	3531	3087	3168	3294	3926	4116
30%	6958	7159	8255	7199	6214	4847	3982	3665	3581	3982	4519	5426
50%	8730	7885	8730	8448	8730	6783	4829	3954	3892	4690	5575	7224
70%	8730	7885	8730	8448	8730	7868	6038	4609	4278	5156	6630	8730
90%	8730	7885	8730	8448	8730	8448	6852	5128	4918	6138	8448	8730
South Powerhouse (MWh)												
10%	1806	1606	1802	1736	1732	1486	1172	1024	1051	1093	1303	1366
30%	2309	2375	2739	2411	2269	1608	1321	1216	1188	1321	1499	1800
50%	2897	3028	3395	3285	3395	2620	1602	1312	1291	1556	1954	2397
70%	3395	3066	3395	3285	3395	3218	2172	1530	1420	1711	2535	2916
90%	3395	3066	3395	3285	3395	3285	2621	1702	1632	2132	3285	3395
Inskip Powerhouse (MWh)												
10%	2361	2061	2349	2696	3192	2534	1560	1130	1268	1330	2001	1465
30%	3630	3813	4422	4259	4154	2892	1996	1689	1668	1995	2575	2346
50%	4806	4691	5194	5026	5194	4660	2815	1968	1968	2680	3596	3793
70%	5194	4691	5194	5026	5194	5026	3984	2602	2342	3131	4539	4844
90%	5194	4691	5194	5026	5194	5026	4691	3104	2960	4052	5026	5194
Coleman Powerhouse (MWh)												
10%	3709	3249	3693	4143	4819	3877	2506	1897	2083	2181	3122	2415
30%	5521	5763	6673	6380	6181	4384	3124	2689	2649	3123	3934	3688
50%	7240	7061	7857	7537	7779	6895	4284	3085	3075	4093	5381	5758
70%	8039	7245	8009	7653	7923	7459	5940	3983	3605	4732	6722	7295
90%	8258	7443	8258	7926	8027	7662	6948	4693	4480	6038	7687	8210

System Total Annual (MWh)	
10%	130581
30%	177392
50%	224636
70%	248238
90%	266750

Table L-7. Calculated Battle Creek Flows for Alternative: No Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Keswick Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	3	3	3	3	3	3	3	3	3	3	3	3
50%	7	20	29	13	11	3	3	3	3	3	3	3
70%	71	67	64	41	44	3	3	3	3	3	3	8
90%	143	118	169	106	68	43	3	3	3	3	49	111
Below North Battle Creek Feeder Diversion Dam												
10%	40	40	40	40	30	30	30	26	28	24	35	36
30%	40	40	47	40	30	30	30	30	32	30	40	40
50%	65	86	102	75	71	30	30	30	35	37	40	40
70%	171	164	160	121	127	44	30	30	39	40	40	67
90%	292	249	334	229	167	125	30	30	40	40	135	237
Below Eagle Canyon Diversion Dam												
10%	50	50	50	50	30	30	30	30	30	30	30	50
30%	50	50	53	50	30	30	30	30	30	30	30	50
50%	79	108	129	92	87	30	30	30	30	30	30	50
70%	227	218	211	157	165	49	30	30	30	30	32	81
90%	396	336	455	309	221	162	30	30	30	30	176	319
Below Wildcat Diversion Dam												
10%	50	50	50	50	30	30	30	30	30	30	30	50
30%	50	50	50	50	30	30	30	30	30	30	30	50
50%	75	104	126	89	84	30	30	30	30	30	30	50
70%	225	216	209	154	162	44	30	30	30	30	30	77
90%	397	336	457	308	219	159	30	30	30	30	173	319
Above South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below South Diversion Dam												
10%	30	30	30	30	20	20	20	20	20	20	20	30
30%	30	30	30	30	20	20	20	20	20	20	20	30
50%	30	40	48	34	33	20	20	20	20	20	20	30
70%	83	80	77	58	61	20	20	20	20	20	20	30
90%	144	122	165	113	81	60	20	20	20	20	65	116
Below Inskip Diversion Dam												
10%	40	40	40	40	30	30	30	30	30	30	30	40
30%	40	48	60	40	30	30	30	30	30	30	30	40
50%	72	86	96	79	76	30	30	30	30	30	30	40
70%	142	138	135	109	113	58	30	30	30	30	30	73
90%	222	194	250	181	139	112	30	30	30	30	118	186
Below Coleman Diversion Dam												
10%	50	50	50	50	30	30	30	30	50	50	50	50
30%	50	50	50	50	30	30	30	30	50	50	50	50
50%	50	62	76	52	49	30	30	30	50	50	50	50
70%	137	131	127	93	98	30	30	30	50	50	50	50
90%	233	200	265	185	133	96	30	30	50	50	105	191
Below Confluence of North Fork and South Fork Battle Creek												
10%	100	100	100	100	60	60	60	60	80	80	80	100
30%	100	100	100	100	60	60	60	60	80	80	80	100
50%	125	167	202	141	133	60	60	60	80	80	80	100
70%	362	346	336	247	260	74	60	60	80	80	80	127
90%	638	540	735	496	352	255	60	60	80	80	278	513
Below Coleman National Fish Hatchery												
10%	345	340	345	343	331	292	220	191	203	205	255	259
30%	445	508	529	476	396	317	250	229	231	250	295	344
50%	579	635	676	605	595	448	305	248	252	296	366	462
70%	864	845	833	729	744	521	384	291	279	327	438	583
90%	1187	1072	1301	1020	851	739	438	325	322	391	765	1041

Table L-8. Calculated Battle Creek Diversions for Alternative: No Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta 2 Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	109	91	73	58	54	54	58	68	80
50%	128	128	128	128	128	103	71	58	59	69	84	106
70%	128	128	128	128	128	119	89	68	65	76	100	128
90%	128	128	128	128	128	128	100	75	75	90	128	128
North Battle Creek Feeder Diversion												
10%	9	8	9	8	17	11	0	0	0	0	0	0
30%	23	33	29	28	26	14	5	1	0	0	1	9
50%	22	22	22	22	22	34	13	4	0	0	12	26
70%	22	22	22	22	22	31	24	11	0	2	22	22
90%	22	22	22	22	22	22	32	16	5	11	22	22
Eagle Canyon Diversion												
10%	33	32	32	32	40	35	24	15	19	20	34	15
30%	47	57	64	52	50	38	28	25	27	33	45	32
50%	64	64	64	64	64	58	37	28	34	47	56	50
70%	64	64	64	64	64	64	48	34	41	54	64	64
90%	64	64	64	64	64	64	56	40	49	64	64	64
Wildcat Diversion												
10%	12	12	12	12	12	12	11	11	11	11	12	12
30%	13	14	17	13	13	12	11	11	11	11	12	12
50%	18	18	18	18	18	13	12	11	11	12	12	13
70%	18	18	18	18	18	18	13	12	12	12	15	18
90%	18	18	18	18	18	18	13	12	12	13	18	18
South Canal Diversion												
10%	23	22	23	22	30	23	9	4	6	6	16	6
30%	41	53	57	47	42	27	15	11	11	15	23	23
50%	67	67	67	67	67	52	25	14	15	23	37	45
70%	67	67	67	67	67	66	40	22	20	29	50	67
90%	67	67	67	67	67	67	50	29	28	41	67	67

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Connector												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Inskip Diversion												
10%	127	124	127	126	138	114	70	56	62	63	86	78
30%	189	220	214	208	179	130	88	76	75	84	106	127
50%	214	214	214	214	214	211	123	87	85	106	150	200
70%	214	214	214	214	214	214	172	114	97	122	194	214
90%	214	214	214	214	214	214	204	135	123	161	214	214
Inskip Connector												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Coleman Diversion												
10%	161	157	161	159	189	158	100	77	67	68	108	91
30%	241	292	307	267	242	178	124	107	89	104	140	160
50%	321	325	323	326	326	284	169	123	106	141	198	255
70%	316	317	317	321	321	325	233	157	127	166	253	322
90%	312	312	312	312	316	321	276	185	162	218	320	312
South Powerhouse Flow												
10%	116	113	116	115	128	106	66	54	59	60	80	72
30%	172	207	212	189	164	120	83	71	71	78	98	116
50%	222	222	222	222	222	194	114	82	79	97	138	182
70%	222	222	222	222	222	221	158	106	90	112	178	222
90%	222	222	222	222	222	222	188	125	113	147	222	222

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inskip Powerhouse Flow												
10%	165	161	164	163	184	154	99	77	86	87	125	98
30%	241	282	283	265	234	173	122	106	108	122	156	164
50%	283	283	283	283	283	274	164	120	124	157	211	254
70%	283	283	283	283	283	283	225	153	144	181	263	283
90%	283	283	283	283	283	283	266	179	177	230	283	283
Coleman Powerhouse Flow												
10%	199	195	199	197	227	194	133	108	98	99	142	125
30%	284	338	357	311	283	215	158	140	122	138	176	199
50%	374	380	380	380	380	327	205	156	140	177	237	299
70%	380	380	380	380	380	375	273	193	162	203	298	375
90%	380	380	380	380	380	380	318	222	199	258	380	380

Table L-9. Calculated Battle Creek Hydro Power Production for Alternative: No Dam Removal

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta Powerhouse (MWh)												
10%	5441	4841	5430	5232	5220	4477	3531	3087	3168	3294	3926	4116
30%	6958	7159	8255	7199	6214	4847	3982	3665	3581	3982	4519	5426
50%	8730	7885	8730	8448	8730	6783	4829	3954	3892	4690	5575	7224
70%	8730	7885	8730	8448	8730	7868	6038	4609	4278	5156	6630	8730
90%	8730	7885	8730	8448	8730	8448	6852	5128	4918	6138	8448	8730
South Powerhouse (MWh)												
10%	2628	2313	2618	2515	2897	2328	1496	1222	1292	1348	1755	1624
30%	3886	4236	4805	4147	3721	2634	1870	1608	1545	1768	2143	2616
50%	5014	4538	5024	4862	5024	4240	2573	1847	1734	2200	3019	4107
70%	5024	4538	5024	4862	5024	4835	3576	2391	1970	2523	3894	5024
90%	5024	4538	5024	4862	5024	4862	4251	2821	2474	3338	4862	5024
Inskip Powerhouse (MWh)												
10%	3028	2667	3017	2899	3374	2737	1818	1409	1530	1600	2228	1807
30%	4425	4671	5194	4711	4290	3077	2234	1942	1911	2233	2775	3014
50%	5194	4691	5194	5026	5194	4861	3014	2208	2197	2886	3748	4671
70%	5194	4691	5194	5026	5194	5026	4128	2812	2553	3315	4678	5194
90%	5194	4691	5194	5026	5194	5026	4878	3290	3142	4220	5026	5194
Coleman Powerhouse (MWh)												
10%	4944	4363	4928	4738	5629	4652	3288	2673	2356	2464	3407	3107
30%	7047	7577	8845	7465	7007	5164	3913	3474	2929	3417	4229	4923
50%	9274	8512	9424	9120	9424	7848	5088	3874	3360	4398	5693	7416
70%	9424	8512	9424	9120	9424	9007	6764	4783	3896	5045	7155	9308
90%	9424	8512	9424	9120	9424	9120	7892	5502	4782	6406	9120	9424

System Total Annual (MWh)

10%	150462
30%	207231
50%	255964
70%	279382
90%	297508

Table L-10. Calculated Battle Creek Flows for Alternative: Three Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Keswick Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	3	3	3	3	3	3	3	3	3	3	3	3
50%	7	20	29	13	11	3	3	3	3	3	3	3
70%	71	67	64	41	44	3	3	3	3	3	3	8
90%	143	118	169	106	68	43	3	3	3	3	49	111
Below North Battle Creek Feeder Diversion Dam												
10%	40	40	40	40	30	30	30	26	28	24	35	36
30%	40	40	47	40	30	30	30	30	32	30	40	40
50%	65	86	102	75	71	30	30	30	35	37	40	40
70%	171	164	160	121	127	44	30	30	39	40	40	67
90%	292	249	334	229	167	125	30	30	40	40	135	237
Below Eagle Canyon Diversion Dam												
10%	83	82	82	82	70	65	54	45	49	50	64	65
30%	97	107	117	102	80	68	58	55	57	63	75	82
50%	143	172	193	156	151	88	67	58	64	77	86	100
70%	291	282	275	221	229	113	78	64	71	84	96	145
90%	460	400	519	373	285	226	86	70	79	94	240	383
Below Wildcat Diversion Dam												
10%	95	94	95	94	83	76	65	56	60	61	76	77
30%	110	120	131	115	93	80	70	67	69	74	87	95
50%	157	186	208	171	166	101	79	70	75	88	98	113
70%	307	298	291	236	244	126	91	76	83	96	109	159
90%	479	418	539	390	301	241	99	82	91	106	255	401
Above South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below South Diversion Dam												
10%	30	30	30	30	20	20	20	20	20	20	20	30
30%	30	30	30	30	20	20	20	20	20	20	20	30
50%	30	40	48	34	33	20	20	20	20	20	20	30
70%	83	80	77	58	61	20	20	20	20	20	20	30
90%	144	122	165	113	81	60	20	20	20	20	65	116
Below Inskip Diversion Dam												
10%	40	40	40	40	30	30	30	30	30	30	30	40
30%	40	65	72	44	30	30	30	30	30	30	30	40
50%	86	102	114	93	91	35	30	30	30	30	30	40
70%	167	162	158	128	133	70	30	30	30	30	30	87
90%	259	226	291	211	163	131	30	30	30	30	139	217
Below Coleman Diversion Dam												
10%	36	36	36	36	26	25	25	25	25	25	25	35
30%	36	61	68	40	26	26	25	25	25	25	25	36
50%	82	98	110	89	87	31	25	25	25	25	26	36
70%	163	158	155	125	129	66	26	25	25	26	26	83
90%	256	223	288	208	160	128	26	26	26	26	135	214
Below Confluence of North Fork and South Fork Battle Creek												
10%	140	140	140	140	118	112	101	92	95	96	111	122
30%	156	191	209	165	128	116	105	102	104	110	122	140
50%	249	294	328	270	262	142	114	105	111	124	134	159
70%	481	466	456	371	383	202	127	112	119	132	145	252
90%	744	651	840	608	471	379	135	117	127	142	401	625
Below Coleman National Fish Hatchery												
10%	345	340	345	343	331	292	220	191	203	205	255	259
30%	445	508	529	476	396	317	250	229	231	250	295	344
50%	579	635	676	605	595	448	305	248	252	296	366	462
70%	864	845	833	729	744	521	384	291	279	327	438	583
90%	1187	1072	1301	1020	851	739	438	325	322	391	765	1041

Table L-11. Calculated Battle Creek Diversions for Alternative: Three Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta 2 Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	109	91	73	58	54	54	58	68	80
50%	128	128	128	128	128	103	71	58	59	69	84	106
70%	128	128	128	128	128	119	89	68	65	76	100	128
90%	128	128	128	128	128	128	100	75	75	90	128	128
North Battle Creek Feeder Diversion												
10%	9	8	9	8	17	11	0	0	0	0	0	0
30%	23	33	29	28	26	14	5	1	0	0	1	9
50%	22	22	22	22	22	34	13	4	0	0	12	26
70%	22	22	22	22	22	31	24	11	0	2	22	22
90%	22	22	22	22	22	22	32	16	5	11	22	22
Eagle Canyon Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Wildcat Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Canal Diversion												
10%	23	22	23	22	30	23	9	4	6	6	16	6
30%	41	53	57	47	42	27	15	11	11	15	23	23
50%	67	67	67	67	67	52	25	14	15	23	37	45
70%	67	67	67	67	67	66	40	22	20	29	50	67
90%	67	67	67	67	67	67	50	29	28	41	67	67
South Connector												
10%	116	113	116	115	128	106	66	54	59	60	80	72
30%	172	207	212	189	164	120	83	71	71	78	98	116

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50%	220	220	220	220	220	194	114	82	79	97	138	182
70%	220	220	220	220	220	220	158	106	90	112	178	220
90%	220	220	220	220	220	220	188	125	113	147	220	220
Inskip Diversion												
10%	22	21	22	22	21	17	10	7	8	8	13	14
30%	31	13	8	31	27	19	13	11	11	13	17	22
50%	0	0	0	0	0	26	18	13	13	17	24	33
70%	0	0	0	0	0	0	26	17	15	20	31	0
90%	0	0	0	0	0	0	31	20	20	26	0	0
Inskip Connector												
10%	143	140	143	142	154	128	81	66	72	73	98	90
30%	208	225	225	225	196	144	100	87	86	96	120	142
50%	225	225	225	225	225	225	137	99	97	119	167	220
70%	225	225	225	225	225	225	189	127	110	137	214	225
90%	225	225	225	225	225	225	224	150	138	179	225	225
Coleman Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Powerhouse Flow												
10%	116	113	116	115	128	106	66	54	59	60	80	72
30%	172	207	212	189	164	120	83	71	71	78	98	116
50%	222	222	222	222	222	194	114	82	79	97	138	182
70%	222	222	222	222	222	221	158	106	90	112	178	222
90%	222	222	222	222	222	222	188	125	113	147	222	222
Inskip Powerhouse Flow												
10%	143	140	143	142	154	128	81	66	72	73	98	90
30%	208	225	225	225	196	144	100	87	86	96	120	142
50%	225	225	225	225	225	225	137	99	97	119	167	220
70%	225	225	225	225	225	225	189	127	110	137	214	225
90%	225	225	225	225	225	225	224	150	138	179	225	225
Coleman Powerhouse Flow												

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10%	159	155	158	157	169	142	92	76	83	83	111	103
30%	228	247	248	246	214	159	113	98	98	108	134	158
50%	250	252	254	251	251	245	151	111	109	133	184	240
70%	261	260	260	256	256	248	206	141	124	152	233	250
90%	274	269	275	267	261	256	243	165	153	196	257	268

Table L-12. Calculated Battle Creek Hydro Power Production for Alternative: Three Dam Removal

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta Powerhouse (MWh)												
10%	5441	4841	5430	5232	5220	4477	3531	3087	3168	3294	3926	4116
30%	6958	7159	8255	7199	6214	4847	3982	3665	3581	3982	4519	5426
50%	8730	7885	8730	8448	8730	6783	4829	3954	3892	4690	5575	7224
70%	8730	7885	8730	8448	8730	7868	6038	4609	4278	5156	6630	8730
90%	8730	7885	8730	8448	8730	8448	6852	5128	4918	6138	8448	8730
South Powerhouse (MWh)												
10%	2628	2313	2618	2515	2897	2328	1496	1222	1292	1348	1755	1624
30%	3886	4236	4805	4147	3721	2634	1870	1608	1545	1768	2143	2616
50%	5014	4538	5024	4862	5024	4240	2573	1847	1734	2200	3019	4107
70%	5024	4538	5024	4862	5024	4835	3576	2391	1970	2523	3894	5024
90%	5024	4538	5024	4862	5024	4862	4251	2821	2474	3338	4862	5024
Inskip Powerhouse (MWh)												
10%	2625	2313	2616	2514	2818	2275	1487	1213	1284	1339	1747	1658
30%	3820	3730	4129	3996	3601	2566	1842	1593	1536	1759	2130	2613
50%	4129	3730	4129	3996	4129	3996	2510	1820	1726	2191	2962	4030
70%	4129	3730	4129	3996	4129	3996	3463	2337	1962	2507	3793	4129
90%	4129	3730	4129	3996	4129	3996	4104	2745	2444	3281	3996	4129
Coleman Powerhouse (MWh)												
10%	3943	3478	3929	3777	4189	3406	2284	1885	1984	2069	2658	2551
30%	5654	5539	6153	5905	5310	3823	2792	2435	2352	2680	3213	3926
50%	6201	5650	6295	6025	6217	5878	3748	2761	2627	3309	4404	5954
70%	6476	5834	6447	6141	6360	5947	5112	3500	2971	3765	5594	6205
90%	6789	6032	6820	6414	6465	6150	6031	4085	3663	4873	6175	6648

System Total Annual (MWh)

10%	135842
30%	183860
50%	222069
70%	241167
90%	258236

Table L-13. Calculated Battle Creek Flows for Alternative: Six Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Keswick Diversion Dam												
10%	3	3	3	3	3	3	3	3	3	3	3	3
30%	3	3	3	3	3	3	3	3	3	3	3	3
50%	7	20	29	13	11	3	3	3	3	3	3	3
70%	71	67	64	41	44	3	3	3	3	3	3	8
90%	143	118	169	106	68	43	3	3	3	3	49	111
Below North Battle Creek Feeder Diversion Dam												
10%	49	48	49	48	47	41	30	26	28	24	35	36
30%	63	73	76	67	47	44	35	31	32	30	41	49
50%	87	88	102	75	71	47	43	34	35	37	47	66
70%	171	164	160	121	127	47	47	41	39	42	47	88
90%	292	249	334	229	167	125	47	46	45	47	135	237
Below Eagle Canyon Diversion Dam												
10%	91	90	91	91	87	75	54	45	49	50	64	65
30%	121	140	146	129	97	83	63	57	57	63	76	91
50%	165	174	193	156	151	105	79	62	64	77	93	126
70%	291	282	275	221	229	116	95	75	71	86	103	166
90%	460	400	519	373	285	226	103	85	84	101	240	383
Below Wildcat Diversion Dam												
10%	103	102	103	103	99	87	65	56	60	61	76	77
30%	134	153	160	142	110	95	74	68	69	74	88	103
50%	179	188	208	171	166	118	91	74	75	88	105	139
70%	307	298	291	236	244	129	108	87	83	98	116	180
90%	479	418	539	390	301	241	116	97	96	113	255	401
Above South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183
Below South Diversion Dam												
10%	53	52	53	52	50	43	29	24	26	26	36	36
30%	71	83	87	77	62	47	35	31	31	35	43	53

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50%	97	107	115	101	100	72	45	34	35	43	57	75
70%	150	147	144	125	128	86	60	42	40	49	70	97
90%	211	189	232	180	148	127	70	49	48	61	132	183
Below Inskip Diversion Dam												
10%	86	86	86	61	40	40	40	40	40	40	40	65
30%	86	86	86	61	40	40	40	40	40	40	40	86
50%	86	100	114	93	91	40	40	40	40	40	40	86
70%	167	162	158	128	133	67	40	40	40	40	40	86
90%	259	226	291	211	163	131	40	40	40	40	139	217
Below Coleman Diversion Dam												
10%	92	92	92	67	46	45	45	45	45	45	45	70
30%	92	92	92	67	46	46	45	45	45	45	45	92
50%	92	106	120	99	97	46	45	45	45	45	46	92
70%	173	168	165	135	139	72	46	45	45	46	46	92
90%	266	233	298	218	170	138	46	46	46	46	145	224
Below Confluence of North Fork and South Fork Battle Creek												
10%	200	198	200	174	150	138	116	107	110	111	126	152
30%	231	250	257	214	160	145	125	118	119	125	139	200
50%	276	299	333	275	267	169	142	124	126	139	156	236
70%	486	471	461	376	388	207	159	137	134	148	167	277
90%	753	656	850	613	476	384	167	148	147	164	406	630
Below Coleman National Fish Hatchery												
10%	345	340	345	343	331	292	220	191	203	205	255	259
30%	445	508	529	476	396	317	250	229	231	250	295	344
50%	579	635	676	605	595	448	305	248	252	296	366	462
70%	864	845	833	729	744	521	384	291	279	327	438	583
90%	1187	1072	1301	1020	851	739	438	325	322	391	765	1041

Table L-14. Calculated Battle Creek Diversions for Alternative: Six Dam Removal (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta 2 Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	109	91	73	58	54	54	58	68	80
50%	128	128	128	128	128	103	71	58	59	69	84	106
70%	128	128	128	128	128	119	89	68	65	76	100	128
90%	128	128	128	128	128	128	100	75	75	90	128	128
North Battle Creek Feeder Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	1	9	0	0	0	0	0	0	0
50%	0	20	22	22	22	17	0	0	0	0	5	0
70%	22	22	22	22	22	28	7	0	0	0	15	1
90%	22	22	22	22	22	22	15	0	0	4	22	22
Eagle Canyon Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Wildcat Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Canal Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Connector												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	110	100	73	58	54	54	58	68	80

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50%	128	148	150	150	150	120	71	58	59	69	89	106
70%	150	150	150	150	150	147	96	68	65	76	116	129
90%	150	150	150	150	150	150	116	75	75	94	150	150
Inskip Diversion												
10%	4	2	3	28	45	34	14	6	9	10	24	0
30%	32	50	56	66	64	42	22	17	17	22	35	3
50%	70	72	70	70	70	79	38	22	23	36	56	37
70%	70	70	70	70	70	73	61	34	31	44	76	71
90%	70	70	70	70	70	70	76	44	43	63	70	70
Inskip Connector												
10%	83	81	83	107	122	102	66	51	57	58	83	60
30%	134	166	177	176	164	115	81	70	71	81	104	83
50%	198	220	220	220	220	198	109	80	82	104	145	143
70%	220	220	220	220	220	220	157	102	95	120	192	200
90%	220	220	220	220	220	220	192	119	117	157	220	220
Coleman Diversion												
10%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
South Powerhouse Flow												
10%	80	79	80	79	77	68	52	45	48	48	59	60
30%	102	116	121	110	100	73	58	54	54	58	68	80
50%	128	148	150	150	150	120	71	58	59	69	89	106
70%	150	150	150	150	150	147	96	68	65	76	116	129
90%	150	150	150	150	150	150	116	75	75	94	150	150
Inskip Powerhouse Flow												
10%	83	81	83	107	122	102	66	51	57	58	83	60
30%	134	166	177	176	164	115	81	70	71	81	104	83
50%	198	220	220	220	220	198	109	80	82	104	145	143
70%	220	220	220	220	220	220	157	102	95	120	192	200
90%	220	220	220	220	220	220	192	119	117	157	220	220

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coleman Powerhouse Flow												
10%	104	101	104	128	142	121	82	66	73	73	101	78
30%	159	193	205	202	187	135	98	87	88	98	123	104
50%	228	252	254	251	251	223	128	97	99	123	167	168
70%	261	260	260	256	256	248	179	121	114	140	216	230
90%	270	269	270	267	261	256	216	139	137	179	257	268

Table L-15. Calculated Battle Creek Hydro Power Production for Alternative: Six Dam Removal

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volta Powerhouse (MWh)												
10%	5441	4841	5430	5232	5220	4477	3531	3087	3168	3294	3926	4116
30%	6958	7159	8255	7199	6214	4847	3982	3665	3581	3982	4519	5426
50%	8730	7885	8730	8448	8730	6783	4829	3954	3892	4690	5575	7224
70%	8730	7885	8730	8448	8730	7868	6038	4609	4278	5156	6630	8730
90%	8730	7885	8730	8448	8730	8448	6852	5128	4918	6138	8448	8730
South Powerhouse (MWh)												
10%	1806	1606	1802	1736	1732	1486	1172	1024	1051	1093	1303	1366
30%	2309	2375	2739	2411	2269	1608	1321	1216	1188	1321	1499	1800
50%	2897	3028	3395	3285	3395	2620	1602	1312	1291	1556	1954	2397
70%	3395	3066	3395	3285	3395	3218	2172	1530	1420	1711	2535	2916
90%	3395	3066	3395	3285	3395	3285	2621	1702	1632	2132	3285	3395
Inskip Powerhouse (MWh)												
10%	1530	1337	1523	1904	2239	1817	1209	938	1017	1064	1480	1108
30%	2456	2752	3248	3123	3014	2042	1484	1291	1270	1484	1842	1521
50%	3632	3647	4037	3907	4037	3523	2001	1467	1459	1916	2571	2618
70%	4037	3647	4037	3907	4037	3907	2875	1867	1695	2200	3402	3670
90%	4037	3647	4037	3907	4037	3907	3517	2183	2085	2877	3907	4037
Coleman Powerhouse (MWh)												
10%	2587	2271	2577	3074	3531	2908	2032	1637	1744	1821	2418	1932
30%	3934	4330	5086	4844	4640	3236	2432	2151	2112	2432	2944	2574
50%	5653	5650	6295	6025	6217	5359	3184	2407	2387	3061	3996	4170
70%	6476	5834	6447	6141	6360	5947	4442	2989	2731	3475	5186	5708
90%	6696	6032	6696	6414	6465	6150	5361	3450	3298	4451	6175	6648

System Total Annual (MWh)

10%	114638
30%	154083
50%	197421
70%	218886
90%	235784

Appendix M

Instream Flow Effects on Water Temperatures in the Battle Creek Restoration Area

Appendix M
Instream Flow Effects on Water Temperatures in the Battle Creek Restoration Area

Introduction

Water temperature directly affects the quality of habitat used by various life stages of stream-resident fish. In Battle Creek, water temperatures are influenced by seasonal hydrological and meteorological conditions, diversions and powerhouse discharges into South Fork, and the instream flow releases below diversion dams, and the diversion of cold spring water from the stream channel (Kier Associates 1999; Thomas R. Payne and Associates 1998a, 1998b). The effects on fish populations are determined by the distribution of water temperatures within the stream habitat.

In this appendix, water temperatures are evaluated for the existing and No Action conditions and the four steelhead and salmon restoration alternatives. The habitat flows and hydroelectric power diversions have been simulated with a monthly model that is described in Appendix K. The temperatures at the upstream end of North Fork and South Fork have been obtained from field measurements. Warming estimates for each reach of Battle Creek that depend on the stream flow and month have been developed to approximate the measured temperatures obtained by DWR during the last five years (1998–2002) and data collected by TRPA in 1989.

The distribution of water temperature within the habitat of stream-resident fish affects their ability to effectively utilize that habitat. Natural temperature conditions in Central Valley streams vary along a continuum from mountain headwaters to lowland rivers (CALFED 2000), and populations of fishes have adapted to this natural continuum. Hydroelectric power diversions that divert relatively cool water from North Fork Battle Creek to South Fork Battle Creek may cool South Fork Battle Creek, but may also disrupt the temperature continuum. Habitat within these artificially cooled areas is considered to be of lower quality during months when it is disconnected from contiguous cool habitat. Furthermore, fish residing in artificially cooled areas are at risk of exposure to sub-optimal water temperatures during planned or unplanned disruptions in the hydropower conveyance system. The normal PG&E practice, however, in the Battle Creek system is to continue the diversion and canal flows, and allow the canal flow to bypass the powerhouse and flow into the river whenever the power plants are shut down.

Methods

Optimal Water Temperatures

Water temperatures are considered optimal when a number of physiological functions, including growth, swimming, feeding, and spawning are not limited. Optimal temperatures provide for normal feeding activity, normal physiological response, and normal behavior (McCullough 1999). The monthly fish life stage production model considers the optimal temperatures for spawning (and emerging fry) and the optimal rearing temperatures for steelhead and for chinook. The monthly survival rates for these two life stages are estimated from the monthly average temperature. Figure M-1 shows the assumed relationships.

For steelhead, optimal water temperatures for spawning and emerging fry are less than 53 ˚F. The monthly survival of incubating eggs is assumed to be less than 80% at a temperature of 56 ˚F. Because steelhead eggs incubate for at least two months, temperatures above 56 ˚F will result in much lower survival of fry. For chinook, the optimal spawning temperature is slightly warmer, with 100% survival below 55 ˚F, and less than 80% survival at 58 ˚F. For Steelhead rearing, the optimal temperature is less than 66 ˚F, with less than 80% monthly survival at a temperature of 70 ˚F. Because juvenile steelhead remain in the stream for an entire year, only a few months above 70 ˚F can be tolerated. Optimal rearing temperatures for chinook are assumed to be less than 65 ˚F, which is slightly cooler than for steelhead. The chinook monthly rearing survival is assumed to be less than 80% at a temperature of 69 ˚F.

For comparing the measured water temperatures in Battle Creek, ideal spawning temperatures would be less than 55 ˚F and ideal rearing temperatures would be less than 65 ˚F. A few months of up to 70 ˚F can be tolerated, but temperatures above 75 ˚F are considered to be unsuitable for steelhead or chinook rearing. These are relatively cool temperatures for streams flowing from the Sierra Nevada or Cascade Mountains into the Central Valley of California in the summer. Battle Creek is somewhat unique because of the large number of cool springs that feed the North Fork and South Fork, and the relatively deep canyon that provides shade on the North Fork.

Measured Water Temperatures

Water temperatures have been measured in Battle Creek during the IFIM studies in 1989 (Thomas R. Payne and Associates 1996a, 1996b) and during recent years by the DWR Northern District Office. These measured temperatures are shown and described here to provide an accurate description of water temperature patterns in the North Fork and South Fork of Battle Creek. Measurements are also available from the diversion canals and powerhouse tailwater, and in the mainstem Battle Creek below the confluence. No measurements have been collected in the springs that feed Battle Creek. The temperature measurements have been used to develop warming estimates for each reach of Battle Creek. These warming estimates were used in the monthly fish production model to estimate the likely future production of fish in each reach for each baseline and restoration alternative.

Water temperatures were collected on Battle Creek using data loggers in 1989 by Thomas R. Payne and Associates (1996a, 1996b) and from 1998-2001 by DWR Northern District. Hourly data was collected, and then reported as daily minimum, mean and maximum temperatures at several stations. Temperatures were analyzed to estimate warming which took place in each reach of Battle Creek during the warmer months of June through September. During this period, flows in both the North and South Forks of Battle Creek were generally less than about 30 cfs. Warming is expected to be less at higher flows. These historical temperature records were evaluated to estimate the general influence of flow on Battle Creek temperatures.

1989 Temperatures

Figure M-2 shows the water temperatures in Battle Creek for May through October 1989. The first graph shows water temperatures in the North Fork. Temperatures in the first reach from Feeder Dam to Eagle Canyon Diversion Dam ranged from about 55 °F to 60 °F in July, the warmest month. Warming in this reach was about 3 °F in June and rose gradually to about 5 °F by September. The second reach is from Eagle Canyon Diversion Dam to Wildcat Diversion Dam. Warming in this reach was stronger. Beginning with about 2 °F in May, it rose to about 10 °F during July, and then declined back to about 2 °F in October. The third reach is from Wildcat Diversion Dam to near the mouth of the North Fork confluence. This reach experienced very little warming. Changes in temperature were less than 1 °F.

The second graph of Figure M-2 shows water temperatures in the South Fork for the May to October period. Temperatures in the first reach from South Diversion Dam to the South Powerhouse were about 50 °F in May and rose to about 60 °F by August. Warming in this reach was about 5 °F. The next reach is from Inskip Diversion Dam to the Inskip Powerhouse. There was no temperature data for Inskip Diversion Dam in 1989 but it was cooled by the South Powerhouse discharge and would have been similar to the South Powerhouse tailwater temperature. Temperatures above Inskip Powerhouse were 70 to 75 °F in July. The warming in July can be estimated as the difference between above Inskip Powerhouse and the South Powerhouse tailwater that was about 60 ˚F. Warming can be estimated to be about 10 to 15 ˚F. The third reach is from Coleman Diversion Dam to near the mouth of the South Fork. There was no temperature data for Coleman Diversion Dam in 1989. Temperatures at the mouth were similar to temperatures above Inskip Powerhouse. The Coleman Powerhouse and canal was shut-off during August and temperatures at the mouth were cooled by the Inskip Powerhouse discharge.

The third graph of Figure M-2 shows water temperatures in the mainstem of Battle Creek. There was no temperature data available for the confluence of the North and South Forks in 1989. The large drop in temperatures evident from above Coleman Powerhouse to Coleman Powerhouse tailwaters is the result of cooler water in the Coleman Canal entering the mainstem. The mainstem was cooled during August while the Coleman Powerhouse was turned off and Coleman Diversion Dam diversions were reduced.

Figure M-3 shows the water temperatures in three of the power diversion canals. The first graph shows the temperatures in the Cross Country Canal and the South Battle Creek Canal. The Cross Country Canal is relatively cool North Fork water, while the South Battle Creek Canal is slightly warmer South Fork water. Accordingly, the temperatures at the South Powerhouse tailwater are between those of the two contributing canals. They ranged from about 55 to 60 °F during the summer period of June, July & August.

The second graph shows the temperatures in the Eagle Canyon Canal and the Inskip Canal. The temperature at the Inskip Powerhouse tailwater represents a blending of the two canals. Temperatures ranged from about 50 to 60 °F during the summer period of June to August.

The third graph shows the temperatures in the Coleman Canal. Warming in this canal was variable, from about 2 to 5 °F. For a period in August, warming jumped to about 6 to 8 °F. This change was the result of the Coleman Powerhouse experiencing an outage that lasted 23 days. With the powerhouse shut down, canal flow was apparently much lower and warming in the canal increased. The monthly temperatures and warming in each reach during 1989 are summarized in Table M-1.

1998 Temperatures

Figure M-4 shows average daily water temperatures in Battle Creek for 1998. The first graph shows temperatures in the North Fork. Temperatures in the North Fork remained below 60 °F for the entire year. Warming in the three North Fork reaches was very slight because of the generally high flows (Table M-2).

The second graph shows water temperatures in the South Fork. South Fork temperatures rose to about 65 °F in August. Warming from South Diversion Dam to the confluence (mouth) was less than 5 °F because of the high flows. Warming in the Coleman reach was about 1 °F in June and about 3 to 4 °F in August.

The third graph shows water temperatures in the mainstem of Battle Creek. Temperatures below the confluence of North and South Forks rose to about 60 °F in August. Warming in this reach was about 5 °F in July and August.

Figure M-5 shows the canal temperatures were less than 65 °F because the river diversion temperatures were generally cool in 1998. Table M-2 summarizes the monthly temperatures and warming measured in 1998.

1999 Temperatures

Figure M-6 shows the water temperatures in Battle Creek for 1999. The first graph shows the temperatures for the North Fork. Flows at Eagle Canyon Diversion Dam dropped to about 35 cfs in mid-June. Temperatures in the first reach rose to about 55 °F in July. Warming in this reach varied from 1 to 2 °F. Warming in the second reach was less than 3 °F. Warming in the third reach ranged from 1 to 3 °F (Table M-3).

The second graph shows water temperatures in the South Fork. After mid-June, flows in the South Fork dropped to less than 35 cfs. Temperatures in the first reach rose to about 60 °F by July. Warming in the South reach was about 4 °F for most of the period of lower flows. Warming in the Inskip reach varied from about 2 to 12 °F, with warming being over about 8 °F for most of the period of lower flows. Warming in the Coleman reach varied from about 1 to 4 °F, with warming being over about 3 °F for most of the period of lower flows (30 cfs interim flow).

The third graph shows water temperatures in the mainstem of Battle Creek. Temperatures below the confluence of North and South Forks rose to about 65 °F in July. Warming in the mainstem was about 1 °F in June and from about 3 to 5 °F in September. Temperatures upstream of the Coleman Powerhouse reached a maximum of about 70 °F in July and August. North Fork and South Fork flows were each about 30 cfs at the confluence.

Figure M-7 shows the water temperatures in three of the canals. The first graph shows the temperatures in the Cross Country Canal and the South Battle Creek Canal. The Cross Country Canal is relatively cool North Fork water, with temperatures that varied from about 50 to 60 °F during the June to September period. The South Battle Creek Canal is slightly warmer South Fork water, with temperatures that varied from about 50 to 65 °F during the summer.

The second graph shows the temperatures in the Eagle Canyon Canal and the Inskip Canal. The temperatures in Eagle Canyon Canal varied from 50 to 62 °F. The temperatures in Inskip Canal varied from about 47 to 61 °F.

The third graph shows the temperatures in the Coleman Canal. The temperatures in Coleman Canal varied from 50 to 65 °F during the summer. Table M-3 gives the monthly temperatures and warming estimates for 1999.

2000 Temperatures

Figure M-8 shows the water temperatures in Battle Creek for 2000. The first graph shows the temperatures for the North Fork. Flows at Eagle Canyon Diversion Dam dropped to about 30 cfs in late-June. Temperatures in the first reach rose to about 60 °F by the end of June. Warming in this reach varied from about 2.5 to 3 °F. Warming in the Eagle reach began about 2 °F in mid-July and declined to about 0.5 °F at the end of August. Warming in the Wildcat reach began about 3 °F in mid-July and declined to about 0.5 °F by the end of August.

The second graph shows water temperatures in the South Fork. Near the end of June, flows in the South Fork dropped to about 35 to 40 cfs. Temperatures in the first reach began about 50 °F and rose to about 65 °F by July. Warming in the first reach varied from about 4 to 5 °F. Warming in the Inskip reach was about 4 to 5 °F in June and rose to 12 to 14 °F in July and August, and then dropped to about 8 °F by the end of August. Warming in the Coleman reach varied from 1 to 2 °F because of the relatively high flow of 30 cfs.

The third graph shows water temperatures in the mainstem of Battle Creek. Temperatures below the confluence of North and South Forks rose to about 67 °F in August. Warming in the mainstem was about 2 to 4.5 °F in June, about 3.5 to 6 °F in July, and about 3 to 6.5 °F in August.

Figure M-9 shows the water temperatures in three of the canals. The Cross Country Canal temperatures varied from about 51 to 59 °F. The South Battle Creek Canal temperatures varied from about 54 to 66 °F. Accordingly, the temperatures at the South Powerhouse Tailwater ranged from about 52 to 60 °F.

The second graph shows the temperatures in the Eagle Canyon Canal and the Inskip Canal. Temperatures were generally 55 to 60 °F during the summer. The third graph shows the temperature changes in the Coleman Canal. Temperatures at Coleman Diversion Dam varied from about 55 to 65 °F. Warming in this canal was less than 2 °F with maximum temperatures of 65 °F. The Coleman Powerhouse temperatures were higher in early June because of the Powerhouse was out for several days. Table M-4 summarizes the monthly temperatures and warming in each Battle Creek reach for 2000.

2001 Temperatures

Figure M-10 shows the water temperatures in Battle Creek for 2001. The first graph shows the temperatures for the North Fork. Flows near the mouth of the North Fork were about 38 to 45 cfs for the period June to September. Temperatures at the Feeder Dam remained below 58 °F. Warming in the Feeder reach varied from about 2 to 3 °F. Warming in the Eagle reach was about 1 to 3 °F in June, about 2 to 3 °F in July and August, and about 1 to 2 °F in September. Warming in the Wildcat reach was about 1.5 to 3.5 °F in June, about

2.5 to 3.5 °F in July, declining to about 2 to 3 °F in August and 1 to 2 °F in September. North Fork temperatures remained below 65 °F at the mouth.

The second graph shows water temperatures in the South Fork. For most of the period June to September, flows in the South Fork were about 6 to 8 cfs. Temperatures in the South reach rose to about 62 °F by July. Warming in the first reach varied from about 12 °F in June, about 14 °F in July, 12 °F in August, and 9 °F in September. Warming in the Inskip reach was 9 °F in June, 10 °F in July and the beginning of August. At the end of September, warming was about 7 °F. South Fork temperatures at the mouth were 70 to 75 °F during the summer.

The third graph shows water temperatures in the mainstem of Battle Creek. Temperatures below the confluence were about 60 °F in June and rose to about 70 °F in July. Warming in the mainstem was only about 1 °F in June, because Coleman Powerhouse and canal was shut off. Warming was about 4 to 6 for July. Warming peaked at 7 to 8 °F in early August, and then gradually declined to 4 to 7 °F in September.

Figure M-11 shows the water temperatures in three of the canals. The first graph shows the temperatures in the Cross Country Canal and the South Battle Creek Canal. The Cross Country Canal temperatures varied from about 55 to 58 °F. The South Battle Creek Canal temperatures varied from about 56 to 64 °F. Temperatures at the South Powerhouse Tailwater ranged from about 54 to 60 °F. The second graph shows the temperatures in the Eagle Canyon Canal and the Inskip Canal. The temperatures in the Eagle Canyon Canal varied from about 56 to 60 °F. The temperatures in Inskip Canal varied from about 54 to 60 °F. The average warming in these canals was about 1 °F in early June, and then about 1 to 2.5 °F in August and early September. The third graph shows the temperatures in the Coleman Canal. Warming in the canal during August and early September was about 3 °F. Coleman Powerhouse was shut down during May and June. Table M-5 gives the monthly summary of 2001 temperatures and warming in each reach.

These temperature measurements from 5 years provide a very accurate description of water temperature conditions in Battle Creek. A wide range of flow conditions is included in the measurements. Temperatures at the upstream end of the restoration area will not be affected by the restoration alternatives. Temperatures in the other reaches can be influenced by instream flows, diversions, and powerhouse tailwater discharges. Warming estimates were developed from these measurements and used in the fish production modeling. The warming estimates will be described in the next section.

Modeling Methodology

Water temperatures in Battle Creek were modeled using SNTEMP, a cross-sectional averaged one-dimensional model, which was applied to the Battle Creek system including the natural stream channels and Hydroelectric Project canals (PG&E 2001a). Development of the SNTEMP model in Battle Creek, including calibration and partial validation, was primarily conducted in the late 1980s by Thomas R. Payne and Associates (1996a, 1996b). Additional development of the model, including re-calibration and validation, was conducted by Pacific Gas and Electric Company staff (2001b) to support development of the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project).

The SNTEMP model simulated the Battle Creek temperature distribution, both spatially and temporally, using specifications of hydrology (dry, normal, and wet water years) and meteorology (hot, normal, and cold climate conditions). However, many of the inputs and assumptions of the SNTEMP model are not available without the computer files used for the modeling cases. The graphical results for the different restoration alternatives indicate the simulated warming in each reach. A simpler approach that would approximate the reach warming under any flow during the summer period was developed for use in the monthly fish production modeling. The development of this method and the comparison with the SNTEMP model output will be described in this section.

Battle Creek Warming Estimates

The upstream temperatures recorded at North Fork Feeder Dam and at South Diversion Dam have been fairly consistent from year to year. The restoration project will not influence the South Fork temperatures or flows upstream of South Diversion Dam. The temperatures at North Fork Battle Creek Feeder Diversion Dam are also assumed to be controlled by Bailey Creek and Rock Creek inflows. The restoration project does not include changing flows below the Keswick Diversion Dam, so the North Fork Battle Creek Feeder Diversion Dam temperatures are assumed to be unchanged by any restoration alternative. The monthly summer temperatures assumed at North Battle Creek Feeder dam are 56 ˚F in June, 57.5 ˚F in July, 56 ˚F in August, and 55 ˚F in September. At the South Diversion Dam the assumed monthly temperatures are slightly higher. The South Diversion Dam summer temperatures are assumed to be 60 ˚F in June, 62.5 ˚F in July, 62.5 ˚F in August, and 60 ˚F in September. All of the monthly temperatures used in the monthly modeling can be reviewed in Appendix L, “Results of the Monthly Flow and Power Model.”

Possible Effects of Flow on Temperature Warming

Warming in the summer months is assumed to be a direct function of the habitat flow. Higher flows will limit the warming. The greatest possible effect from increased flow is a direct inverse relationship with temperature:

Temperature Warming (˚F) = A / Flow (cfs)

If this relationship holds, then doubling the flow will reduce the warming to 50%. Increasing the flow by a factor of 10 will reduce the warming to 10%. This is the greatest possible effect because the higher flows will increase the volume and surface area of the stream reach and allow more heat exchange and a slightly longer travel time for warming to occur. This theoretical relationship will also assign the greatest benefit to the first increment of flow. For example increasing the South Fork flow from 5 cfs to 10 cfs would reduce the warming to 50% reduction of the existing warming. Increasing the flow to 20 cfs would reduce the warming to 25% of the existing warming. Increasing the flow to 40 cfs would reduce the warming to 12.5% of the existing warming. If the existing warming was 10 ºF in July and August, the increase from 5 cfs to 10 cfs would reduce the warming by 5 ºF. The increase in flow from 10 cfs to 20 cfs would reduce the warming by an additional 2.5 ºF. Increasing the flow from 20 cfs to 40 cfs would reduce the warming only by an additional 1.25 ºF.

A smaller estimated change in warming with flow was used in the monthly model. The warming in each reach is assumed to be proportional to the square root of flow:

$$\text{Warming (˚F)} = A / \text{Flow (cfs)}^{0.5}$$

If this relationship holds, a 4x increase in flow (from 5 cfs to 20 cfs) would be required to reduce the warming to 50% of the existing warming at 5 cfs. An increase in flow from 5 cfs to 80 cfs (16x increase) would be required to reduce the warming to 25% of the existing warming. This assumed relationship will "even out" the potential temperature benefits from increased flow, and will require a greater increase in flow to achieve the same reduction in warming.

The warming observed in July and August is generally the highest. Warming in other months is assumed to be a simple fraction of the potential warming in July or August. Warming in June and September is assumed to be 80% of the maximum value for July or August. Warming in May and October is assumed to be 60% of the maximum value. Warming in April and November is assumed to be 40% of the maximum and warming in the other months is assumed to be 20%. This is a simple, yet effective, way to account for the change in meteorology throughout the year.

Measured Warming Relationships

Tables M-1 through M-5 provide a summary of the monthly temperatures measured in Battle Creek during the 5 years with data. For 1989, the measured warming between North Fork Battle Creek Feeder and Eagle Canyon Diversion Dam was about 4 ˚F in July and August with a flow of 5 cfs. The assumed warming equation is:

$$\text{Feeder Warming (˚F)} = 9 / \text{Flow (cfs)}^{0.5}$$

The warming at a flow of 5 cfs is 4 ˚F, and the warming with a flow of 20 cfs would be 2 ˚F. Unfortunately, the higher flows at North Fork Battle Creek Feeder Dam are not estimated from the stage records (limited stage-discharge rating curve) and so the validity of the warming relationship cannot be confirmed. The 1989 warming in the Eagle reach was about 8 ˚F at a flow of 4 cfs. The assumed Eagle warming equation is:

$$\text{Eagle Warming (˚F)} = 16 / \text{Flow (cfs)}^{0.5}$$

The warming at a flow of 5 cfs would be 7 ˚F, and the warming at a flow of 20 cfs would be 3.5 ˚F. Warming at a flow of 40 cfs would be 2.5 ˚F. The actual warming measured in 1999, 2000, and 2001 when the interim Eagle Canyon Diversion Dam Flow was between about 33 cfs and 40 cfs suggests that the warming was between 1.5 and 2.5 ˚F. This is less warming than would be expected from the assumed relationship, but more than would be expected if the alternative 1/flow warming equation was used. The observed warming was less than the 3 ˚F expected from the 35 cfs interim flow condition using the $1/\text{flow}^{0.5}$ warming equation.

The measured warming in the Wildcat reach was very small in 1989. The warming observed in the 1999–2001 period with interim flows of about 35–40 cfs was about 3–4 ˚F. The assumed warming equation for the Wildcat reach is:

$$\text{Wildcat Warming (˚F)} = 18 / \text{Flow (cfs)}^{0.5}$$

For the three South Fork reaches, similar warming equations were estimated. For the South reach in 1989 with a flow of 6 cfs the warming in July and August was about 6 ˚F. The warming was about 4–5 ˚F for flows of 6–7 cfs in the 1999–2001 measurements. The assumed warming in the South reach is:

$$\text{South Warming (˚F)} = 12 / \text{Flow (cfs)}^{0.5}$$

For the Inskip reach, the measured warming in June and July of 2000 and 2001 was about 10–14 ˚F for flows of about 8–10 cfs. During 1999 the warming was still 10 ºF for flows of 14–22 cfs. The assumed warming in the Inskip reach is:

$$\text{Inskip Warming (˚F)} = 40 / \text{Flow (cfs)}^{0.5}$$

The calculated warming will be 13 ˚F with a flow of 10 cfs and 9 ˚F with a flow of 20 cfs. The warming was reduced by about the expected amount between flows of 10 cfs and 20 cfs. An adaptive management experiment to measure temperatures while the flows are varied from 5 cfs to 10 cfs to 20 cfs to 40 cfs for about a week each during the July and August period would increase the accuracy of the Inskip warming estimates.

The measured warming in the Coleman reach was about 3 ˚F when the interim flows were 33-36 cfs in 1998–2000. The warming was about 9–10 ˚F in July and August of 2001 when the Coleman flows were reduced to 6 cfs to discourage fish from using the South Fork. The assumed Coleman reach warming is:

$$\text{Coleman Warming (˚F)} = 24 / \text{Flow (cfs)}^{0.5}$$

The mainstem warming in 2001 with a flow of 42 cfs was 5–7 ˚F in July and August. During July and August of 1999 and 2000 when the confluence flow was about 75 cfs, the measured warming was still 4–5 ˚F. The assumed mainstem warming between the confluence and upstream of the Coleman powerhouse is:

Mainstem Warming (˚F) = 42 / Flow (cfs) $^{0.5}$

The estimated warming with a flow of 10 cfs would be 13 ˚F. The estimated warming with a flow of 40 cfs would be 7 ˚F, and the estimated warming with a flow of 80 cfs would be 5 ˚F. These estimates match the measured warming in 1999 and 2000 when the confluence flow was about 75 cfs.

The Coleman warming estimate of 4 ˚F with a flow of 36 cfs is slightly higher than measured. The temperature-warming model used in the fish habitat assessment will calculate temperatures that are generally warmer than observed at higher flows. This will lead to conservative assessment of temperature benefits from alternative restoration actions because the actual temperatures may be slightly lower than calculated.

Temperatures along the North Fork Battle Creek have not been measured at Keswick Dam, so the temperatures in the Keswick reach are assumed to be the same as measured at North Battle Creek Feeder Diversion Dam. However, the temperatures at the North Battle Creek Feeder Diversion Dam may be largely influenced by the Rock Creek and Bailey Creek flows that enter North Fork Battle Creek just upstream of the North Battle Creek Feeder Diversion Dam. There may be substantial warming, therefore, below Keswick Dam at the minimum required FERC flows of only 3 cfs. A temperature measurement location should be established upstream of the Rock Creek confluence to identify this possible warming condition in the Keswick reach with relatively low flows.

A similar situation may exist at the Eagle Canyon Diversion Dam, where temperature measurements may be influenced by the Digger Creek flows that enters North Fork Battle Creek just upstream of the Eagle Canyon Diversion Dam. Temperature measurements at the mouth of Digger Creek in 2001 and 2002 were identical to the Eagle Canyon Diversion Dam measurements, with June and July temperatures of almost 60ºF. A temperature measurement location should be established upstream of Digger Creek to identify the potential warming in the North Battle Creek Feeder reach with relatively low flows.

Calculated Temperatures for 2000 and 2001

Figure M-10 shows the North Fork calculated and historical water temperatures for 2000. Warming in the Feeder reach was about 2 to 3 ˚F. The calculated temperatures at Eagle Canyon Diversion Dam matched this warming. Warming in the Eagle reach was about 1 to 2 ˚F. The calculated temperatures at Wildcat Diversion Dam were about 1 ˚F less than the historical record. Warming in the Wildcat reach was about 1 to 3 ˚F. The calculated temperatures at the mouth were about 1 ˚F higher than the historical record. Warming in the mainstem reach was about 3–5 ˚F during the summer months. The calculated warming in the mainstem reach were similar, although calculated temperatures at the Coleman Powerhouse were higher than the historical data. Overall, the calculated temperatures provide a reasonable approximation of the measured data during the year.

Figure M-11 shows the South Fork calculated and historical water temperatures for 2000. Warming in the South reach was about 4 ˚F. The calculated temperatures at the South Powerhouse matched this warming. Warming in the Inskip reach was about 8 to 12 ˚F. The calculated temperatures at the Inskip Powerhouse matched this warming. The calculated temperatures in July, August, and September produced more warming than the historical record. Warming in the Coleman reach was about 1 to 3 ˚F because of the interim flow of 30 cfs. The calculated temperatures at the mouth produced about 3 ˚F more warming than the historical record. The calculated South Fork temperatures generally matched the 2000 data.

Figure M-12 shows the North Fork calculated and historical water temperatures for 2001. Warming in the Feeder reach was about 2 ˚F. The calculated temperatures at Eagle Canyon Diversion Dam matched this warming in June and September, but produced about 1 ˚F more warming than the historical record in July and August. Warming in the Eagle reach was about 2 ˚F. The calculated temperatures at Wildcat Diversion Dam matched this warming in June, but were about 1 ˚F higher than the historical data in July through September. Warming in the Wildcat reach was about 2 to 3 ˚F. The calculated temperatures at the mouth matched this warming in June and July, but produced about 1 ˚F more warming than the historical record in August and September. The warming in the mainstem reach was about 3 to 6 ˚F. The calculated temperatures at the Coleman Powerhouse were about 3 to 4 ˚F higher than the historical data in June and July, and about 1 ˚F higher than the historical record in August and September. Overall the match of the calculated temperatures with the 2001 data was good.

Figure M-13 shows the South Fork calculated and historical water temperatures for 2001. Warming in the South reach was about 5 ˚F. The calculated temperatures at the South Powerhouse matched the data in July and August, but were about 1 ˚F cooler than the historical record in June and September. Warming in the Inskip reach was about 9 to 13 ˚F. The calculated temperatures at the Inskip Powerhouse were about 1 ˚F less than the historical record in June and July, but matched the data in August and September. Warming in the Coleman reach was about 7 to 10 ˚F. The calculated temperatures at the mouth matched this warming, but were about 1 ˚F higher than the historical record in July through September.

The releases below Coleman Diversion Dam were greater than 30 cfs in 2000 (Interim flows) but were reduced to about 8 cfs in 2001. The warming estimates in 2000 were a little higher than measured. The warming estimates in 2001 when the flows were reduced were very close to measurements. The assumed warming relationship with $1/\text{flow}^{0.5}$ may overestimate the actual warming at higher flows.

These two years of data suggest that the monthly temperature estimates are adequate for accurate assessment of the temperature effects from flow changes in Battle Creek.

Calculating Monthly Temperature Survival

Many of the Battle Creek reaches have a wide range of temperatures from a relatively cool temperature at the upstream end to a warmer temperature at the downstream end. The monthly fish production model assumed a linear effect of temperature and calculated the survival at the cooler upstream end and the survival at the warmer downstream end. An average survival was used for fish in the reach.

No direct comparisons of the average reach temperatures for the different alternatives were made, because the effects of temperature on fish survival was accounted for in the fish production model. The fish production model was run with all temperatures assumed to be ideal (below 53 ˚F) to estimate the fish production without any temperature limits. Comparison of the change in fish production when temperatures are included in the calculations provides a direct indication of the magnitude of the potential temperature effects for each alternative. The calculated reduction in fish production from temperature effects was quite large for several of the alternatives. The winter run and spring run chinook are most severely limited by temperatures. Temperature change is not considered a significant impact itself unless the potential fish production is reduced by the warmer temperatures.

Battle Creek Temperature Results

The monthly temperatures calculated for each restoration alternative for the range of Battle Creek flows in each reach are given in Tables M-6 through M-11. The consequences of water temperatures for minimum instream flow requirements on fish populations are described in Section 4.1, "Fish."

Table M-1a. North Fork Battle Creek Warming Estimates, 1989

	June	July	August	September
Flows (cfs)				
North Battle Creek Feeder	30+	5	5	4
Eagle Canyon	4	4	4	4
Wildcat	6	6	6	6
Temperatures (˚F)				
North Battle Creek Feeder	56.1	56.6	55.3	53.5
Eagle Canyon	59.5	60.3	59.6	57.9
Wildcat	64.4	69.2	67.1	61.9
Mouth	64.2	68.7	67.1	62.6
ΔT				
North Battle Creek Feeder – Eagle	3.4	3.7	4.3	4.4
Eagle – Wildcat	4.9	8.9	7.5	4.0
Wildcat – Mouth	-0.2	-0.5	0.0	0.7

Table M-1b. South Fork Battle Creek Warming Estimates, 1989

	June	July	August	September
Flows (cfs)				
South	6	6	6	6
Inskip	7	6	6	7
Coleman	8	7	7	7
Temperatures (˚F)				
South	58.5	58.9	57.2	54.4
above South Powerhouse	64.4	65.1	63.4	59.8
Inskip	--	--	--	--
above Inskip Powerhouse	63.4	72.1	69.4	63.4
Coleman	--	--	--	--
Mouth	64.2	65.1	59.9	60.0
ΔT				
South – above South Powerhouse	5.9	6.2	6.2	5.4
Inskip – above Inskip Powerhouse	--	--	--	--
Coleman – Mouth	--	--	--	--

Table M-2a. North Fork Battle Creek Warming Estimates, 1998

	June	July	August	September
Flows (cfs)				
North Battle Creek Feeder	30+	30+	30+	30+
Eagle	30+	30+	30+	30+
Wildcat	30+	30+	30+	30+
Temperatures (˚F)				
North Battle Creek Feeder	51.8	56.1	57.9	52.7
Eagle	52.8	57.2	58.0	56.3
Wildcat	--	58.5	59.3	57.7
Mouth	54.2	59.4	60.8	56.1
ΔT				
North Battle Creek Feeder – Eagle	1.0	1.1	0.1	3.6
Eagle – Wildcat	--	1.3	1.3	1.4
Wildcat – Mouth	--	0.9	1.5	-1.6

Table M-2b. South Fork Battle Creek Warming Estimates, 1998

	June	July	August	September
Flows (cfs)				
South	30+	30+	7	7
Inskip	30+	30+	35	25
Coleman	30+	30+	33	33
Temperatures (˚F)				
South	50.9	58.9	--	54.1
above South Powerhouse	--	--	--	--
Inskip	54.3	60.0	--	53.8
above Inskip Powerhouse	--	--	--	--
Coleman	55.4	60.3	60.8	55.0
Mouth	54.7	63.4	63.9	59.0
ΔT				
South – above South Powerhouse	--	--	--	--
Inskip – above Inskip Powerhouse	--	--	--	--
Coleman – Mouth	-0.7	3.1	3.1	4.0

Table M-3a. North Fork Battle Creek Warming Estimates, 1999

	June	July	August	September
Flows (cfs)				
North Battle Creek Feeder	30+	30+	6	5
Eagle	30+	35	33	33
Wildcat	30+	40	36	36
Temperatures (˚F)				
North Battle Creek Feeder	54.1	56.8	56.0	54.6
Eagle	55.7	58.5	57.7	56.2
Wildcat	56.9	60.2	59.8	57.8
Mouth				
ΔT				
North Battle Creek Feeder – Eagle	1.6	1.7	1.7	1.6
Eagle – Wildcat	1.2	1.7	2.1	1.6
Wildcat – Mouth	-2.2	3.2	4.1	1.2

Table M-3b. South Fork Battle Creek Warming Estimates, 1999

	June	July	August	September
Flows (cfs)				
South	30+	7	6	7
Inskip	49	22	14	11
Coleman	38	36	36	35
Temperatures (˚F)				
South	57.5	61.9	60.5	57.7
above South Powerhouse	60.6	66.3	64.7	61.5
Inskip	57.1	59.2	58.0	55.8
above Inskip Powerhouse	61.8	68.9	68.1	64.0
Coleman	58.6	60.7	59.5	57.2
Mouth	60.6	63.9	62.0	58.7
ΔT				
South – above South Powerhouse	3.1	4.4	4.2	3.8
Inskip – above Inskip Powerhouse	4.7	9.7	10.1	8.2
Coleman – Mouth	2.0	3.2	2.5	1.5

Table M-4a. North Fork Battle Creek Warming Estimates, 2000

	June	July	August	September
Flows (cfs)				
North Battle Creek Feeder	30+	5	5	5
Eagle	10	34	37	38
Wildcat	47	37	40	41
Temperatures (˚F)				
North Battle Creek Feeder	55.9	56.6	55.9	53.2
Eagle	--	59.6	58.6	55.6
Wildcat	59.2	61.5	60.0	56.4
Mouth	--	64.2	62.2	57.5
ΔT				
North Battle Creek Feeder – Eagle	--	3.0	2.7	2.4
Eagle – Wildcat	--	1.9	1.4	0.8
Wildcat – Mouth	--	2.7	2.2	1.1

Table M-4b. South Fork Battle Creek Warming Estimates, 2000

	June	July	August	September
Flows (cfs)				
South	7	6	7	6
Inskip	32	10	8	8
Coleman	30+	39	33	33
Temperatures (˚F)				
South	61.2	62.1	61.2	55.7
above South Powerhouse	65.3	66.6	65.5	59.6
Inskip	59.1	59.1	58.4	53.6
above Inskip Powerhouse	66.9	70.9	70.1	61.8
Coleman	60.9	61.1	60.5	55.5
Mouth	62.1	63.3	63.3	57.5
ΔT				
South – above South Powerhouse	4.1	4.5	4.3	3.9
Inskip – above Inskip Powerhouse	7.8	11.8	11.7	8.2
Coleman – Mouth	1.2	2.2	2.8	2.0

Table M-5a. North Fork Battle Creek Warming Estimates, 2001

	June	July	August	September
Flows (cfs)				
North Battle Creek Feeder	--	--	--	--
Eagle	34	33	33	33
Wildcat	37	36	36	36
Temperatures (˚F)				
North Battle Creek Feeder	55.6	56.7	56.1	54.6
Eagle	58.1	59.2	58.6	56.9
Wildcat	60.1	61.8	60.9	58.6
Mouth	62.7	64.8	63.6	60.4
ΔT				
North Battle Creek Feeder – Eagle	2.5	2.5	2.5	2.3
Eagle – Wildcat	2.0	2.6	2.3	1.7
Wildcat – Mouth	2.6	3.0	2.7	1.8

Table M-5b. South Fork Battle Creek Warming Estimates, 2001

	June	July	August	September
Flows (cfs)				
South	--	--	--	--
Inskip	8	8	9	9
Coleman	6	6	6	6
Temperatures (˚F)				
South	59.6	61.7	60.2	56.8
above South Powerhouse	64.9	67.0	65.4	61.7
Inskip	58.0	60.0	59.0	56.5
above Inskip Powerhouse	69.7	73.6	71.2	65.3
Coleman	59.6	62.0	61.3	57.6
Mouth	68.8	72.0	69.9	64.9
ΔT				
South – above South Powerhouse	5.3	5.3	5.2	4.9
Inskip – above Inskip Powerhouse	11.7	13.6	12.2	8.8
Coleman – Mouth	9.2	10.0	8.6	7.3

Table M-6. Temperature Results for No Action Baseline (FERC Flows)

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
At North Fork Battle Creek Feeder Assumed												
	45.0	45.0	47.5	52.5	55.0	56.0	57.5	56.0	55.0	52.5	50.0	45.0
At Eagle Canyon Diversion Dam												
10	45.7	45.7	48.2	53.9	57.1	58.8	61.0	59.5	57.8	54.6	51.4	45.7
30	45.3	45.2	47.7	53.0	56.5	58.8	61.0	59.5	57.8	54.6	51.4	45.7
50	45.1	45.1	47.6	52.8	55.4	57.2	61.0	59.5	57.8	54.6	51.4	45.3
70	45.1	45.1	47.6	52.7	55.3	56.7	60.3	59.5	57.8	54.6	50.7	45.1
90	45.1	45.1	47.6	52.7	55.3	56.4	59.2	59.5	57.8	54.6	50.2	45.1
At Wildcat Diversion Dam												
10	47.4	47.4	49.9	57.3	62.3	65.7	69.6	68.1	64.7	59.8	54.8	47.4
30	46.3	45.7	48.1	54.2	61.6	65.7	69.6	68.1	64.7	59.8	54.8	47.4
50	45.5	45.4	47.9	53.4	56.4	60.9	69.6	68.1	64.7	59.8	54.8	46.0
70	45.3	45.3	47.8	53.2	56.0	58.4	69.0	68.1	64.7	59.8	53.3	45.5
90	45.2	45.2	47.7	53.0	55.9	57.4	65.8	68.1	64.7	59.8	50.7	45.2
North Fork Battle Creek at Confluence												
10	49.2	49.2	51.7	60.8	67.5	72.6	78.3	76.8	71.6	65.0	58.3	49.2
30	47.9	46.1	48.5	55.5	66.8	72.6	78.3	76.8	71.6	65.0	58.3	49.2
50	45.8	45.7	48.1	54.0	57.4	66.0	78.3	76.8	71.6	65.0	58.3	46.8
70	45.5	45.5	48.0	53.7	56.7	60.2	77.7	76.8	71.6	65.0	56.8	45.8
90	45.4	45.4	47.8	53.3	56.5	58.3	74.4	76.8	71.6	65.0	51.1	45.4
Above South Diversion Dam Assumed												
	45.0	45.0	47.5	50.0	55.0	60.0	62.5	62.5	60.0	55.0	50.0	45.0
Above South Powerhouse												
10	46.1	46.1	48.6	52.1	58.2	64.3	67.9	67.9	64.3	58.2	52.1	46.1
30	45.8	45.5	48.0	51.2	58.2	64.3	67.9	67.9	64.3	58.2	52.1	46.1
50	45.4	45.4	47.8	50.8	56.2	63.0	67.9	67.9	64.3	58.2	52.1	45.7
70	45.3	45.3	47.8	50.6	55.9	62.0	67.9	67.9	64.3	58.2	51.7	45.4
90	45.2	45.2	47.7	50.4	55.8	61.2	66.7	67.9	64.3	58.2	50.6	45.2
At Inskip Diversion Dam												
10	45.7	45.7	48.1	52.5	56.3	59.1	61.1	60.0	58.2	54.6	51.0	45.8
30	45.7	45.6	48.0	52.2	56.3	59.2	61.2	60.3	58.3	54.7	51.0	45.7
50	45.6	45.5	48.0	52.0	56.0	59.2	61.4	60.3	58.4	54.8	51.0	45.6
70	45.5	45.5	47.9	51.8	55.9	59.3	61.6	60.5	58.5	54.8	50.9	45.6
90	45.4	45.4	47.8	51.5	55.9	59.5	61.6	60.6	58.6	54.9	50.7	45.4

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Above Inskip Powerhouse												
10	48.8	48.8	51.2	58.5	65.4	71.3	76.3	75.2	70.4	63.8	57.1	48.9
30	46.6	46.4	48.8	54.0	60.4	71.3	76.4	75.5	70.5	63.8	57.1	48.8
50	46.3	46.2	48.6	53.4	58.1	62.9	76.6	75.5	70.6	63.9	55.6	46.5
70	46.0	46.0	48.4	53.0	57.7	62.4	69.3	75.7	70.6	63.9	52.8	46.3
90	45.8	45.9	48.2	52.4	57.5	61.8	66.3	75.8	70.7	59.3	51.8	45.9
At Coleman Diversion Dam												
10	45.4	45.4	47.8	52.9	57.1	60.1	62.2	60.7	58.5	54.6	50.9	45.2
30	45.5	45.5	47.9	52.9	57.3	60.3	62.5	61.3	58.9	55.0	51.1	45.4
50	45.5	45.5	47.9	52.7	57.1	60.6	63.0	61.5	59.1	55.3	51.4	45.5
70	45.5	45.5	47.9	52.5	57.0	60.5	63.6	61.9	59.4	55.5	51.4	45.5
90	45.5	45.5	47.9	52.2	56.9	60.7	63.4	62.2	59.6	55.8	51.2	45.5
South Fork Battle Creek at Confluence												
10	48.7	48.7	51.0	59.3	66.7	73.0	78.3	76.8	71.4	64.2	57.3	48.4
30	48.8	47.1	49.3	57.3	67.0	73.1	78.6	77.4	71.8	64.7	57.5	48.7
50	46.6	46.4	48.7	54.7	60.1	73.4	79.1	77.6	72.0	65.0	57.8	48.5
70	46.1	46.1	48.5	54.0	59.1	66.2	79.7	78.0	72.2	65.1	57.9	46.6
90	45.9	46.0	48.3	53.3	58.8	63.6	79.5	78.3	72.5	65.5	52.6	46.0
At Confluence												
10	48.8	48.8	51.3	59.9	67.0	72.8	78.3	76.8	71.5	64.5	57.7	48.7
30	48.4	46.5	48.8	56.1	66.9	72.9	78.5	77.2	71.7	64.8	57.8	48.8
50	46.1	46.0	48.4	54.3	58.4	69.5	78.8	77.3	71.9	65.0	58.0	47.3
70	45.7	45.7	48.2	53.8	57.6	62.4	78.9	77.6	72.0	65.1	57.5	46.1
90	45.6	45.6	48.0	53.3	57.4	60.3	77.6	77.7	72.2	65.3	51.7	45.6
Above Coleman Powerhouse												
10	51.8	51.8	54.2	65.8	75.9	84.7	93.1	91.7	83.4	73.4	63.6	51.7
30	51.2	47.6	49.8	59.1	75.9	84.8	93.3	92.0	83.6	73.7	63.8	51.8
50	46.9	46.6	49.0	55.7	60.6	79.9	93.6	92.2	83.7	73.9	64.0	49.3
70	46.2	46.2	48.7	54.9	59.2	66.4	93.8	92.4	83.9	74.0	63.4	46.9
90	45.9	46.0	48.3	54.1	58.7	62.4	92.5	92.6	84.1	74.2	52.7	46.0
At Coleman National Fish Hatchery												
10	46.3	46.3	48.4	53.5	57.6	60.7	62.7	61.3	59.1	55.2	51.6	46.1
30	46.3	46.3	48.5	53.5	57.9	60.8	63.1	62.0	59.5	55.7	51.8	46.3
50	46.3	46.3	48.5	53.2	57.5	61.2	63.7	62.2	59.7	56.0	52.1	46.3
70	46.4	46.4	48.5	53.1	57.3	61.0	64.3	62.7	59.9	56.1	52.1	46.3
90	46.4	46.4	48.5	52.7	57.2	60.9	64.2	62.9	60.3	56.5	51.8	46.4

Table M-7. Temperature Results for Five Dam Removal Alternative

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
At North Fork Battle Creek Feeder Assumed												
	45.0	45.0	47.5	52.5	55.0	56.0	57.5	56.0	55.0	52.5	50.0	45.0
At Eagle Canyon Dam												
10	45.2	45.2	47.7	52.8	55.5	56.8	58.6	57.2	55.9	53.2	50.4	45.2
30	45.2	45.1	47.6	52.8	55.5	56.7	58.5	57.1	55.9	53.2	50.4	45.2
50	45.1	45.1	47.6	52.8	55.4	56.7	58.4	57.0	55.8	53.1	50.4	45.1
70	45.1	45.1	47.6	52.7	55.3	56.7	58.4	56.9	55.8	53.1	50.4	45.1
90	45.1	45.1	47.6	52.7	55.3	56.4	58.4	56.9	55.7	53.0	50.2	45.1
At Wildcat Diversion Dam												
10	45.6	45.6	48.1	53.7	57.0	58.8	61.1	59.7	57.9	54.8	51.4	45.6
30	45.5	45.5	48.0	53.5	57.0	58.7	61.1	59.6	57.9	54.7	51.4	45.6
50	45.4	45.4	47.9	53.4	56.4	58.6	61.0	59.6	57.8	54.6	51.4	45.5
70	45.3	45.3	47.8	53.2	56.0	58.4	60.9	59.5	57.8	54.6	51.3	45.4
90	45.2	45.2	47.7	53.0	55.9	57.4	60.8	59.4	57.7	54.5	50.7	45.2
North Fork Battle Creek at Confluence												
10	46.0	46.0	48.5	54.5	58.4	60.5	63.3	61.9	59.7	56.1	52.3	46.0
30	45.9	45.8	48.3	54.2	58.4	60.5	63.3	61.8	59.6	56.0	52.3	46.0
50	45.7	45.7	48.1	54.0	57.3	60.2	63.1	61.8	59.6	55.9	52.2	45.9
70	45.5	45.5	48.0	53.7	56.7	59.9	63.1	61.7	59.6	55.9	52.1	45.7
90	45.4	45.4	47.8	53.3	56.5	58.3	62.8	61.6	59.5	55.8	51.1	45.4
Above South Diversion Dam Assumed												
	45.0	45.0	47.5	50.0	55.0	60.0	62.5	62.5	60.0	55.0	50.0	45.0
Above Powerhouse												
10	45.3	45.3	47.8	50.7	56.0	61.5	64.7	65.0	61.9	56.4	50.8	45.4
30	45.3	45.3	47.8	50.5	55.9	61.4	64.5	64.7	61.7	56.2	50.7	45.3
50	45.2	45.2	47.7	50.5	55.7	61.1	64.3	64.5	61.6	56.1	50.6	45.3
70	45.2	45.2	47.7	50.4	55.6	61.0	64.0	64.3	61.5	56.0	50.6	45.2
90	45.2	45.2	47.7	50.4	55.6	60.9	63.9	64.2	61.4	55.9	50.4	45.2
At Inskip Diversion Dam												
10	45.3	45.3	47.8	50.7	56.0	61.5	64.7	65.0	61.9	56.4	50.8	45.4
30	45.3	45.3	47.8	50.5	55.9	61.4	64.5	64.7	61.7	56.2	50.7	45.3
50	45.2	45.2	47.7	50.5	55.7	61.1	64.3	64.5	61.6	56.1	50.6	45.3
70	45.2	45.2	47.7	50.4	55.6	61.0	64.0	64.3	61.5	56.0	50.6	45.2
90	45.2	45.2	47.7	50.4	55.6	60.9	63.9	64.2	61.4	55.9	50.4	45.2

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Above Inskip Powerhouse												
10	46.1	46.1	48.6	52.4	59.2	65.8	70.1	70.3	66.2	59.6	53.0	46.2
30	46.0	46.0	48.5	52.3	59.1	65.7	69.9	70.0	66.0	59.4	52.9	46.1
50	46.0	45.9	48.4	51.9	57.9	65.4	69.7	69.9	65.9	59.3	52.8	46.0
70	45.7	45.7	48.2	51.6	57.4	64.3	69.4	69.7	65.8	59.3	52.7	46.0
90	45.6	45.6	48.1	51.3	57.2	63.2	69.3	69.6	65.7	59.1	51.6	45.6
At Coleman Diversion Dam												
10	46.1	46.1	48.6	52.4	59.2	65.8	70.1	70.3	66.2	59.6	53.0	46.2
30	46.0	46.0	48.5	52.3	59.1	65.7	69.9	70.0	66.0	59.4	52.9	46.1
50	46.0	45.9	48.4	51.9	57.9	65.4	69.7	69.9	65.9	59.3	52.8	46.0
70	45.7	45.7	48.2	51.6	57.4	64.3	69.4	69.7	65.8	59.3	52.7	46.0
90	45.6	45.6	48.1	51.3	57.2	63.2	69.3	69.6	65.7	59.1	51.6	45.6
South Fork Battle Creek at Confluence												
10	46.8	46.8	49.3	54.2	62.4	70.0	75.4	75.7	70.5	62.8	55.1	47.1
30	46.8	46.7	49.2	54.0	62.3	70.0	75.3	75.4	70.3	62.7	55.0	46.8
50	46.7	46.6	49.0	53.3	60.0	69.7	75.0	75.3	70.2	62.5	54.9	46.8
70	46.3	46.3	48.8	52.9	59.2	67.7	74.8	75.1	70.1	62.5	54.9	46.7
90	46.0	46.1	48.5	52.3	58.8	65.7	74.6	74.9	70.0	62.3	52.8	46.1
At Confluence												
10	46.5	46.5	49.0	54.3	60.4	65.2	69.3	68.8	65.0	59.4	53.7	46.6
30	46.4	46.3	48.7	54.1	60.3	65.2	69.2	68.5	64.9	59.3	53.6	46.5
50	46.2	46.1	48.5	53.7	58.6	64.6	69.0	68.4	64.8	59.2	53.6	46.4
70	45.8	45.8	48.3	53.3	57.8	64.0	68.8	68.3	64.7	59.1	53.4	46.2
90	45.6	45.7	48.1	52.9	57.5	61.5	68.3	68.2	64.6	58.9	51.8	45.7
Above Coleman Powerhouse												
10	47.2	47.2	49.7	55.8	62.9	68.6	73.6	73.0	68.5	62.0	55.4	47.4
30	47.0	46.9	49.4	55.5	62.8	68.6	73.5	72.8	68.3	61.8	55.3	47.2
50	46.7	46.7	49.0	54.8	60.4	67.8	73.2	72.7	68.2	61.7	55.2	47.0
70	46.2	46.2	48.8	54.3	59.2	66.8	73.0	72.5	68.2	61.7	55.1	46.7
90	45.9	46.0	48.4	53.6	58.7	63.4	72.5	72.4	68.0	61.5	52.7	46.0

Table M-8. Temperature Results for No Dam Removal Alternative

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
At North Fork Battle Creek Feeder Assumed												
	45.0	45.0	47.5	52.5	55.0	56.0	57.5	56.0	55.0	52.5	50.0	45.0
At Eagle Canyon Dam												
10	45.2	45.2	47.7	52.9	55.7	56.9	58.6	57.2	55.9	53.2	50.4	45.2
30	45.2	45.2	47.7	52.9	55.7	56.9	58.6	57.1	55.9	53.2	50.4	45.2
50	45.1	45.1	47.6	52.8	55.4	56.9	58.6	57.1	55.8	53.1	50.4	45.2
70	45.1	45.1	47.6	52.7	55.3	56.7	58.6	57.1	55.8	53.1	50.4	45.1
90	45.1	45.1	47.6	52.7	55.3	56.4	58.6	57.1	55.8	53.1	50.2	45.1
At Wildcat Diversion Dam												
10	45.6	45.6	48.1	53.7	57.3	59.1	61.3	59.9	58.1	54.9	51.5	45.6
30	45.6	45.6	48.1	53.7	57.3	59.1	61.3	59.8	58.0	54.8	51.5	45.6
50	45.5	45.4	47.9	53.4	56.4	59.1	61.3	59.8	58.0	54.7	51.5	45.6
70	45.3	45.3	47.8	53.2	56.0	58.4	61.3	59.8	58.0	54.7	51.4	45.5
90	45.2	45.2	47.7	53.0	55.9	57.4	61.3	59.8	57.9	54.7	50.7	45.2
North Fork Battle Creek at Confluence												
10	46.0	46.0	48.5	54.5	58.7	60.9	63.7	62.3	60.0	56.3	52.4	46.0
30	46.0	46.0	48.5	54.5	58.7	60.9	63.7	62.2	59.9	56.2	52.4	46.0
50	45.8	45.7	48.1	54.0	57.3	60.9	63.7	62.2	59.9	56.1	52.4	46.0
70	45.5	45.5	48.0	53.7	56.7	60.0	63.6	62.2	59.8	56.1	52.3	45.8
90	45.4	45.4	47.8	53.3	56.5	58.3	63.6	62.1	59.8	56.1	51.1	45.4
Above South Diversion Dam Assumed												
	45.0	45.0	47.5	50.0	55.0	60.0	62.5	62.5	60.0	55.0	50.0	45.0
Above South Powerhouse												
10	45.4	45.4	47.9	50.9	56.6	62.1	65.2	65.2	62.1	56.6	51.1	45.4
30	45.4	45.4	47.9	50.9	56.6	62.1	65.2	65.2	62.1	56.6	51.1	45.4
50	45.4	45.4	47.8	50.8	56.3	62.1	65.2	65.2	62.1	56.6	51.1	45.4
70	45.3	45.3	47.8	50.6	55.9	62.1	65.2	65.2	62.1	56.6	51.1	45.4
90	45.2	45.2	47.7	50.5	55.8	61.2	65.2	65.2	62.1	56.6	50.6	45.2
At Inskip Diversion Dam												
10	45.6	45.6	48.0	52.1	56.2	59.4	61.7	60.9	58.8	54.9	50.9	45.6
30	45.5	45.5	48.0	52.1	56.2	59.4	61.7	61.0	58.9	54.9	50.9	45.6
50	45.5	45.5	47.9	52.0	56.1	59.4	61.7	61.0	59.0	55.0	50.9	45.5
70	45.4	45.4	47.9	51.8	56.0	59.5	61.7	61.0	59.0	55.0	50.9	45.5
90	45.3	45.4	47.8	51.5	56.0	59.6	61.7	61.0	59.0	54.9	50.7	45.4

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Above Inskip Powerhouse												
10	46.6	46.6	49.1	54.2	59.9	64.4	67.9	67.1	63.8	58.6	53.4	46.7
30	46.6	46.3	48.7	54.2	59.9	64.4	67.9	67.2	63.9	58.7	53.4	46.6
50	46.2	46.1	48.5	53.4	58.2	64.0	67.9	67.2	63.9	58.7	53.4	46.6
70	45.9	45.9	48.4	53.0	57.8	62.6	67.9	67.2	64.0	58.7	53.4	46.2
90	45.8	45.8	48.2	52.4	57.5	61.9	68.0	67.2	64.0	58.7	51.9	45.8
At Coleman Diversion Dam												
10	45.1	45.1	47.5	52.3	56.8	60.1	62.4	61.2	58.8	54.5	50.6	44.7
30	45.3	45.4	47.9	52.7	57.0	60.2	62.7	61.6	59.1	54.9	50.8	45.1
50	45.4	45.4	47.9	52.7	57.1	60.6	63.0	61.8	59.2	55.1	51.1	45.4
70	45.4	45.4	47.9	52.5	57.0	60.7	63.3	62.1	59.4	55.3	51.2	45.4
90	45.4	45.4	47.9	52.2	57.0	60.8	63.4	62.2	59.6	55.5	51.2	45.4
South Fork Battle Creek at Confluence												
10	46.1	46.1	48.5	54.3	60.8	65.4	69.0	67.8	62.9	57.5	52.6	45.7
30	46.4	46.4	48.9	54.8	61.0	65.5	69.2	68.2	63.1	57.9	52.8	46.1
50	46.5	46.5	48.8	54.7	60.8	65.9	69.6	68.4	63.3	58.2	53.1	46.4
70	46.1	46.1	48.6	54.2	59.4	66.0	69.9	68.6	63.4	58.3	53.3	46.5
90	45.9	46.0	48.3	53.3	59.0	64.1	70.0	68.8	63.6	58.5	52.8	46.0
At Confluence												
10	46.0	46.0	48.5	54.4	59.6	62.8	65.9	64.6	61.6	57.0	52.5	45.9
30	46.2	46.2	48.6	54.6	59.6	62.8	66.0	64.7	61.7	57.1	52.6	46.0
50	46.0	45.9	48.3	54.2	58.2	62.9	66.1	64.8	61.7	57.2	52.8	46.2
70	45.7	45.7	48.2	53.8	57.5	61.9	66.2	64.9	61.8	57.3	52.8	46.0
90	45.6	45.6	48.0	53.3	57.3	60.0	66.2	64.9	61.9	57.4	51.6	45.6
Above Coleman Powerhouse												
10	46.8	46.8	49.3	56.0	62.5	66.7	70.9	69.6	65.1	59.6	54.3	46.7
30	46.9	47.0	49.4	56.2	62.6	66.8	71.0	69.7	65.2	59.8	54.4	46.8
50	46.7	46.6	48.9	55.6	60.3	66.9	71.1	69.7	65.3	59.9	54.5	47.0
70	46.1	46.1	48.6	54.9	59.1	65.4	71.1	69.8	65.3	59.9	54.5	46.7
90	45.9	45.9	48.3	54.1	58.6	62.1	71.2	69.9	65.4	60.0	52.6	46.0
At Coleman National Fish Hatchery												
10	46.2	46.2	48.2	52.8	57.2	60.4	62.2	60.9	58.3	54.6	51.3	46.1
30	46.3	46.3	48.5	53.2	57.5	60.6	62.8	61.7	58.9	55.2	51.5	46.2
50	46.3	46.3	48.5	53.2	57.7	61.2	63.4	62.0	59.2	55.6	51.7	46.3
70	46.4	46.4	48.5	53.0	57.5	61.3	63.9	62.5	59.5	55.8	51.9	46.3
90	46.4	46.4	48.5	52.7	57.3	61.2	64.1	62.7	59.9	56.0	51.9	46.4

Table M-9. Temperature Results for Six Dam Removal Alternative

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
At North Fork Battle Creek Feeder Assumed												
	45.0	45.0	47.5	52.5	55.0	56.0	57.5	56.0	55.0	52.5	50.0	45.0
At Eagle Canyon Dam												
10	45.2	45.2	47.7	52.8	55.5	56.8	58.6	57.2	55.9	53.2	50.4	45.2
30	45.2	45.1	47.6	52.8	55.5	56.7	58.5	57.1	55.9	53.2	50.4	45.2
50	45.1	45.1	47.6	52.8	55.4	56.7	58.4	57.0	55.8	53.1	50.4	45.1
70	45.1	45.1	47.6	52.7	55.3	56.7	58.4	56.9	55.8	53.1	50.4	45.1
90	45.1	45.1	47.6	52.7	55.3	56.4	58.4	56.9	55.7	53.0	50.2	45.1
At Wildcat Diversion Dam												
10	45.5	45.5	48.0	53.5	56.5	58.1	60.6	59.4	57.6	54.5	51.2	45.6
30	45.4	45.4	47.9	53.3	56.4	58.0	60.4	59.1	57.4	54.3	51.1	45.5
50	45.4	45.4	47.8	53.3	56.2	57.9	60.1	58.9	57.3	54.1	51.0	45.4
70	45.3	45.3	47.8	53.1	55.9	57.8	59.9	58.7	57.2	54.0	50.9	45.4
90	45.2	45.2	47.7	53.0	55.8	57.2	59.9	58.5	57.0	53.9	50.6	45.2
North Fork Battle Creek at Confluence												
10	45.8	45.8	48.3	54.1	57.4	59.4	62.5	61.4	59.2	55.7	51.8	45.9
30	45.7	45.6	48.1	53.8	57.3	59.3	62.2	60.9	58.9	55.3	51.7	45.8
50	45.6	45.6	48.0	53.7	56.9	59.0	61.7	60.7	58.7	55.1	51.6	45.7
70	45.4	45.4	48.0	53.5	56.5	58.9	61.4	60.3	58.5	54.9	51.5	45.6
90	45.3	45.4	47.8	53.3	56.3	58.0	61.2	60.0	58.2	54.8	51.0	45.4
Above South Diversion Dam Assumed												
	45.0	45.0	47.5	50.0	55.0	60.0	62.5	62.5	60.0	55.0	50.0	45.0
Above South Powerhouse												
10	45.3	45.3	47.8	50.7	56.0	61.5	64.7	65.0	61.9	56.4	50.8	45.4
30	45.3	45.3	47.8	50.5	55.9	61.4	64.5	64.7	61.7	56.2	50.7	45.3
50	45.2	45.2	47.7	50.5	55.7	61.1	64.3	64.5	61.6	56.1	50.6	45.3
70	45.2	45.2	47.7	50.4	55.6	61.0	64.0	64.3	61.5	56.0	50.6	45.2
90	45.2	45.2	47.7	50.4	55.6	60.9	63.9	64.2	61.4	55.9	50.4	45.2
At Inskip Diversion Dam												
10	45.3	45.3	47.8	50.7	56.0	61.5	64.7	65.0	61.9	56.4	50.8	45.4
30	45.3	45.3	47.8	50.5	55.9	61.4	64.5	64.7	61.7	56.2	50.7	45.3
50	45.2	45.2	47.7	50.5	55.7	61.1	64.3	64.5	61.6	56.1	50.6	45.3
70	45.2	45.2	47.7	50.4	55.6	61.0	64.0	64.3	61.5	56.0	50.6	45.2
90	45.2	45.2	47.7	50.4	55.6	60.9	63.9	64.2	61.4	55.9	50.4	45.2

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Above Inskip Powerhouse												
10	46.1	46.1	48.6	52.4	59.2	65.8	70.1	70.3	66.2	59.6	53.0	46.2
30	46.0	46.0	48.5	52.3	59.1	65.7	69.9	70.0	66.0	59.4	52.9	46.1
50	46.0	45.9	48.4	51.9	57.9	65.4	69.7	69.9	65.9	59.3	52.8	46.0
70	45.7	45.7	48.2	51.6	57.4	64.4	69.4	69.7	65.8	59.3	52.7	46.0
90	45.6	45.6	48.1	51.3	57.2	63.2	69.3	69.6	65.7	59.1	51.6	45.6
At Coleman Diversion Dam												
10	46.1	46.1	48.6	52.4	59.2	65.8	70.1	70.3	66.2	59.6	53.0	46.2
30	46.0	46.0	48.5	52.3	59.1	65.7	69.9	70.0	66.0	59.4	52.9	46.1
50	46.0	45.9	48.4	51.9	57.9	65.4	69.7	69.9	65.9	59.3	52.8	46.0
70	45.7	45.7	48.2	51.6	57.4	64.4	69.4	69.7	65.8	59.3	52.7	46.0
90	45.6	45.6	48.1	51.3	57.2	63.2	69.3	69.6	65.7	59.1	51.6	45.6
South Fork Battle Creek at Confluence												
10	46.8	46.8	49.3	54.2	62.4	70.0	75.4	75.7	70.5	62.8	55.1	47.1
30	46.8	46.7	49.2	54.0	62.3	70.0	75.3	75.4	70.3	62.7	55.0	46.8
50	46.7	46.6	49.0	53.3	60.1	69.7	75.0	75.3	70.2	62.5	54.9	46.8
70	46.3	46.3	48.8	52.9	59.2	67.8	74.8	75.1	70.1	62.5	54.9	46.7
90	46.0	46.1	48.5	52.3	58.8	65.7	74.6	74.9	70.0	62.3	52.8	46.1
At Confluence												
10	46.3	46.3	48.8	54.1	59.0	63.1	67.8	67.8	64.0	58.7	53.1	46.5
30	46.1	46.1	48.5	53.9	58.8	62.7	67.1	66.7	63.4	58.1	52.8	46.3
50	46.0	45.9	48.4	53.6	58.0	62.0	66.1	66.2	63.0	57.6	52.6	46.1
70	45.7	45.8	48.3	53.3	57.5	62.1	65.3	65.4	62.6	57.3	52.4	46.0
90	45.6	45.6	48.1	52.9	57.2	60.8	65.0	64.8	62.0	56.9	51.6	45.6
Above Coleman Powerhouse												
10	46.9	46.9	49.4	55.4	61.0	65.9	71.7	71.8	67.2	61.1	54.6	47.2
30	46.7	46.6	49.1	55.0	60.8	65.5	70.9	70.5	66.5	60.4	54.3	46.9
50	46.5	46.4	48.9	54.6	59.6	64.6	69.6	70.0	66.0	59.7	53.9	46.7
70	46.1	46.1	48.7	54.1	58.8	64.4	68.7	68.9	65.5	59.4	53.7	46.5
90	45.9	46.0	48.3	53.6	58.4	62.5	68.3	68.2	64.8	58.9	52.5	46.0
At Coleman National Fish Hatchery												
10	47.2	47.2	49.2	54.0	58.0	61.1	62.9	61.1	59.4	55.9	52.5	47.3
30	47.0	46.9	49.1	53.8	58.1	61.3	63.5	62.2	59.9	56.3	52.5	47.2
50	46.9	46.9	49.1	54.0	58.1	61.7	64.0	62.5	60.2	56.5	52.5	47.0
70	47.0	47.0	49.1	53.9	57.9	61.5	64.5	63.1	60.5	56.6	52.5	46.9
90	47.1	47.1	49.1	53.7	57.8	61.1	64.6	63.4	60.8	56.8	52.4	47.1

Table M-10. Temperature Results for the Three Dam Removal Alternative

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
At North Fork Battle Creek Feeder Assumed												
	45.0	45.0	47.5	52.5	55.0	56.0	57.5	56.0	55.0	52.5	50.0	45.0
At Eagle Canyon Dam												
10	45.2	45.2	47.7	52.9	55.7	56.9	58.6	57.2	55.9	53.2	50.4	45.2
30	45.2	45.2	47.7	52.9	55.7	56.9	58.6	57.1	55.9	53.2	50.4	45.2
50	45.1	45.1	47.6	52.8	55.4	56.9	58.6	57.1	55.8	53.1	50.4	45.2
70	45.1	45.1	47.6	52.7	55.3	56.7	58.6	57.1	55.8	53.1	50.4	45.1
90	45.1	45.1	47.6	52.7	55.3	56.4	58.6	57.1	55.8	53.1	50.2	45.1
At Wildcat Diversion Dam												
10	45.5	45.5	48.0	53.5	56.7	58.4	60.6	59.4	57.6	54.5	51.2	45.6
30	45.5	45.5	48.0	53.5	56.7	58.3	60.6	59.1	57.4	54.3	51.1	45.5
50	45.4	45.4	47.8	53.3	56.2	58.2	60.4	59.1	57.3	54.1	51.0	45.5
70	45.3	45.3	47.8	53.1	55.9	57.9	60.3	59.0	57.2	54.1	51.0	45.4
90	45.2	45.2	47.7	53.0	55.8	57.2	60.2	58.9	57.1	54.0	50.6	45.2
North Fork Battle Creek at Confluence												
10	45.8	45.8	48.3	54.2	57.7	59.7	62.5	61.4	59.2	55.7	51.8	45.9
30	45.8	45.8	48.2	54.0	57.6	59.7	62.4	61.0	58.9	55.3	51.7	45.8
50	45.6	45.6	48.0	53.7	56.9	59.4	62.1	60.9	58.7	55.1	51.6	45.8
70	45.4	45.4	48.0	53.5	56.5	58.9	61.9	60.7	58.5	55.0	51.6	45.6
90	45.3	45.4	47.8	53.3	56.3	58.0	61.7	60.6	58.4	54.9	51.0	45.4
Above South Diversion Dam Assumed												
	45.0	45.0	47.5	50.0	55.0	60.0	62.5	62.5	60.0	55.0	50.0	45.0
Above South Powerhouse												
10	45.4	45.4	47.9	50.9	56.6	62.1	65.2	65.2	62.1	56.6	51.1	45.4
30	45.4	45.4	47.9	50.9	56.6	62.1	65.2	65.2	62.1	56.6	51.1	45.4
50	45.4	45.4	47.8	50.8	56.3	62.1	65.2	65.2	62.1	56.6	51.1	45.4
70	45.3	45.3	47.8	50.6	55.9	62.1	65.2	65.2	62.1	56.6	51.1	45.4
90	45.2	45.2	47.7	50.5	55.8	61.2	65.2	65.2	62.1	56.6	50.6	45.2
At Inskip Diversion Dam												
10	45.4	45.4	47.9	50.9	56.6	62.1	65.2	65.2	62.1	56.6	51.1	45.4
30	45.4	45.4	47.9	50.9	56.6	62.1	65.2	65.2	62.1	56.6	51.1	45.4
50	45.4	45.4	47.8	50.9	56.3	62.1	65.2	65.2	62.1	56.6	51.1	45.4
70	45.3	45.3	47.8	50.7	55.9	62.1	65.2	65.2	62.1	56.6	51.1	45.4
90	45.2	45.2	47.7	50.5	55.8	61.2	65.2	65.2	62.1	56.6	50.6	45.2

Range of Flow (%)	Temperature (ºF)											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Above Inskip Powerhouse												
10	46.5	46.5	49.0	53.0	60.3	67.1	71.4	71.4	67.1	60.3	53.6	46.5
30	46.5	46.3	48.7	52.9	60.3	67.1	71.4	71.4	67.1	60.3	53.6	46.5
50	46.2	46.1	48.5	52.3	58.4	66.7	71.4	71.4	67.1	60.3	53.6	46.5
70	45.8	45.8	48.3	51.9	57.7	65.4	71.4	71.4	67.1	60.3	53.6	46.2
90	45.6	45.7	48.1	51.4	57.4	63.6	71.4	71.4	67.1	60.3	51.8	45.7
At Coleman Diversion Dam												
10	46.5	46.5	49.0	53.0	60.3	67.1	71.4	71.4	67.1	60.3	53.6	46.5
30	46.5	46.3	48.7	52.9	60.3	67.1	71.4	71.4	67.1	60.3	53.6	46.5
50	46.2	46.1	48.5	52.3	58.4	66.7	71.4	71.4	67.1	60.3	53.6	46.5
70	45.8	45.8	48.3	51.9	57.7	65.4	71.4	71.4	67.1	60.3	53.6	46.2
90	45.6	45.7	48.1	51.4	57.4	63.6	71.4	71.4	67.1	60.3	51.8	45.7
South Fork Battle Creek at Confluence												
10	47.7	47.7	50.2	55.4	64.6	72.8	78.5	78.6	72.8	64.6	56.4	47.7
30	47.7	47.2	49.6	55.2	64.6	72.8	78.5	78.5	72.8	64.6	56.4	47.7
50	47.0	46.8	49.2	53.8	60.7	71.9	78.5	78.5	72.8	64.6	56.4	47.7
70	46.4	46.4	48.9	53.1	59.6	68.9	78.5	78.5	72.8	64.6	56.4	47.0
90	46.1	46.2	48.5	52.4	59.1	66.1	78.5	78.5	72.8	64.6	53.0	46.2
At Confluence												
10	46.3	46.3	48.8	54.5	59.3	63.0	67.0	66.7	63.2	58.3	53.0	46.5
30	46.3	46.2	48.7	54.3	59.1	62.8	66.7	65.8	62.6	57.7	52.8	46.3
50	46.1	46.0	48.4	53.7	58.2	62.3	66.1	65.6	62.3	57.2	52.6	46.2
70	45.8	45.8	48.3	53.4	57.6	62.3	65.5	65.1	61.9	57.0	52.5	46.1
90	45.6	45.6	48.1	53.0	57.3	60.8	65.2	64.8	61.5	56.8	51.7	45.7
Above Coleman Powerhouse												
10	47.1	47.1	49.6	55.9	61.7	66.2	71.2	71.1	66.7	60.9	54.6	47.2
30	46.9	46.8	49.3	55.6	61.3	66.0	70.8	70.0	65.9	60.1	54.3	47.1
50	46.6	46.5	48.9	54.8	59.7	65.1	70.1	69.7	65.5	59.5	54.1	46.9
70	46.1	46.2	48.7	54.3	58.9	64.7	69.3	69.1	64.9	59.2	53.9	46.6
90	45.9	46.0	48.4	53.7	58.5	62.5	68.8	68.7	64.5	58.9	52.5	46.0
At Coleman National Fish Hatchery												
10	45.5	45.5	47.6	52.4	56.7	59.6	60.5	58.3	56.7	53.1	50.3	44.9
30	45.9	45.9	48.1	53.0	57.2	59.9	61.5	60.0	57.6	54.2	50.7	45.5
50	46.0	46.0	48.2	53.1	57.2	60.8	62.6	60.6	58.1	54.8	51.3	45.9
70	46.2	46.2	48.2	53.0	57.0	60.5	63.5	61.5	58.7	55.2	51.6	46.0
90	46.4	46.3	48.3	52.9	56.9	60.2	63.9	62.1	59.3	55.7	51.6	46.3

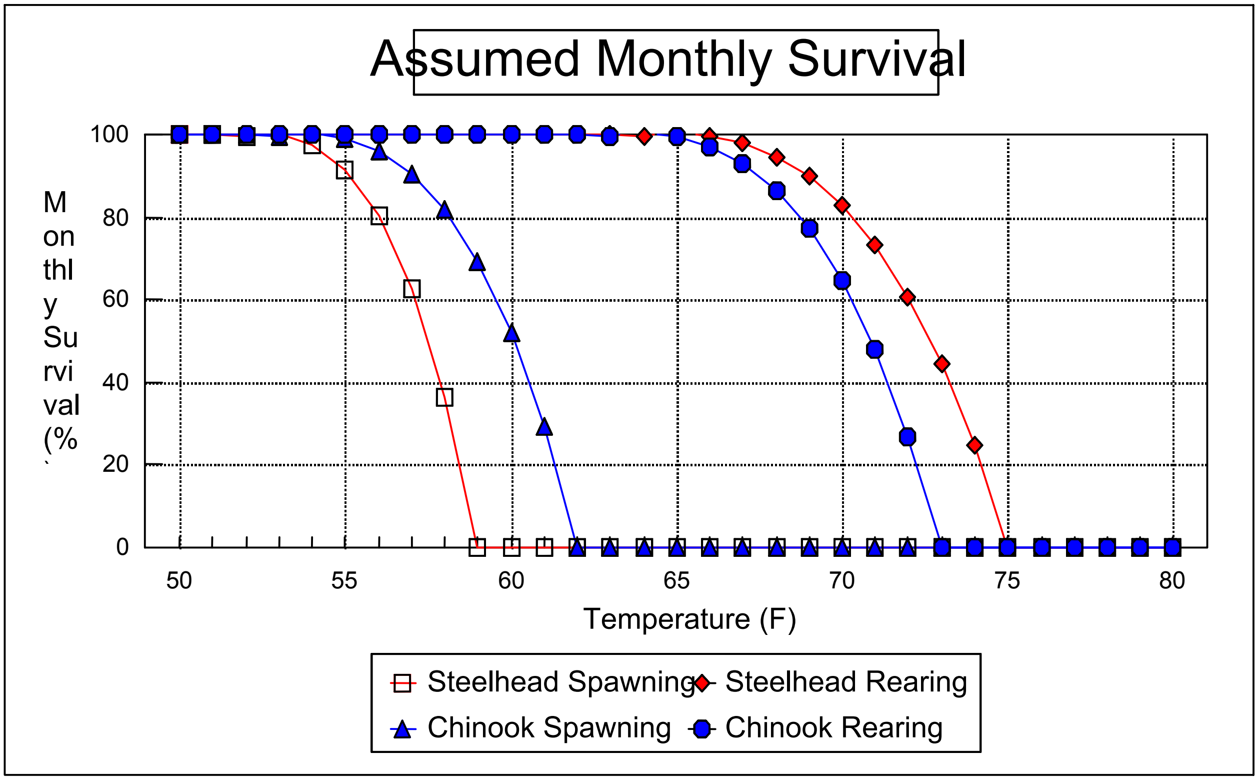


Figure M-1. Effects of Temperature on Monthly Survival of Steelhead and Chinook.

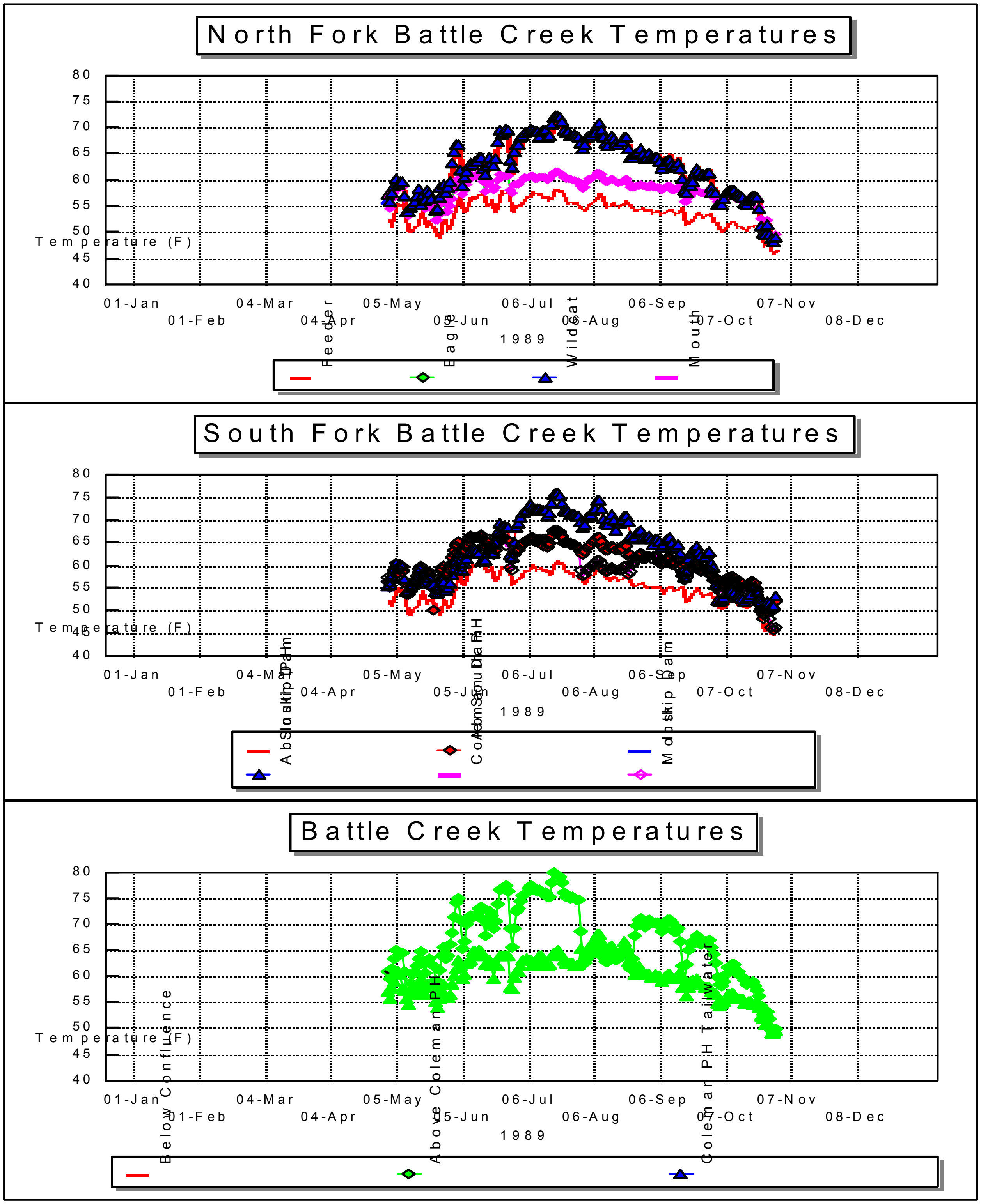


Figure M-2. Battle Creek Water Temperatures, 1989

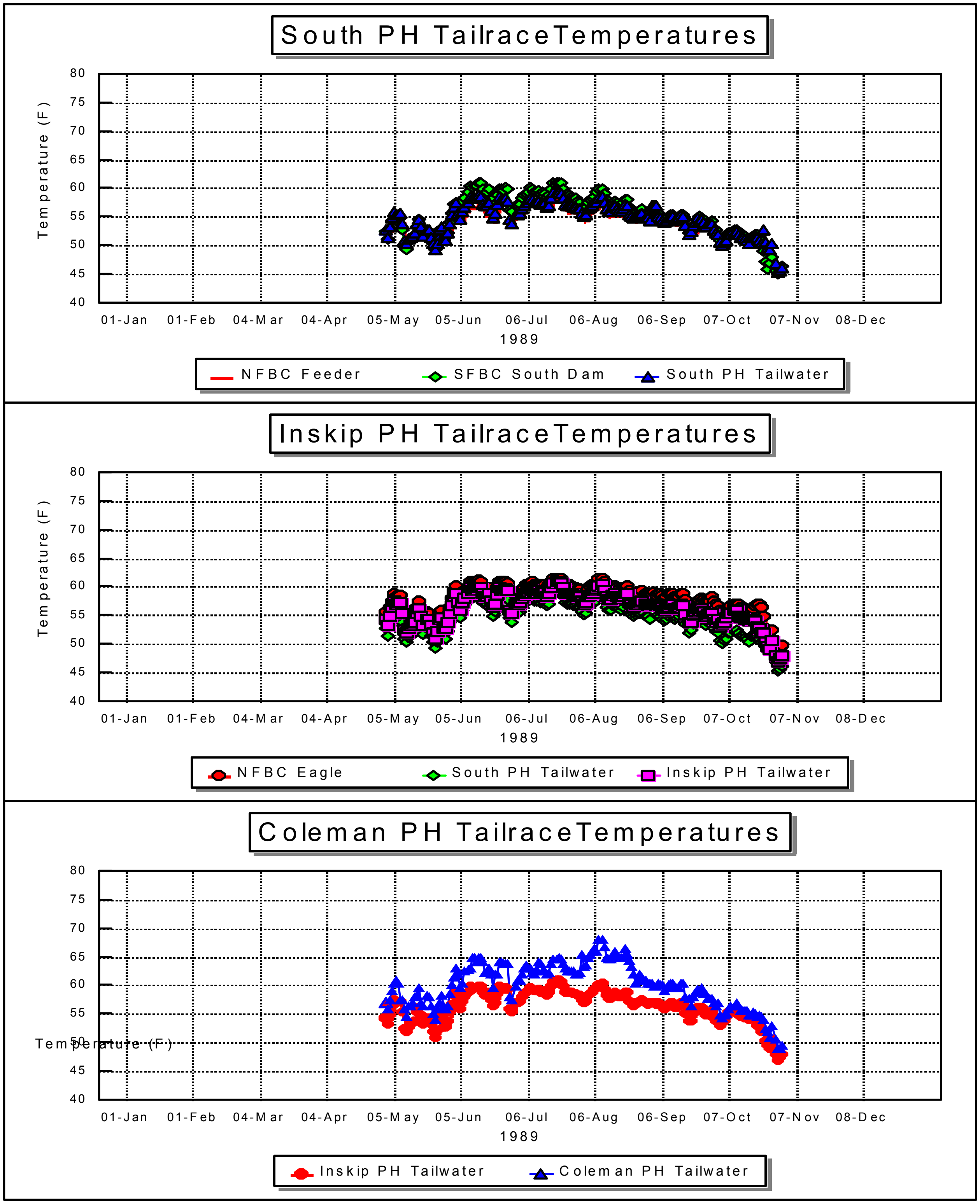


Figure M-3. Battle Creek Operational Water Temperatures, 1989.

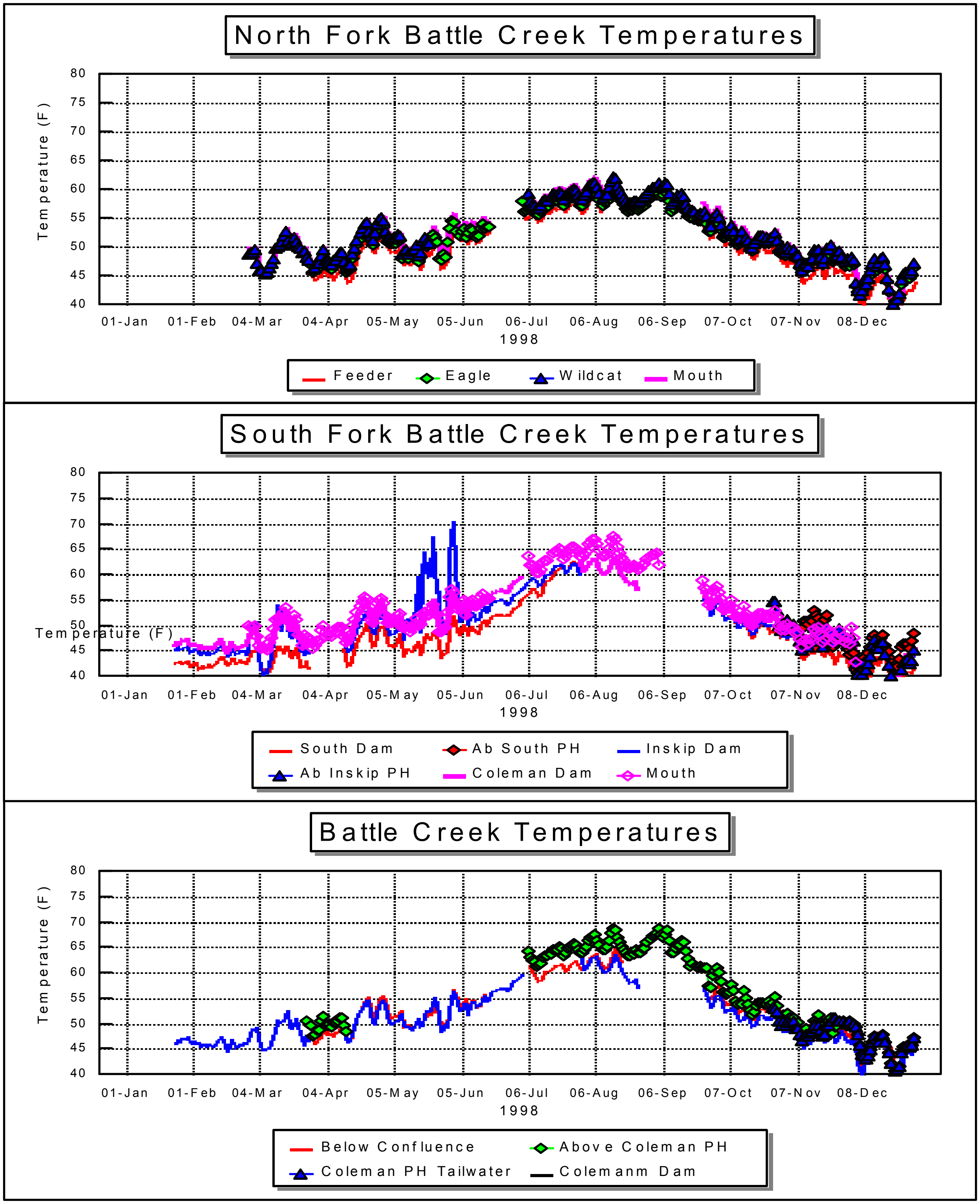


Figure M-4. Battle Creek Water Temperatures, 1998.

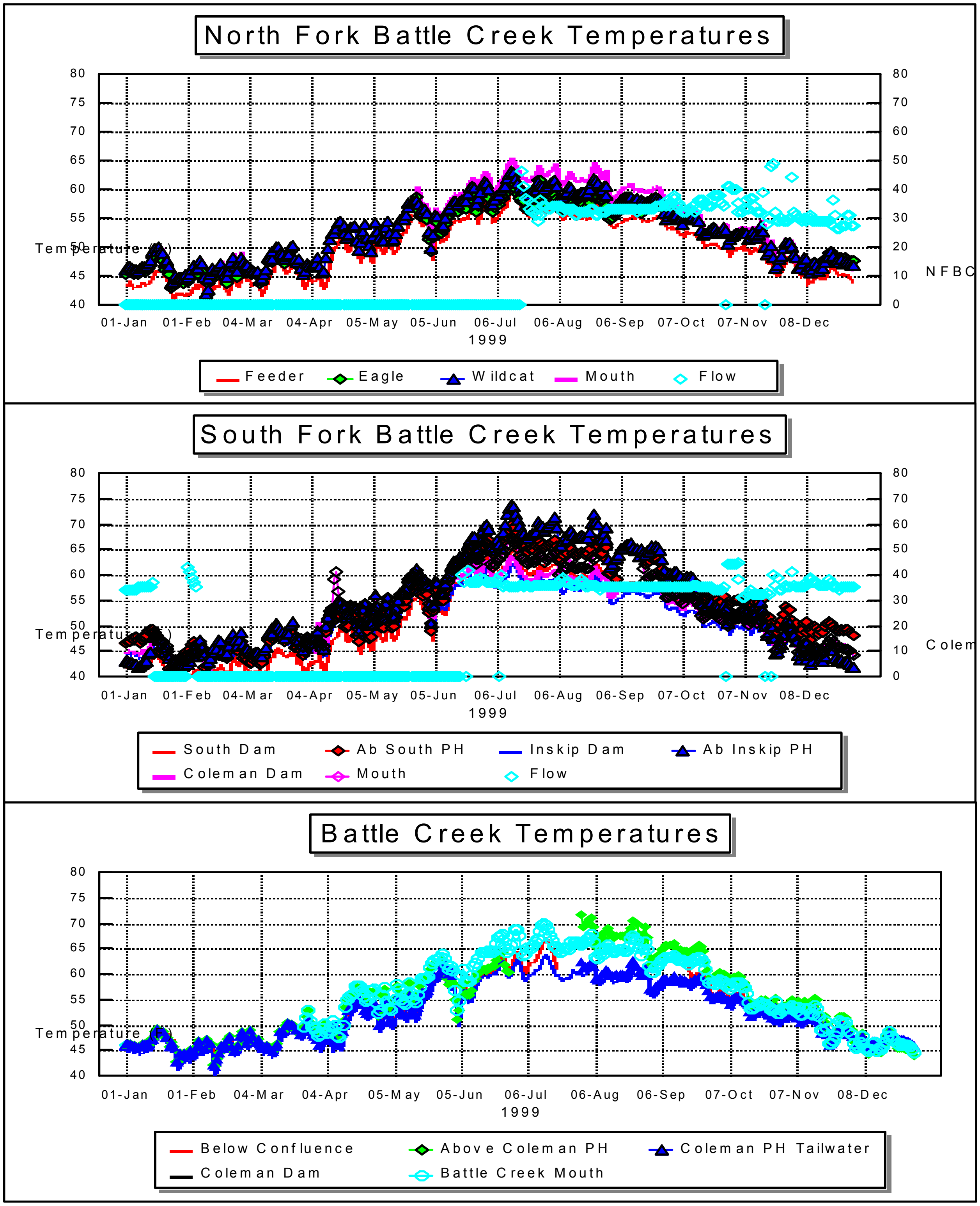


Figure M-5. Battle Creek Water Temperatures and Flows, 1999.

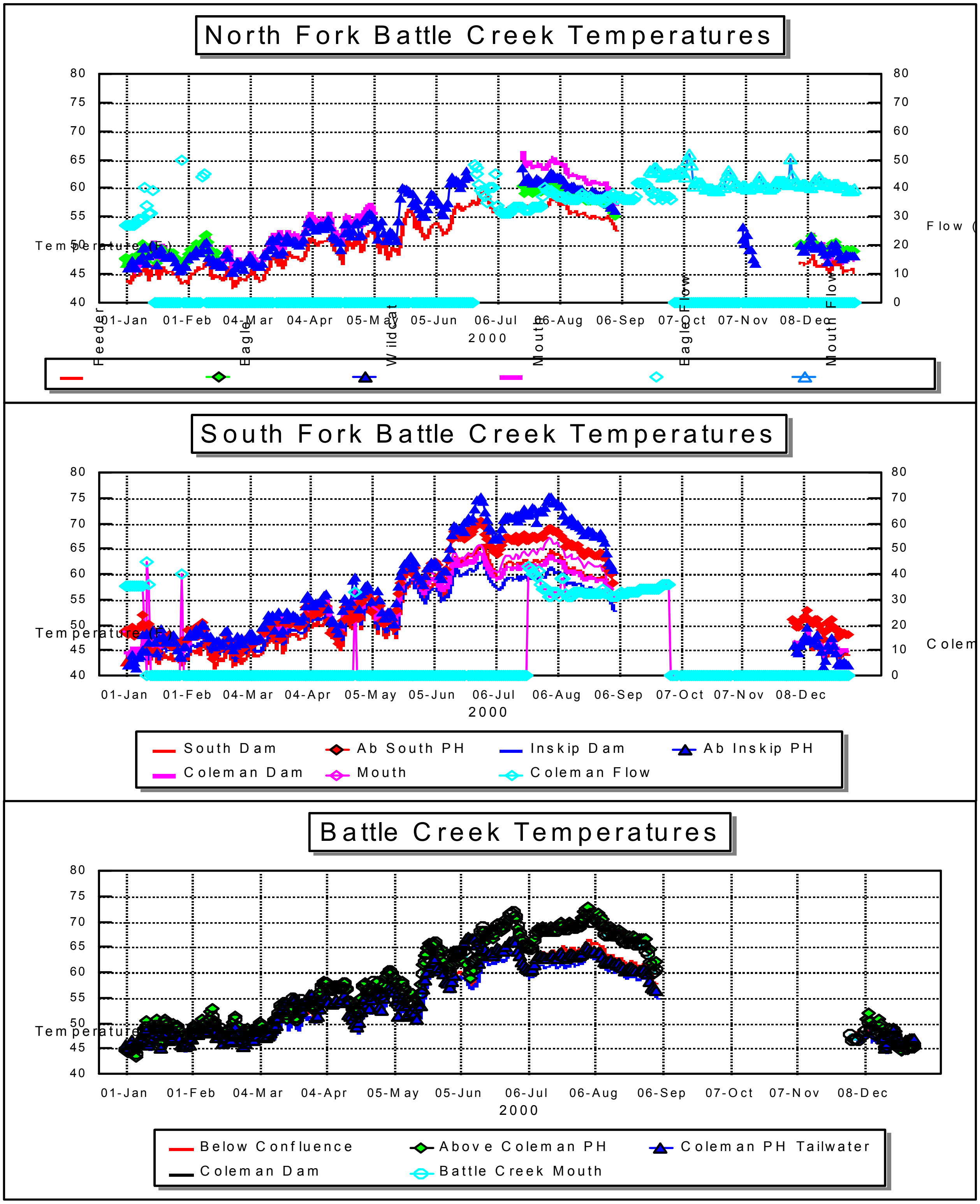


Figure M-6. Battle Creek Water Temperatures and Flows, 2000.

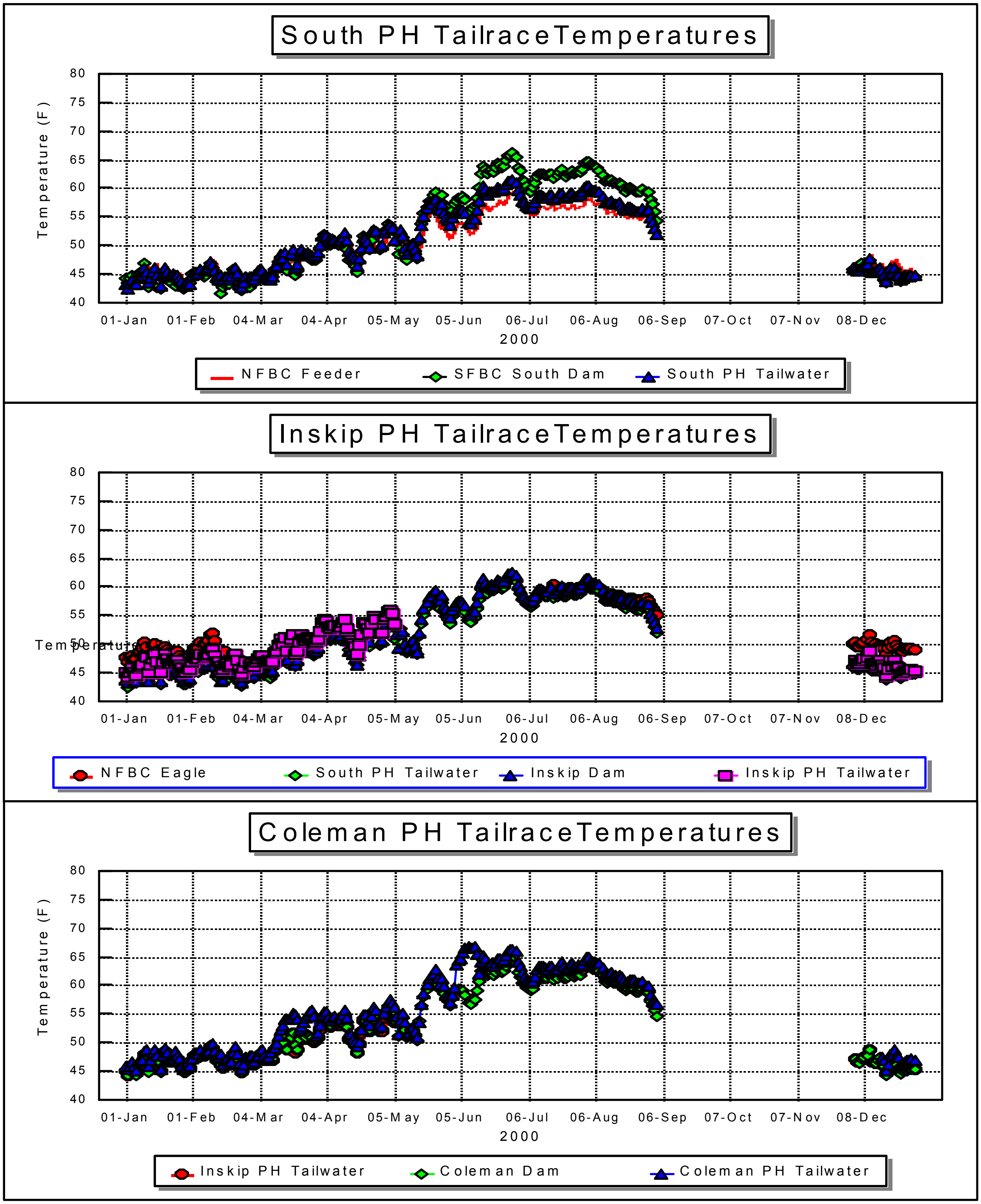


Figure M-7. Battle Creek Operational Water Temperatures, 2000.

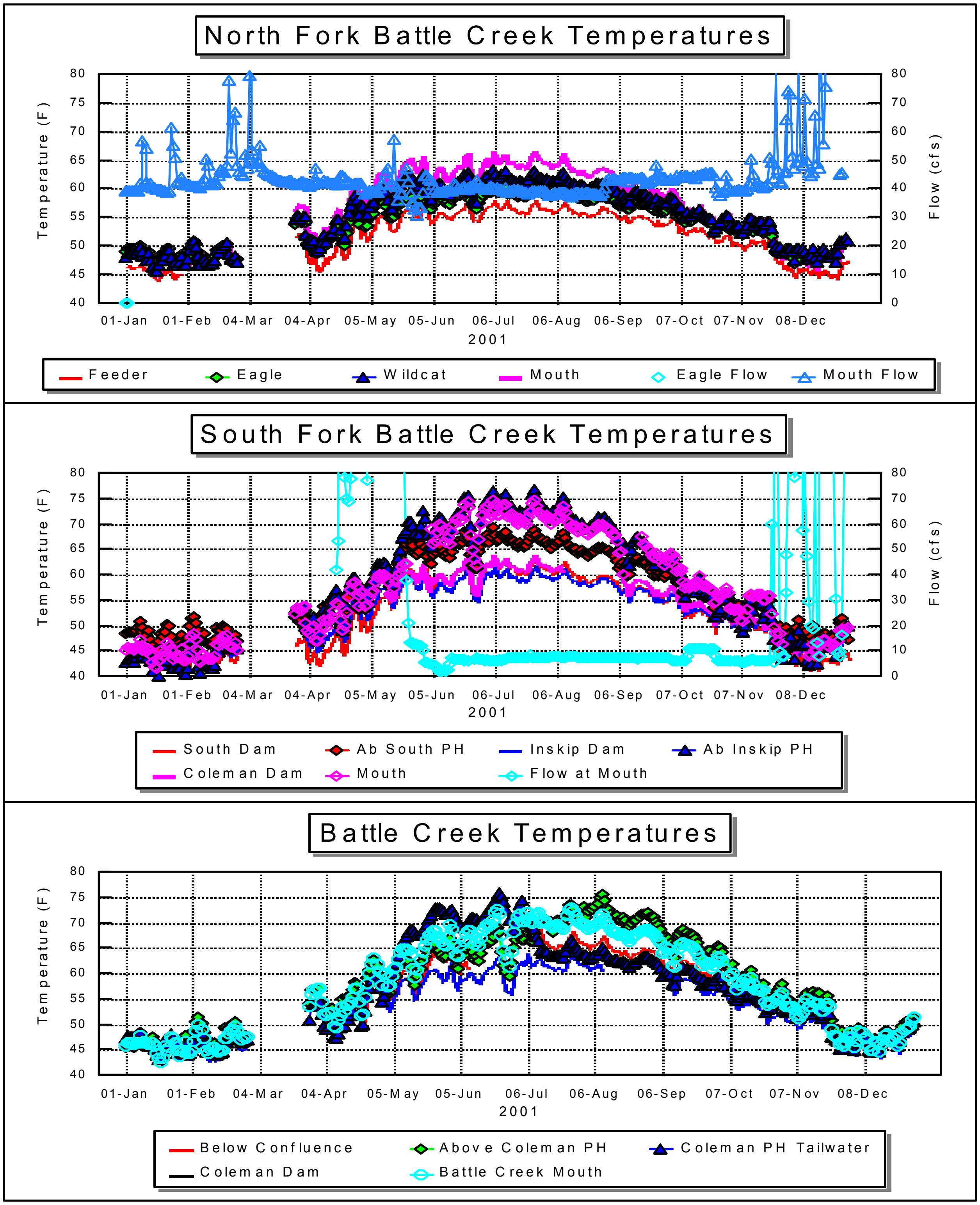


Figure M-8. Battle Creek Water Temperatures and Flows, 2001.

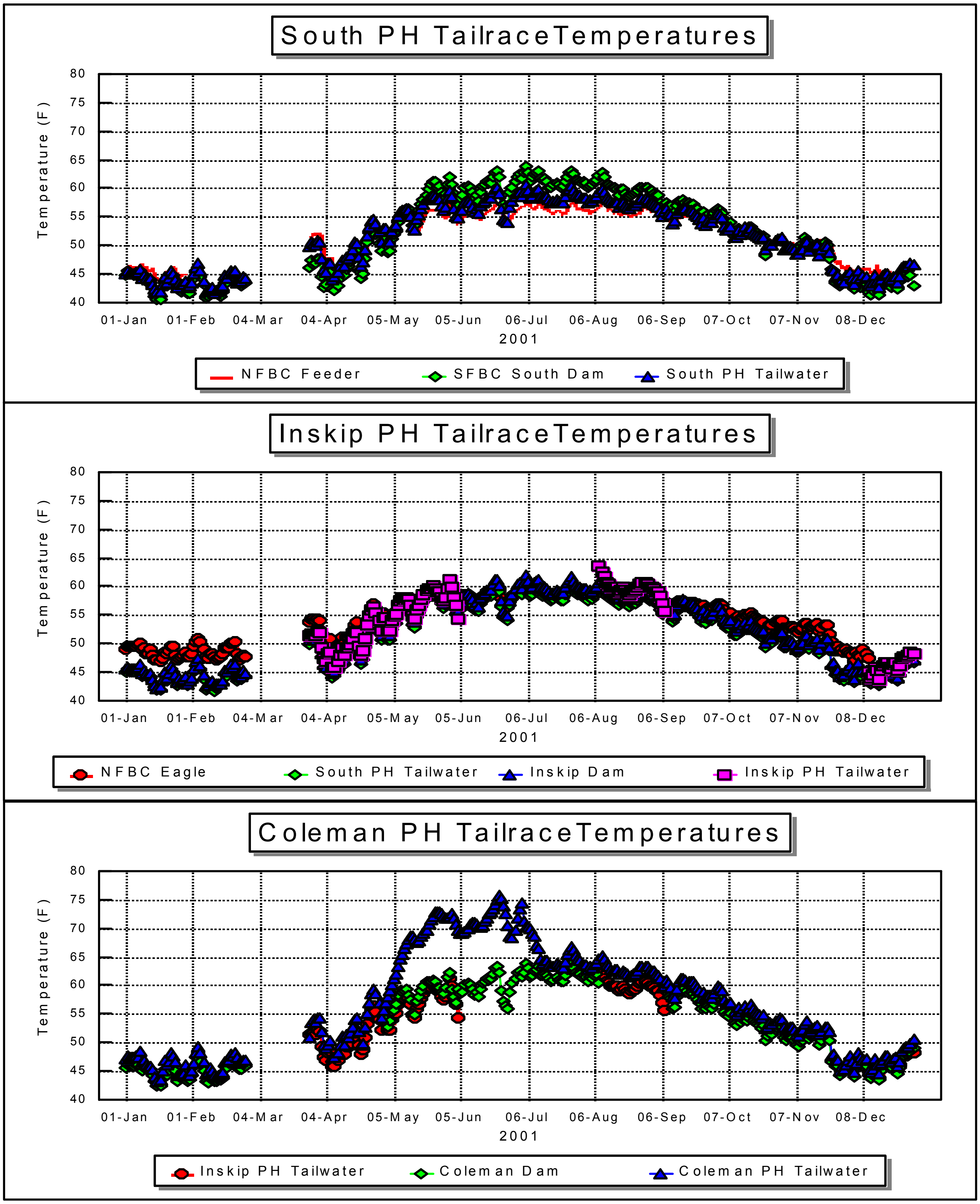
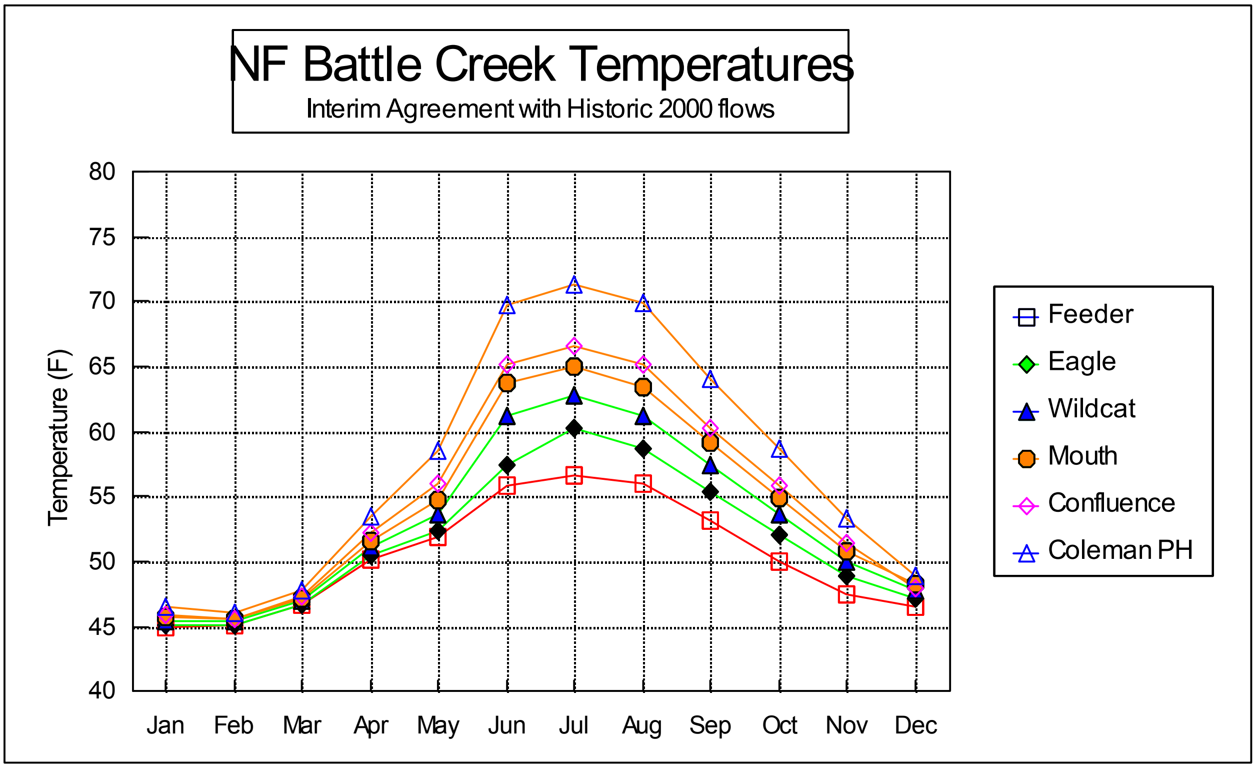


Figure M-9. Battle Creek Operational Water Temperatures, 2001.



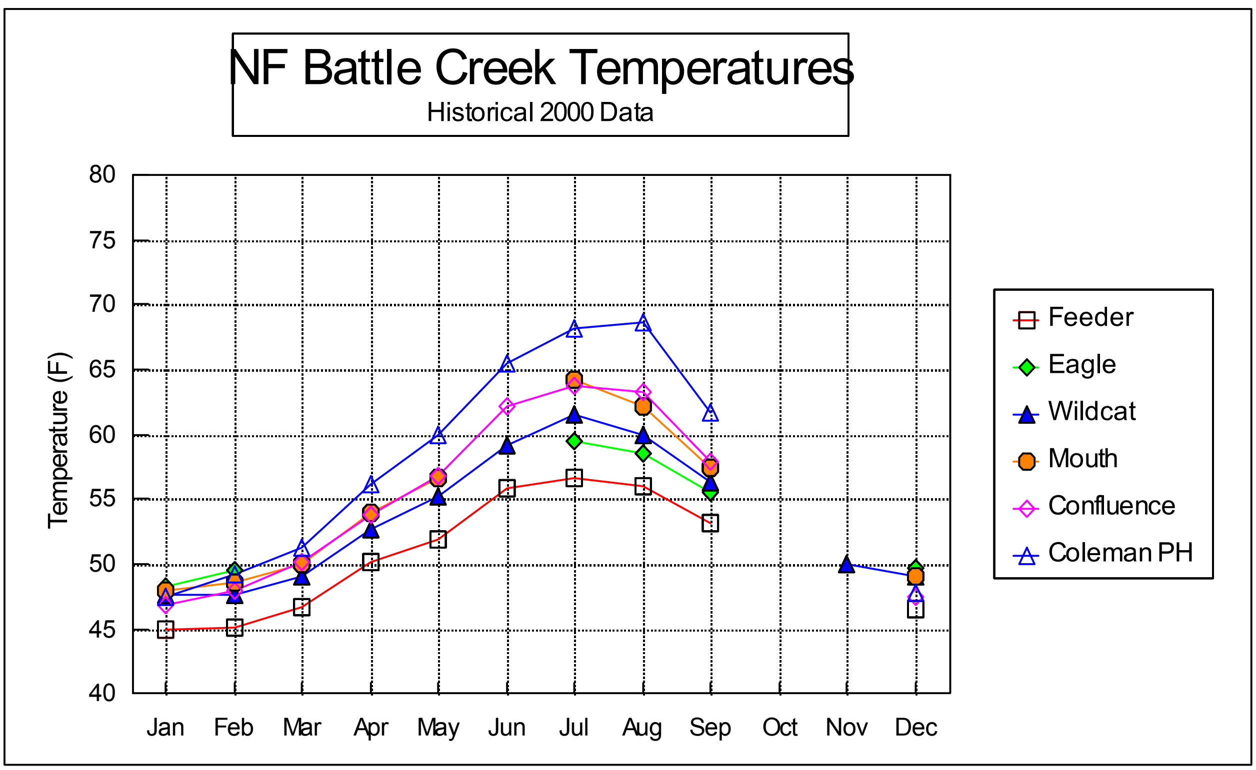
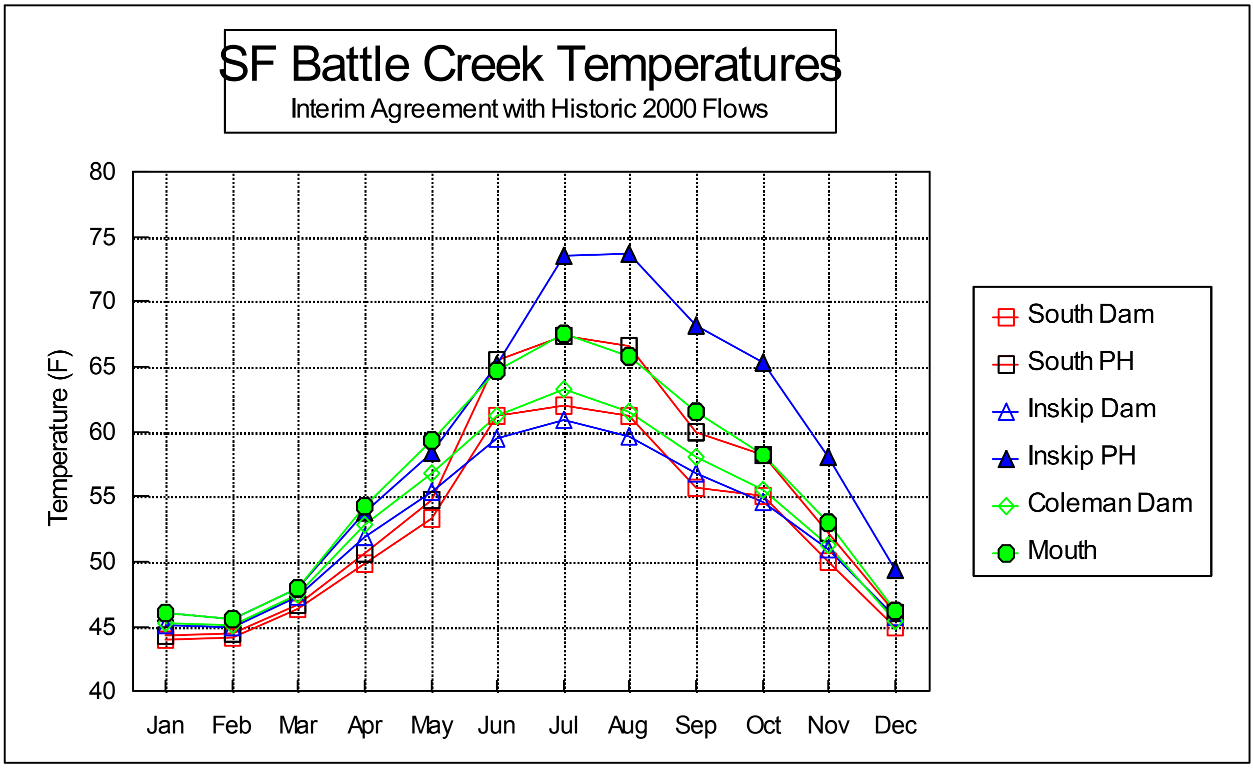


Figure M-10. North Fork Battle Creek Calibration for 2000.



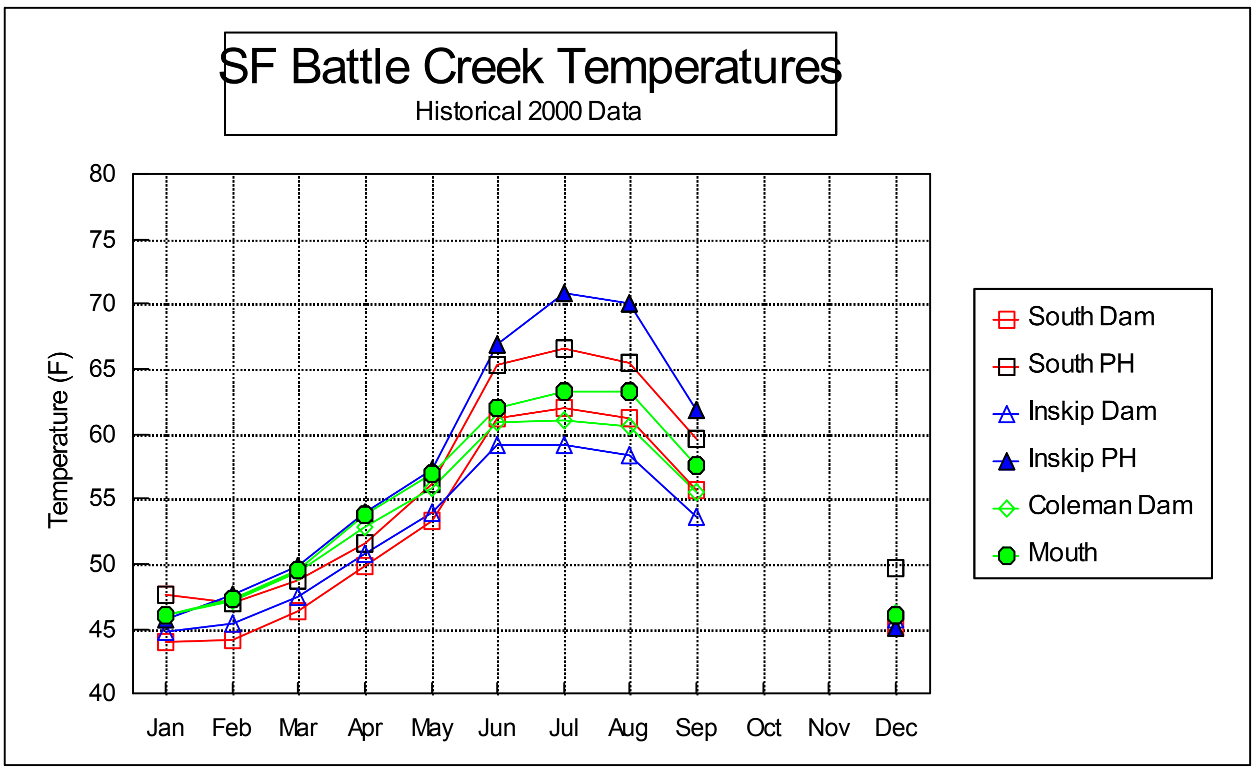
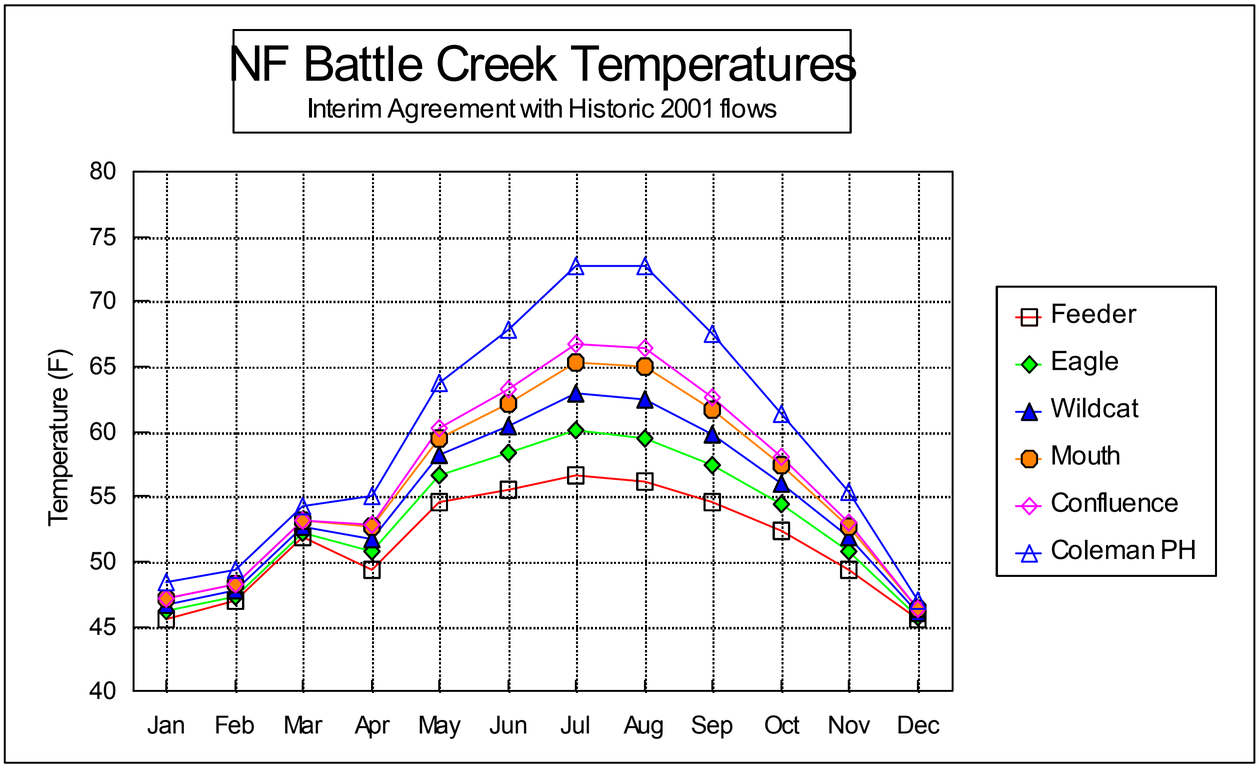


Figure M-11. South Fork Battle Creek Calibration for 2000.



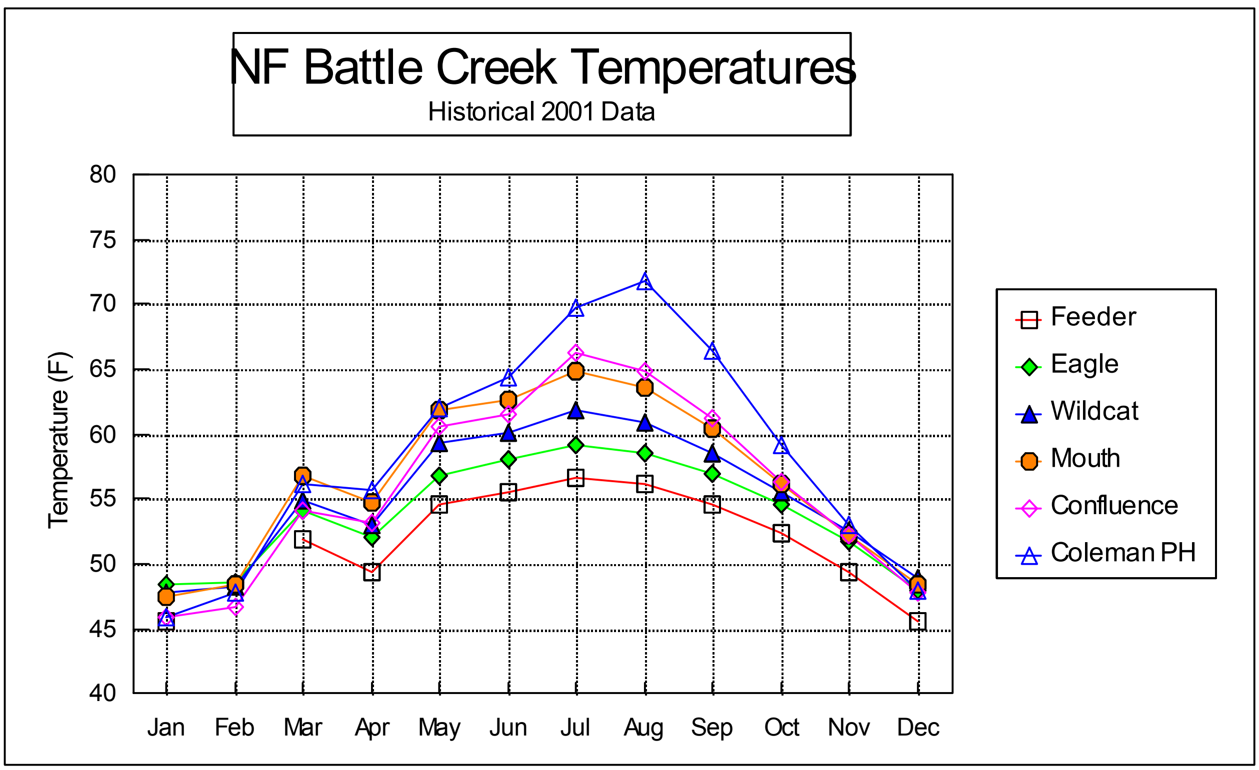
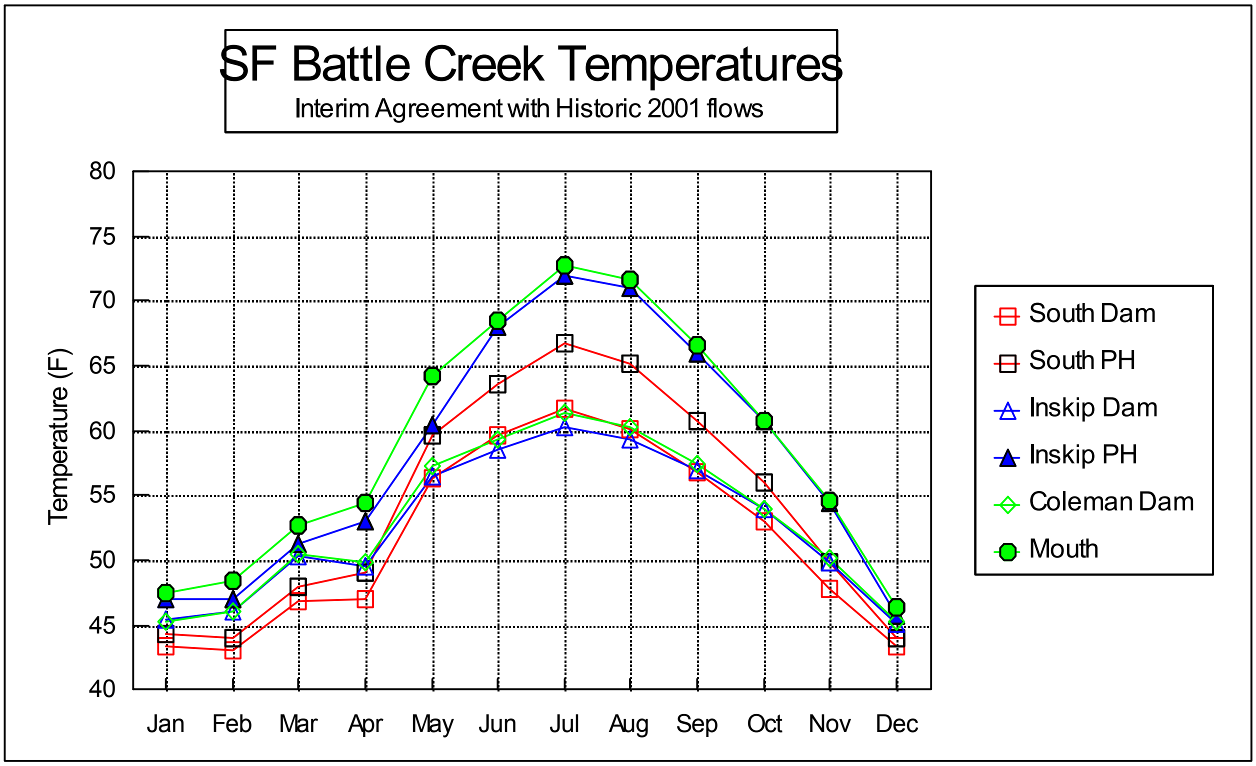


Figure M-12. North Fork Battle Creek Calibration for 2001.



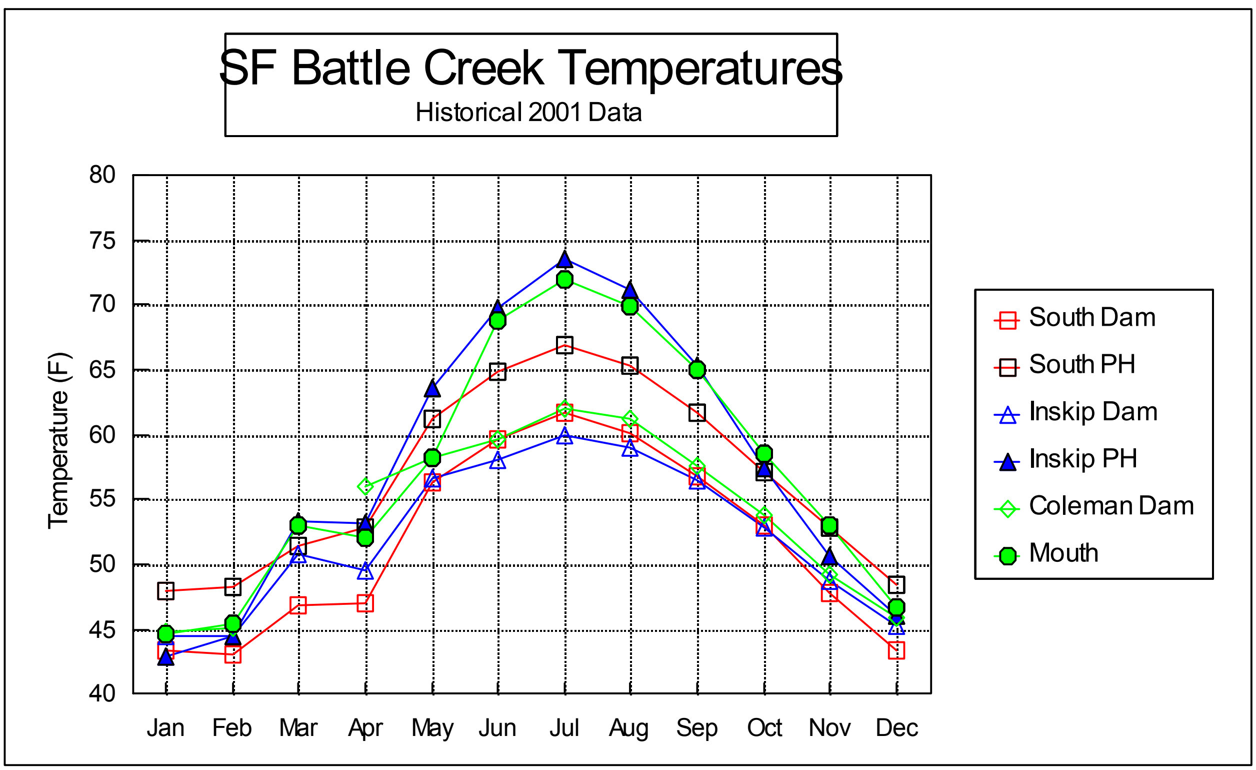


Figure M-13. South Fork Battle Creek Calibration for 2001.

Appendix N

Historical Battle Creek Water Quality Data

Appendix N
Historical Battle Creek Water Quality Data

This appendix contains water quality measurements made in Battle Creek by a variety of agencies that indicate the general mineral water composition. Water temperature measurements collected by TRPA in 1989 and DWR from 1998 to 2001 are also summarized as daily average values.

Table N-1. USGS Water Quality Data for Battle Creek below Coleman National Fish Hatchery (40°23’54” N 122°08’43” W; 5.7 miles upstream from mouth), 1961–1970

Date	Temp (°F)	Flow (cfs)	TSS (mg/L)	TDS (mg/L)	Specific Conductance (: mhos/cm)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)
10/5/61		213			148	8.4	71	59		
11/2/61	52	241	3							
11/9/61		241			153	8.1	74	58		
11/21/61	43	245	3							
11/29/61	48	461	12							
12/7/61		304			142	7.9	68	57		
12/20/61	47	709	17							
12/27/61	47	219	9							
1/4/62	45	286	16							
1/11/62		273			147	7.8	67	59		
1/19/62	47	866	121							
2/6/62	47	309	12							
2/9/62	50	1080	69		80	7.4	34	31		
2/15/62	46	2650	149							
2/16/62	46	930	27							
3/9/62	47	530	7							
3/13/62	48	426	7							
3/14/62		417			126	7.6	59	49		
4/6/62	58	484	16							

Date	Temp (°F)	Flow (cfs)	TSS (mg/L)	TDS (mg/L)	Specific Conductance (: mhos/cm)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)
4/11/62	458				107	7.9	52	43		
5/3/62	61	512	12							
6/3/62		498		93	106	7.8	48	40	8.0	4.9
6/5/62	59	408	35							
6/8/62		399			114	7.8	54	44		
6/15/62	58	422	12							
7/2/62		268			130	8.1	61	51		
8/1/62		206			146	8.1	69	56		
8/2/62	67	201	4							
9/11/62		170		125	156	8.1	75	60	12.0	7.3
9/26/62	58	188	3							
10/1/62		210			152	8.0	75	57		
10/16/62	51	579	40							
11/1/62		322			135	8.0	66	50		
11/23/62	50	309	5							
12/7/62		417			118	8.1	59	45		
12/19/62	49	704	16							
1/4/63		368			128	7.8	62	49		
1/24/63	45	309	4							
2/4/63		1120			77	7.6	35	29		
2/12/63	51	602	11							
2/28/62		385	9							
3/4/63		365			124	7.9	62	48		
3/21/63	52	355	11							
4/5/63		461			118	8.1	58	45		
4/25/63	51	704	10							
5/3/63		856		86	94	7.9	46	37	7.2	4.6
5/21/63	59	814	25							
6/5/63		520			104	8.0	56	42		
6/27/63	63	372	42							
7/12/63		314			130	8.2	65	51		
8/1/63	64	304	7							
8/2/63		250			137	8.2	68	52		

Date	Temp (°F)	Flow (cfs)	TSS (mg/L)	TDS (mg/L)	Specific Conductance (:mhos/cm)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)
9/4/63	64	237	8							
9/12/63		242		119	146	8.2	71	56	10.0	7.5
10/3/63	61	246	5							
10/1063		278			138	8.0		56		
11/7/63		404			125	8.0		44		
11/8/63	50	555	40							
11/14/63	54	358	12							
12/5/63	40	318	4		137	8.0		52		
12/13/63	45	309	7							
12/31/63	49	309	6							
1/2/64		309			137	8.2		52		
1/16/64	45	296	4							
2/4/64	45	370	5							
2/6/64		352			130	8.2		50		
2/20/64	50	334	4							
3/4/64	50	334	8							
3/12/64		343			139	8.3		49		
3/26/64	52	320	9							
3/31/64		384	11							
4/9/64		384			124	8.2		48		
5/2/64	49	428	6							
5/5/64	50	388	7							
5/7/64		366		110	122	8.0		49	11.0	5.2
6/11/64	59	338	23		114	7.9		45		
7/9/64		235			142	8.3		54		
7/15/64	67	732	8							
8/3/64		182			154	8.5		60		
8/19/64	64	660	17							
9/4/64		190		124	150	8.3		59	11.0	7.7
9/26/64	59	235	7							
10/8/64		222			153	8.1		58		
11/9/64		1300			80	7.3		28		
11/13/64	47	440	6							

Date	Temp (°F)	Flow (cfs)	TSS (mg/L)	TDS (mg/L)	Specific Conductance (: mhos/cm)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)
12/10/64		395			132	8.0		48		
12/17/64	42	375	4							
12/2264	52	9340	722							
12/29/64	42	1250	72							
1/14/65		827			98	8.2		38		
1/19/65	47	748	19							
2/1/65		685			106	8.2		40		
2/28/65	45	585	7							
3/1/65		540			113	8.5		43		
4/1/65	49	530	15							
4/5/65		515			115	7.9		45		
5/6/65	52	645	12	88	99	8.0		39	9.6	3.6
6/14/65		498			107	8.6		41		
6/16/65	61	455	10							
7/12/65		371			123	8.2		46		
8/3/65	69	264	5							
8/13/65		328			130	8.3		51		
9/1/65	61	291	5							
9/13/65		277		124	142	8.1		54	8.8	7.8
10/7/65		272			142	8.3		58		
10/9/65	58	273	3							
11/4/65		272			143	8.2		55		
11/18/65	51	827	102							
12/13/65		380			138	7.8		52		
12/16/65	41	282	7							
1/5/66	46	906	21		85	7.7		34		
2/4/66		844			93	8.1		36		
3/1/66	48	380	20							
3/8/66		377			131	8.1		52		
3/10/66	52	425	12							
3/31/66	53	535	39							
4/11/66	49	620	21							
4/12/66		583			100	8.0		38		

Date	Temp (°F)	Flow (cfs)	TSS (mg/L)	TDS (mg/L)	Specific Conductance (:mhos/cm)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)
5/2/66	57	450	10	101	110	7.9		44	8.8	5.4
6/2/66		331			125	8.2		48		
7/6/66		266			142	8.2		55		
9/1/66		190		125	152	8.2		58	10.0	8.0
103/66	58	217	5							
11/1/66	54	233	5							
12/2/66	51	632	9							
1/3/67	43	290	5							
2/1/67	48	1260	37							
3/1/67	50	410	6							
4/3/67	49	590	9							
11/2/67	55	244	6							
12/4/67	48	440	8							
1/9/68	45	280	4							
2/12/68	52	464	11							
2/20/68	50	2440	147							
3/19/68	48	608	4							
5/3/68	57	410	8							
6/4/68	61	350	7							
7/31/68	63	220	8							
9/5/68	61	234	14							
10/3/68	54	244	10							
11/21/68	50	324	11							
12/20/68	41	440	7							
1/22/69	41	2630	341							
2/11/69	46	1620	204							
2/17/69	46	1070	19							
3/5/69	45	795	26							
4/7/69	46	970	35							
5/6/69	54	942	31							
6/5/69	61	893	25							
8/11/69	63	324	10							
9/19/69	59	297	12							

Date	Temp (°F)	Flow (cfs)	TSS (mg/L)	TDS (mg/L)	Specific Conductance (:mhos/cm)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)
10/6/69	52	306	6							
11/3/69	58	316	4							
12/15/69	49	618	10							
12/20/69	53	2820	112							
1/7/70	45	466	7							
1/14/70	48	4380	383							
1/19/70	50	1690	79							
1/30/70	45	1590	109							
2/18/70	46	905	30							
3/9/70	47	1060	65							
3/20/70	50	710	10							
4/9/70	54	710	7							
5/8/70	55	604	13							
6/11/70	58	541	24							
7/6/70	66	473	7							
8/27/70	60	281	4							

Table N-1 Continued. USGS Water Quality Data for Battle Creek below Coleman National Fish Hatchery (40°23’54” N 122°08’43” W; 5.7 miles upstream from mouth), 1961–1970

Date	Na (mg/L)	K (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	B (:g/L)	SiO_2 (mg/L)	NO_3-N (mg/L)
10/5/61	8.4							
11/2/61								
11/9/61	8.7		2.4			100		
11/21/61								
11/29/61								
12/7/61	7.7		1.5			100		
12/20/61								
12/27/61								
1/4/62								
1/11/62	7.9		4.2			0		
1/19/62								
2/6/62								

Date	Na (mg/L)	K (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	B (:g/L)	SiO_2 (mg/L)	NO_3-N (mg/L)
2/9/62	4.3		1.1			0		
2/15/62								
2/16/62								
3/9/62								
3/13/62								
3/14/62	6.6		2.0			100		
4/6/62								
4/11/62	6.5		1.2			300		
5/3/62								
6/3/62	5.9	1.7	1.5	0.00	3.4	0	39	0.00
6/5/62								
6/8/62	6.3		1.3			100		
6/15/62								
7/2/62	7.9		1.8			0		
8/1/62	9.2		4.3			0		
8/2/62								
9/11/62	9.1	2.1	2.5	0.01	1.0	0	45	0.07
9/26/62								
10/1/62	9.6		2.8			200		
10/16/62								
11/1/62	7.8		1.2			0		
11/23/62								
12/7/62	6.6		0.1			0		
12/19/62								
1/4/63	7.3		3.5			0		
1/24/63								
2/4/63	3.9		1.0			0		
2/12/63								
2/28/62								
3/4/63	6.6		3.6			0		
3/21/63								
4/5/63	6.3		2.1			0		
4/25/63								
5/3/63	5.0	1.5	1.5	0.10	0.0	0	37	1.00

Date	Na (mg/L)	K (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	B (:g/L)	SiO_2 (mg/L)	NO_3-N (mg/L)
5/21/63								
6/5/63	5.6		1.2			100		
6/27/63								
7/12/63	7.2		1.8			0		
8/1/63								
8/2/63	7.4		1.5			200		
9/4/63								
9/12/63	7.8	1.8	2.0	0.01	1.0	0	45	0.05
10/3/63								
10/1063	7.6		3.9			0		
11/7/63	7.0		2.0			100		
11/8/63								
11/14/63								
12/5/63	8.0		3.4			0		
12/13/63								
12/31/63								
1/2/64	8.0		3.6			0		
1/16/64								
2/4/64								
2/6/64	8.5		3.0			0		
2/20/64								
3/4/64								
3/12/64	8.6		3.2			100		
3/26/64								
3/31/64								
4/9/64	7.5		3.0			0		
5/2/64								
5/5/64								
5/7/64	6.9	1.8	3.2	0.0	3.0	100	43	1.0
6/11/64	7.0		1.0			0		
7/9/64	8.2		1.0			100		
7/15/64								
8/3/64	9.0		3.0			0		
8/19/64								

Date	Na (mg/L)	K (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	B (: g/L)	SiO_2 (mg/L)	NO_3-N (mg/L)
9/4/64	8.3	3.1	2.1		2.0	100	46	0.8
9/26/64								
10/8/64	8.1		1.9			0		
11/9/64	4.4		2.1			100		
11/13/64								
12/10/64	7.1		1.4			0		
12/17/64								
12/2264								
12/29/64								
1/14/65	5.3		1.1			0		
1/19/65								
2/1/65	5.8		1.0			0		
2/28/65								
3/1/65	5.7		1.0			0		
4/1/65								
4/5/65	6.2		1.3			0		
5/6/65	5.3	2.1	1.1		1.0	0	37	1.4
6/14/65	5.8		1.2			0		
6/16/65								
7/12/65	7.1		1.3			0		
8/3/65								
8/13/65	7.4		1.7			0		
9/1/65								
9/13/65	8.3	2.0	2.0		3.0	0	48	0.2
10/7/65	8.2		1.3			0		
10/9/65								
11/4/65	8.1		1.3			0		
11/18/65								
12/13/65	7.6		2.1			0		
12/16/65								
1/5/66	5.0		1.6			0		
2/4/66	4.9		1.4			100		
3/1/66								
3/8/66	7.1		0.9			0		

Date	Na (mg/L)	K (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	B (:g/L)	SiO_2 (mg/L)	NO_3-N (mg/L)
3/10/66								
3/31/66								
4/11/66								
4/12/66	5.4		0.6			0		
5/2/66	6.1	1.6	1.3		3.0	0	35	0.5
6/2/66	7.0		1.2			0		
7/6/66	7.9		1.4			0		
9/1/66	9.2	2.3	1.8		3.0	0	46	0.1
103/66								
11/1/66								
12/2/66								
1/3/67								
2/1/67								
3/1/67								
4/3/67								
11/2/67								
12/4/67								
1/9/68								
2/12/68								
2/20/68								
3/19/68								
5/3/68								
6/4/68								
7/31/68								
9/5/68								
10/3/68								
11/21/68								
12/20/68								
1/22/69								
2/11/69								
2/17/69								
3/5/69								
4/7/69								
5/6/69								

Date	Na (mg/L)	K (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	B (: g/L)	SiO_2 (mg/L)	NO_3-N (mg/L)
6/5/69								
8/11/69								
9/19/69								
10/6/69								
11/3/69								
12/15/69								
12/20/69								
1/7/70								
1/14/70								
1/19/70								
1/30/70								
2/18/70								
3/9/70								
3/20/70								
4/9/70								
5/8/70								
6/11/70								
7/6/70								
8/27/70								

Source: U.S. Geological Survey; U.S. Environmental Protection Agency STORET database.

Table N-2. EPA Water Quality Data for Battle Creek below Coleman Powerhouse (40°23’54” N 122°08’10” W), 1971–1972

Date	BOD_5 (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Total Residue (mg/L)	TSS (mg/L)	NH_3+NH_4 (mg/L)	NO_2-N (mg/L)
7/14/71	3.5	75	102	66	15.0	0.02	0.20
8/10/71	2.3	88	116	97	8.0	0.05	0.03
9/13/71	1.8	73	100	68	10.0	0.01	0.02
10/21/71	1.2	70	110	69	11.0	0.04	0.06
11/8/71	2.1	72	85	72	16.0	0.10	0.05
12/20/71	3.1	74	73	146	12.0	0.30	0.02
1/10/72	2.0	75	52	115	3.7	0.33	0.09
2/14/72	2.3	70	52	112	2.5	0.35	0.10
3/15/72	2.5	56	45	110	2.1	0.30	0.10
4/10/72	3.0	54	50	110	3.7	0.30	0.14
5/8/72	4.0	66	72	120	3.0	0.26	0.14
6/15/72	2.8	68	60	124	2.0	0.20	0.09

Table N-2 Continued. EPA Water Quality Data for Battle Creek below Coleman Powerhouse (40°23’54” N 122°08’10” W), 1971–1972

Date	NO_3-N (mg/L)	Total Kjeldahl N (mg/L)	Total PO_4 (mg/L)	OrthoPO_4 (mg/L)	Total Coliforms (100/mL)	Fecal Coliforms (100/mL)
7/14/71	0.10	0.14	0.36	0.03	10	0
8/10/71	0.11	0.20	0.40	0.03	32	0
9/13/71	0.15	0.20	0.30	0.03	75	0
10/21/71	0.14	0.30	0.23	0.05		
11/8/71	0.17	0.42	0.43	0.04		
12/20/71	0.14	0.75	0.73	0.03		
1/10/72	0.20	0.65	0.35	0.15	32	3
2/14/72	0.38	0.88	0.33	0.30		
3/15/72	0.16	0.58	0.45	0.28		
4/10/72	0.14	0.59	0.46	0.30		
5/8/72	0.12	0.58	0.70	0.29		
6/15/72	0.10	0.45	0.88	0.30		

Source: U.S. Environmental Protection Agency (USEPA) Region 1, USEPA STORET database.

Table N-3. DWR Water Quality Data for Battle Creek Below Coleman National Fish Hatchery (40°23"54" N 122°08'43" W; 5.7 miles upstream from mouth), 1988–1989

Date	Time	Temp (°F)	Specific Conductance (:mhos/cm)	Turbidity (NTU)	D.O. (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	SO_4 mg/L	B mg/L
1988													
3/16	0930	49	142		12.0	7.5		54	10	7	7	3	<0.1
6/13	0508	60	160	1.0	6.5	7.3	78						
6/13	1000	66	126	0.8	11.7	7.8	68						
6/13	1400	68	135	0.7	10.4	8.2	65						
6/13	1940	66	140	0.9	7.7	8.1	62						
6/13	2110	66	143	0.9	8.3	7.9	64						
6/14	0215	63	142	0.8	8.3	7.3	63						
6/14	0505	61	160	1.1	7.2	7.2	65						
6/14	1010	67	145	1.9	10.2	8.1							
6/14	1400	69	140	1.1	9.6	7.8	65						
6/14	1910	67	141	1.1	8.3	7.9							
6/14	2100	67	158	1.1	8.2	7.9	66						
6/15	0150	64	155	1.0	8.3	7.9							
9/12	0505	59	87	0.4	8.2	7.3	76						
9/12	0910	60	165	0.9	10.7	7.5							
9/12	1330	65	258	0.5	11.0	8.3							
9/12	1715	64	176	0.4	10.1	8.6	75						
9/12	2135	64	120	0.5	8.6	7.9							
9/13	0125	59	160	0.5	9.0	7.6							
9/13	0515	66	156	0.6	9.3	7.7							
9/13	0930	59	160	0.5	10.6	8.0	75	64	11	9	9	3	<0.1
9/13	1320	63	165	0.5	11.2	8.1							
9/13	1820	62	170	0.5	8.5	8.2							
9/13	2115	61	137	0.5	8.7	8.0							
9/14	0050	60	162	0.5	9.6	7.6	75						
1989													
3/20	0615	48	67	5.0	11.0	7.2							
3/20	1005	50	88	3.5	11.8	7.3	42						
3/20	1435	52	112		10.8	7.5							
3/20	1915	54	95	2.6	10.3	7.5							

Date	Time	Temp (°F)	Specific Conductance (: mhos/cm)	Turbidity (NTU)	D.O. (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	SO_4 mg/L	B mg/L
3/20	2220	52	105	2.8	10.6	7.3							
3/21	0235	52	30	2.5	3.2	7.2	45						
3/21	0615	51	117	2.4	10.6	7.1							
3/21	1105	53	96	2.1	10.6	7.2		38	7	5	5	2	<0.1
3/21	1505	55	122	3.0	11.2	7.3	46						
3/21	1815	55	100	3.1	10.8	7.4							
3/21	2220	53	108	3.2	10.6	7.3							
3/22	0240	52	97	3.1	10.5	7.3	46						
8/14	0600	69	120	0.7	8.1	7.8	85						
8/14	0910	66	153	0.6	10.2	8.1							
8/14	1325	70	173	0.7	9.8	8.1	82						
8/14	1710	73	156	0.6	8.6	8.3	75						
8/14	2140	68	158	0.9	8.8	8.5							
8/15	0115	64	156	0.7	8.6	8.2	75						
8/15	0530	63	148	0.9	8.5	7.9							
8/15	0916	67	157	0.7	9.8	8.1		58	10	8	9	2	<0.1
8/15	1435	74	154	0.8	9.1	8.1	83						
8/15	1725	70	153	0.9	8.6	8.4							
8/15	2125	66	150	0.9	8.3	8.6							
8/16	0120	68	147	0.6	8.6	8.3	80						

Table N-3 Continued. DWR Water Quality Data for Battle Creek Below Coleman Fish Hatchery (40°23"54" N 122°08'43" W; 5.7 miles upstream from mouth), 1988–1989

Date	Time	Cl mg/L	Br mg/L	Cd µg/L	Cu µg/L	Fe mg/L	Pb µg/L	Mn µg/L	Hg µg/L	Zn µg/L	NH_3+ Org N mg/L	NO_2+ NO_3 mg/L	NO_3 mg/L	Ortho PO_4 mg/L	Total P mg/L
1988															
3/16	0930	2	0.02	<5	<5	0.1	<5	7	<1	<5	0.2		0.07	0.04	0.08
6/13	0508														
6/13	1000														
6/13	1400														
6/13	1940														
6/13	2110														

Date	Time	Cl mg/L	Br mg/L	Cd µg/L	Cu µg/L	Fe mg/L	Pb µg/L	Mn µg/L	Hg µg/L	Zn µg/L	NH_3+ Org N mg/L	NO_2+ NO_3 mg/L	NO_3 mg/L	Ortho PO_4 mg/L	Total P mg/L
6/14	0215														
6/14	0505														
6/14	1010														
6/14	1400														
6/14	1910														
6/14	2100														
6/15	0150														
9/12	0505														
9/12	0910														
9/12	1330														
9/12	1715														
9/12	2135														
9/13	0125														
9/13	0515														
9/13	0930	2	<1.00	<5	<5	<0.1	<5	7	<1	33	0.5		0.03	0.03	0.05
9/13	1320														
9/13	1820														
9/13	2115														
9/14	0050														
1989															
3/20	0615														
3/20	1005														
3/20	1435														
3/20	1915														
3/20	2220														
3/21	0235														
3/21	0615														
3/21	1105	1		<5	<5	0.2	<5	47	<1	13	0.4		0.13	0.02	0.04
3/21	1505														
3/21	1815														
3/21	2220														
3/22	0240														
8/14	0600														

Date	Time	Cl mg/L	Br mg/L	Cd μg/L	Cu μg/L	Fe mg/L	Pb μg/L	Mn μg/L	Hg μg/L	Zn μg/L	NH_3+ Org N mg/L	NO_2+ NO_3 mg/L	NO_3 mg/L	Ortho PO_4 mg/L	Total P mg/L
8/14	0910														
8/14	1325														
8/14	1710														
8/14	2140														
8/15	0115														
8/15	0530														
8/15	0916	22		<5	<5	<0.1	<5	37	<1	11	0.4	0.01		0.02	0.05
8/15	1435														
8/15	1725														
8/15	2125														
8/16	0120														

Source: California Department of Water Resources (DWR), Red Bluff.

Table N-4. EPA Water Quality Data for Battle Creek below Coleman Powerhouse (40°23’54” N 122°08’10” W), 1971-1972

Date	BOD5 (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Total Residue (mg/L)	TSS (mg/L)	NH_3+NH_4 (mg/L)	NO_2-N (mg/L)
7/14/71	3.5	75	102	66	15.0	0.02	0.20
8/10/71	2.3	88	116	97	8.0	0.05	0.03
9/13/71	1.8	73	100	68	10.0	0.01	0.02
10/21/71	1.2	70	110	69	11.0	0.04	0.06
11/8/71	2.1	72	85	72	16.0	0.10	0.05
12/20/71	3.1	74	73	146	12.0	0.30	0.02
1/10/72	2.0	75	52	115	3.7	0.33	0.09
2/14/72	2.3	70	52	112	2.5	0.35	0.10
3/15/72	2.5	56	45	110	2.1	0.30	0.10
4/10/72	3.0	54	50	110	3.7	0.30	0.14
5/8/72	4.0	66	72	120	3.0	0.26	0.14
6/15/72	2.8	68	60	124	2.0	0.20	0.09

Table N-4 Continued. EPA Water Quality Data for Battle Creek below Coleman Powerhouse (40°23’54” N 122°08’10” W), 1971-1972

Date	NO_3-N (mg/L)	Total Kjeldahl N (mg/L)	Total PO_4 (mg/L)	OrthoPO_4 (mg/L)	Total Coliforms (100/mL)	Fecal Coliforms (100/mL)
7/14/71	0.10	0.14	0.36	0.03	10	0
8/10/71	0.11	0.20	0.40	0.03	32	0
9/13/71	0.15	0.20	0.30	0.03	75	0
10/21/71	0.14	0.30	0.23	0.05		
11/8/71	0.17	0.42	0.43	0.04		
12/20/71	0.14	0.75	0.73	0.03		
1/10/72	0.20	0.65	0.35	0.15	32	3
2/14/72	0.38	0.88	0.33	0.30		
3/15/72	0.16	0.58	0.45	0.28		
4/10/72	0.14	0.59	0.46	0.30		
5/8/72	0.12	0.58	0.70	0.29		
6/15/72	0.10	0.45	0.88	0.30		

Source: U.S. Environmental Protection Agency (USEPA) Region 1, USEPA STORET database.

Table N-5. SWRCB Water Quality Data for Battle Creek below Coleman Powerhouse (40º23’54” N 122º08’06” W), 1955-1989

Date	Temp (°F)	Flow (cfs)	D.O. (mg/L)	Turbidity (NTU)	Specific Conductance (:mhos/cm)	TDS (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	K mg/L
1/28/55	46	300	10.7	1	133		7.4		52	11.0	5.8	7.6	2.0
4/28/58	59	700	9.2		102		7.4	51	38	7.8	4.5	6.2	2.0
5/21/58	58	750	8.8	2	76		7.8		30	6.0	3.6	4.1	1.3
6/26/58	66		8.0		100		7.9	48	40	7.8	5.0	5.0	1.5
7/25/58	72	500	8.5		121		7.2	57	44	8.6	5.5	6.4	2.0
8/27/58	62	400	8.2		142		7.5	67	53	12.0	5.6	7.6	2.3
9/19/58	63		10.0		149		7.8	69	54	9.5	7.4	9.0	2.4
10/24/58	55	280	6.3		148		7.4	66	53	9.4	7.2	8.0	2.4
11/14/58	58	300			146		7.6		52	8.4	7.5	7.6	2.4
12/23/58	47		10.3		139		7.6	69	54	9.6	7.3	8.2	2.3
1/5/59		350			111		7.5	47	44	7.6	6.1	6.6	1.9
2/9/59	42	290			134		7.8	65	54	10.0	7.1	7.7	2.1
3/11/59	51		12.0		122		7.4	58	46	9.6	5.5	6.5	1.9
4/15/59	57		10.6		117		7.7	58	48	8.8	6.3	6.5	1.4
5/15/59	54		10.9	3	118		7.8		45	8.0	6.1	6.5	1.9
6/16/59	63		10.0		135		8.1	65	52	9.2	7.1	7.5	1.8
7/9/59	64	700	8.7		154		8.1	69	54	12.0	5.8	8.7	2.6
8/11/59	63		9.4	20	152		7.9	72	60			9.1	1.5
9/1/59	59		10.2	10	148		8.0		58	11.0	7.4	8.8	2.2
10/13/59	56		10.0	2	149		7.8	75	58			10.0	3.5
11/11/59	49		11.4	4	149		7.8	74	58			9.7	
12/10/59	44		12.6	4	147		7.8	74	58			9.0	
1/14/60	42		11.5	2	147		7.9	72	57			8.8	
2/24/60	48		11.0	35	123		7.6	63	57			7.2	
3/7/60	53		10.0	125	68		7.2	30	26			2.7	
4/11/60	57		10.0	15	117		7.8	54	48			5.6	
5/11/60	59	600	9.9	25	108		7.7		46	7.6	6.6	5.7	2.1
6/13/60	68		9.2	4	116		7.8	24	48			5.6	
7/12/60	64	350	10.0	1	142		8.0	72	54			16.0	
8/8/60	63	90	9.5	1	149		8.0	77	58			8.8	
9/5/60	65	200	10.1	3	149		7.6		58	11.0	7.4	11.0	2.4

Date	Temp (°F)	Flow (cfs)	D.O. (mg/L)	Turbidity (NTU)	Specific Conductance (:mhos/cm)	TDS (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	K mg/L
10/10/60	54	179	10.5	2	149		8.0	71	59			8.5	
11/7/60	56	171	10.9	4	154		7.9	73	58			9.2	
12/12/60	47	255	11.6	3	140		8.0	71	57			8.5	
1/3/61	43	233	11.6	5	144		7.9	71	58			8.5	
2/15/61	52	1320	10.8	20	95		7.9	42	38			4.2	
3/14/61	55	271	11.4	3	127		8.1	63	51			7.5	
4/11/61	53	409	10.4	1	118		7.9	53	47			6.6	
5/2/61	52	379	10.2	5	113		8.0		43	9.2	4.9	7.9	1.8
6/6/61	58	367	8.4	1	109		8.1	51	43			6.0	
7/6/61	65	233	10.1	4	135		8.1	64	52			7.9	
8/8/61	65	180	9.5	3	145		8.1	71	56			8.5	
9/7/61	63	200	10.3	3	153		8.3		56	10.0	7.5	8.4	2.2
10/5/61	65	217	10.4	10	148		8.4	72	59			8.4	
11/9/61	51	225	11.2	5	153		8.1	74	58			8.7	
12/7/61	46	305	11.2	5	142		7.9	68	57			7.7	
1/11/62	47	280	10.2	2	147		7.8	67	59			7.9	
2/9/62	51	1530	10.5	20	80		7.4	34	31			4.3	
3/14/62	48	432	11.4	5	126		7.6	59	49			6.6	2.0
4/11/62	55	460	10.9	4	107		7.9	52	43			6.5	
5/3/62	60	470	10.0	2	106		7.8	48	40	8.0	4.7	5.9	1.7
6/8/62	64	400	9.6	10	114		7.8	54	44			6.3	
7/2/62	66	230	9.5	2	130		8.1	61	51			7.9	
8/1/62	70	222	9.5	5	146		8.1	69	56			9.2	4.3
9/11/62	65	138	10.4	3	156	133	8.1	75	60	12.0	7.3	9.1	2.1
10/1/62	62	217	11.5	10	152		8.0	75	57			9.6	
11/1/62	57	277	10.4	5	135		8.0	66	50			7.8	
12/7/62	50	380	11.6	3	118		8.1	59	45			6.6	
1/4/63	46	355	11.7	2	128		7.8	62	49			7.3	
2/4/63	51	1060	11.0	9	77		7.6	35	29			3.9	
3/4/63	47	398	12.7	1	124		7.9	62	48			6.6	
4/5/63	53	470	10.7	3	118		8.1	58	45			6.3	
5/3/63	55	990	10.1	6	94	82	7.9	46	37	7.2	4.6	5.0	1.5
6/5/63	63	510	10.1	1	104		8.0	56	42			5.6	

Date	Temp (°F)	Flow (cfs)	D.O. (mg/L)	Turbidity (NTU)	Specific Conductance (:mhos/cm)	TDS (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	K mg/L
7/12/63	65	322	9.8	1	130		8.2	65	51			7.2	
8/2/63	63	235	10.1	6	137		8.2	68	52			7.4	
9/12/63	60	300	9.8	3	146	115	8.2	71	56	10.0	7.5	7.8	1.8
10/10/63	57	278	10.1	1	138		8.0	71	56			7.6	
11/7/63	50	420	11.0	15	125		8.0	59	44			7.0	
12/5/63	48	322	12.1	1	137		8.0	66	52			8.0	
1/2/64	46	318	11.9	2	137		8.2	67	52			8.0	
2/6/64	45	370	12.7	2	130		8.2	62	50			8.5	
3/12/64	47	345	12.5	1	139		8.3	67	49			8.6	
4/9/64	54	426	11.1	2	124		8.2	57	48			7.5	
5/7/64	55	365	11.0	2	122	102	8.0	58	49	11.0	5.2	6.9	1.8
6/11/64	57	390	10.5	3	114		7.9	54	45			7.0	
7/9/64	65		9.9	2	142		8.3	68	54			8.2	
8/3/64	63	190	9.9	1	154		8.5	75	60			9.0	
9/4/64	63	204	10.1	3	150	112	8.3	72	59	11.0	7.7	8.3	3.1
10/8/64	58	271	10.0	1	153		8.1	72	58			8.1	
11/9/64	52	2100	10.7	40	80		7.2	23	28			4.4	
12/10/64	50	356	9.6	3	132		8.0	61	48			7.1	
1/14/65	47	806	10.3	5	98		8.2	44	38			5.3	
2/1/65	48	664	10.4	4	106		8.2	49	40			5.8	
3/1/65	50	532	10.2	1	113		8.5	53	43			5.7	
4/3/65	53	537	9.3	5	115		7.9	54	45			6.2	
5/6/65	52	658	9.5	3	99	82	8.0	44	39	9.6	3.6	5.3	2.1
6/14/65	57	505	8.2	6	107		8.6	49	41			5.8	
7/12/65	67	380	8.6	1	123		8.2	59	46			7.1	
8/13/65	61	307	9.6	5	130		8.3	61	51			7.4	
9/13/65	59	284	10.3	1	142	124	8.1	69	54	8.8	7.8	8.3	2.0
10/7/65	58	296	10.0	1	142		8.3	70	58			8.2	
11/4/65	55	325	10.8	1	143		8.2	69	55			8.1	
12/13/65	46	330	12.0	3	138		7.8	64	52			7.6	
1/5/66	46	906	11.3	10	85		7.7	38	34			5.0	
2/4/66	47	815	11.5	5	93		8.1	41	36			4.9	
3/8/66	52	376	12.2	2	131		8.1	63	52			7.1	

Date	Temp (°F)	Flow (cfs)	D.O. (mg/L)	Turbidity (NTU)	Specific Conductance (:mhos/cm)	TDS (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	K mg/L
4/12/66	54	589	11.3	5	100		8.0	47	38			5.4	
5/2/66	57	450	10.6	1	110	101	7.9	54	44	8.8	5.4	6.1	1.6
6/2/66	56	312	10.7	1	125		8.2	60	48			7.0	
7/6/66	62	275	10.5	1	142		8.2	69	55			7.9	
9/1/66	60	250	9.5	2	152	119	8.2	75	58	10.0	8.0	9.2	2.3
11/2/66	53	250	11.7	1	152		8.2	74	60	11.0	7.8	9.1	2.4
1/10/67	48	304	12.1	1	140		8.2	67	54	9.8	7.0	8.2	2.0
3/6/67	49	390	12.3	1	128		8.0	62	50	9.5	6.6	7.4	1.9
5/4/67	54	686	11.3	1	110	101	7.8	52	42	8.0	5.4	5.8	1.7
7/5/67	65	579	9.5	2	106		7.9	46	40			5.6	
9/6/67	64	254	9.5		144	123	8.2	69	54	9.8	7.1	8.5	2.2
11/2/67	55	258	10.6	2	147		8.0	69	55			8.3	
1/16/68	44	1240	11.6	25	81		7.7	34	33			3.6	
3/7/68	49	632	11.3	5	112		7.9	51	48			5.0	
5/1/68	57	425	10.6	2	117	102	7.9	55	44	8.3	5.7	6.8	1.2
7/5/68	68	258	9.4	5	146		8.3	68	62			8.0	
9/3/68	64	240	10.6	2	152	130	7.8	71	57	10.0	7.8	9.2	2.4
11/4/68	52	372	11.4		131		8.1	59	54			7.4	
1/6/69	46	423	12.2		129		8.0	61	56			6.9	
5/1/69	55	907	11.7		89	66	7.6	41	34	5.5	5.0	4.2	1.5
9/3/69	62	320	10.4		139	115	7.9	69	58	9.7	8.3	7.2	1.6
1/7/70	43	472	13.0	2	124		7.6	60	48			6.6	
5/7/70	54	449	11.7	2	119	91	7.9	58	45	8.1	6.1	7.2	1.7
10/7/70	54	305	11.6	7	146	116	8.3	68	58	9.8	8.1	8.2	2.2
2/8/71	48	546	12.3	3	120	86	8.1	58	47	11.0	4.7	6.0	1.5
2/9/72	46	407	11.8	2	127		8.4	63	56			7.2	
10/16/72	54	502	10.0	5	123		7.7	53	44			7.3	
2/2/73	46	546	11.6	2	118		7.4						
10/11/73	52	281	12.9	1	148		7.7	74	56			10.0	
1/18/74		1000		35	63								
2/14/74	45	604	12.7	3	115		7.4						
10/11/74	54	390	12.2	1	143		7.8						
2/6/75	45	676	12.2	4	101		7.6	51	42			7.0	

Date	Temp (°F)	Flow (cfs)	D.O. (mg/L)	Turbidity (NTU)	Specific Conductance (:mhos/cm)	TDS (mg/L)	pH	Alkalinity (mg/L)	Total Hardness (mg/L)	Ca mg/L	Mg mg/L	Na mg/L	K mg/L
10/17/75	54	325	10.4	1	142		7.6						
2/11/76	46	325	12.4	1	150		7.6	68	54			7.6	
10/18/76	54	237	11.0	1	155		8.2	74	61			9.1	
1/3/77		750		9	141								
6/15/77	63		10.3	1	155		7.8	68					
10/14/77	57	197	10.7	0	166		7.6	75	61			8.8	
2/14/78	47	800	12.1	4	97		7.4						
10/18/78	56		10.5	1	153		7.6						
2/21/79	47	2320	11.4		64	63	7.4	28	22	4.0	3.0	3.0	1.1
10/22/79	52	228	11.9	2	147		7.5						
1/14/80	49	5000		60	56		7.5	25	25	5.0	3.0	3.0	1.3
2/19/80	49	1000		31	57		8.4						
2/26/80	51	882	11.2	4	115		7.7						
10/24/80	56	250	12.0	1	153		7.9	69	54	10.0	7.0	9.0	2.5
2/26/81	47	465	12.1	2	126		8.1	57	47	9.0	6.0	7.0	1.9
10/27/81	59	158	10.7	3	164		7.9						
2/10/82	46	481	12.3		122		7.8						
10/28/82	51	415	11.3	1	125		7.5	59	47	9.0	6.0	7.0	2.1
12/22/82	45	1000		15	84		7.3						
2/9/83	48		11.5	3	97		7.6	40	38	7.0	5.0	5.0	1.5
10/19/83	52		10.6	2	135		7.3						
2/23/84	45	675	12.7	2	118		7.6						
2/14/85	50	384	11.3	2	142		8.1	65	54	10.0	7.0	8.0	
10/24/85	55	376	11.1	5	141		7.6						
3/3/86	56	937	10.8	33	99		7.8						
10/21/86	58	353	11.7	3	276		8.3	69	68	9.0	11.0	30.0	
2/19/87	48		11.9	3	135		7.6	54	45	8.0	6.0	7.0	
2/16/88	45	371	12.5	1	138	112	7.9	64	52	9.0	7.0	7.0	2.0
9/19/88	59	280	10.2	2	190	132	7.9	79	64	11.0	9.0	10.0	3.0
10/20/88	59	181	10.0		157		7.7						
2/15/89	48		12.7		153		7.7						

Table N-6. USEPA Water Quality Data for Battle Creek near Coleman Power House (40°24’04” N 122°07’43” W), 1971–1972

Date	BOD_5 (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Total Residue (mg/L)	TSS (mg/L)	NH_3+NH_4 (mg/L)	NO_2-N (mg/L)
7/14/71	3.3	76	112	72	1.5	0.03	0.01
8/10/71	3.1	94	115	103	1.4	0.06	0.03
9/13/71	2.3	74	115	85	1.2	0.02	0.03
10/21/71	1.2	70	85	60	0.8	0.08	0.02
11/8/71	1.0	78	78	67	0.9	0.09	0.01
12/20/71	1.5	84	61	94	0.8	0.08	0.02
1/10/72	1.7	80	55	103	0.2	0.32	0.05
2/14/72	1.5	80	54	110	0.6	0.22	0.06
3/15/72	1.4	56	50	106	2.0	0.23	0.05
4/10/72	1.2	54	48	115	1.0	0.21	0.06
5/8/72	1.5	56	50	110	1.3	0.25	0.05
6/15/72	0.8	58	48	118	1.0	0.22	0.04

Table N-6 Continued. USEPA Water Quality Data for Battle Creek near Coleman Power House (40°24’04” N 122°07’43” W), 1971–1972

Date	NO_3-N (mg/L)	Total Kjeldahl N (mg/L)	Total PO_4 (mg/L)	OrthoPO_4 (mg/L)	Total Coliforms (100/mL)	Fecal Coliforms (100/mL)
7/14/71	0.18	0.23	0.20	0.05	0	0
8/10/71	0.20	0.31	0.30	0.06	0	0
9/13/71	0.20	0.25	0.25	0.05	15	0
10/21/71	0.22	0.36	0.20	0.01		
11/8/71	0.20	0.38	0.20	0.03		
12/20/71	0.16	0.30	0.22	0.05		
1/10/72	0.12	0.52	0.25	0.08	10	
2/14/72	0.10	0.40	0.20	0.05		
3/15/72	0.10	0.42	0.25	0.02		
4/10/72	0.15	0.45	0.20	0.05		
5/8/72	0.13	0.44	0.26	0.03		
6/15/72	0.13	0.42	0.25	0.05		

Source: U.S. Environmental Protection Agency (USEPA) Region 1, USEPA STORET database.

Appendix O

Shasta and Tehama County Production Statistics and Field Notes from Site Visit to Mount Lassen Trout Farms, Inc.

Appendix O

Shasta and Tehama County Production Statistics and Field Notes from Site Visit to Mount Lassen Trout Farms, Inc.

Table O-1. Tehama County Production Statistics, 1992 and 1997

		All Farms	
Item	Unit	1997	1992
Farms	number	1,362	1,381
Land in farms	acres	885,426	1,016,851
Average size of farm	acres	650	736
Value of land and buildings*			
Average per farm	Dollars	772,234	651,023
Average per acre	Dollars	1,106	939
Estimated market value of all machinery and equipment*			
Average per farm	Dollars	39,255	34,737
Farms by size			
1 to 9 acres		251	240
10 to 49 acres		529	556
50 to 179 acres		259	249
180 to 499 acres		144	142
500 to 999 acres		67	70
1,000 acres or more		112	124
Total cropland	farms	1,063	1,116
	acres	127,019	20,902
Harvested cropland	farms	831	897
	acres	62,038	60,380
Irrigated land	farms	1,001	988
	acres	85,571	71,572

Item	Unit	All Farms 1997	All Farms 1992
Market value of agricultural products sold			
Total for county	Dollars	$107,102	$95,041
Average per farm	Dollars	$78,636	$68,820
Crops, including nursery and greenhouse crops	Dollars	$66,798	$56,677
Livestock, poultry, and their products	Dollars	$40,304	$38,364
Farms by value of sales			
Less than $2,500		357	383
$2,500 to $4,999		176	182
$5,000 to $9,999		160	181
$10,000 to $24,999		241	213
$25,000 to $49,999		125	136
$50,000 to $99,999		109	94
$100,000 or more		194	192
Total farm production expenses			
Total for county	Dollars	80,743	79,887
Average per farm	Dollars	59,282	57,874
Operators by principal occupation			
Farming		694	719
Other		668	662
Operators by days worked off farm			
Any		716	743
200 days or more		462	480
Livestock and poultry			
Cattle and calves inventory	Farms	559	570
	Number	85,270	80,440
Hogs and pigs inventory	Farms	40	52
	Number	458	2,053
Sheep and lambs inventory	Farms	74	110
	Number	6,522	7,782
Layers and pullets 13 weeks old and older inventory	Farms	62	83
	Number	1,226	1,582

Item	Unit	All Farms	
		1997	1992
Selected crops harvested			
Wheat for grain	Farms	35	28
	Acres	6,413	4,367
	Bushels	331,438	263,592
Barley for grain	Farms	4	7
	Acres	465	1,242
	Bushels	21,250	47,114
Rice	Farms	4	7
	Acres	723	1,277
	Hundred-weight	51,805	90,210
Hay, alfalfa, other wild silage	Farms	149	214
	Acres	12,069	14,123
	Tons, dry	36,301	48,232
Vegetables harvested	Farms	28	16
	Acres	186	61
Land in orchards	Farms	662	685
	Acres	36,956	35,422

* Data are based on a sample of farms.

Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 1997 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 1997." This electronic series presents summary statistics for each county and state together with comparable data from the 1992 census. The items included are the same for all States and counties, except selected crops harvested, which vary by state. Data for 1997 and 1992 are directly comparable for acreage and inventories. Dollar values have not been adjusted for changes in price levels.

Table O-2. Shasta County Production Statistics, 1992 and 1997

Item	Unit	All Farms	
		1997	1992
Farms	number	850	844
Land in farms	acres	316,743	388,084
Average size of farm	acres	373	460
Value of land and buildings*			
Average per farm	Dollars	$419,564	$469,095
Average per acre	Dollars	$1,021	$1,066
Estimated market value of all machinery and equipment*			
Average per farm	Dollars		
Farms by size			
1 to 9 acres		261	224
10 to 49 acres		260	272
50 to 179 acres		135	137
180 to 499 acres		75	93
500 to 999 acres		47	37
1,000 acres or more		72	81
Total cropland	farms	612	621
	acres	59,487	62,649
Harvested cropland	farms	401	396
	acres	22,659	23,897
Irrigated land	farms	605	594
	acres	38,863	44,282
Market value of agricultural products sold			
Total for county	Dollars	$31,349	$33,198
Average per farm	Dollars	$36,881	$39,334
Crops, including nursery and greenhouse crops	Dollars	$18,375	$13,031
Livestock, poultry, and their products	Dollars	$12,975	$20,167

Item	Unit	All Farms 1997	All Farms 1992
Farms by value of sales			
Less than $2,500		356	346
$2,500 to $4,999		135	141
$5,000 to $9,999		112	102
$10,000 to $24,999		106	108
$25,000 to $49,999		5,741	6,024
$50,000 to $99,999		43	63
$100,000 or more			
Total farm production expenses			
Total for county	Dollars	$23,652	$28,965
Average per farm	Dollars	$27,794	$32,359
Operators by principal occupation			
Farming		354	385
Other		496	459
Operators by days worked off farm			
Any		477	457
200 days or more		319	282
Livestock and poultry			
Cattle and calves inventory	Farms	486	482
	Number	37,758	45,050
Hogs and pigs inventory	Farms	43	67
	Number	273	1,189
Sheep and lambs inventory	Farms	65	74
	Number	1,417	1,682
Layers and pullets 13 weeks old and older inventory	Farms	78	74
	Number	1,819	1,682

Item	Unit	All Farms 1997	1992
Selected crops harvested			
Wheat for grain	Farms	15	17
	Acres	945	958
	Bushels	46,518	43,663
Barley for grain	Farms	9	14
	Acres	493	706
	Bushels	29,064	44,873
Rice	Farms	1	14
Hay, alfalfa, other wild silage	Farms	189	213
	Acres	13,363	17,147
	Tons, dry	41,670	66,512
Vegetables harvested	Farms	37	28
	Acres	99	235
Land in orchards	Farms	163	174
	Acres	997	1,539

* Data are based on a sample of farms.

Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 1997 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 1997." This electronic series presents summary statistics for each county and state together with comparable data from the 1992 census. The items included are the same for all States and counties, except selected crops harvested, which vary by state. Data for 1997 and 1992 are directly comparable for acreage and inventories. Dollar values have not been adjusted for changes in price levels.

Table O-3. Mount Lassen Trout Farms Facilities Visited on December 14, 2000, and Excerpted Notes About Each Facility

Facility and Location	Type of Visit	Potential Connection to Restoration Project	Comments
Willow Springs Battle Creek Watershed; 1000' NW of Coleman Canal and South Fork Battle Creek near Coleman Diversion Dam	Drove by, did not tour but saw from a distance, saw water supply pipe	The source springs for this facility are hydrologically connected to the Inskip canal. Potential connectivity with the environment is high, entails direct use of Battle Creek water in facility.	Water supply here is reduced up to 50% (4-5 cfs) when PG&E's Inskip canal is offline. PG&E believes that Willow Springs are augmented by leakage from canal (per Mr. Mackey). <u>Even without a disease risk, construction of new facilities at Inskip could temporarily and/or permanently affect water supply at this facility.</u>
Macam Springs Battle Creek Watershed; 1400' SW South Fork Battle Creek about 0.5 miles u.s. Inskip Powerhouse	Toured raceways, exterior of R&D facilities, saw water supply from about 100 yards	Potential connectivity with environment from birds is moderate, lower potential connectivity due to terrestrial animals.	
Jeffcot West Battle Creek Watershed; water supply springs are about 30 feet west of Eagle Canyon Canal, approx. 1.3 miles due south of EC Diversion Dam and about 0.3 miles S. of North Fork Battle Creek; earthen ponds are about 1000 feet S. of North Fork Battle Creek directly under transmission lines.	Toured water supply springs, concrete raceways, earthen ponds	Extremely high potential connectivity with environment from avian, terrestrial, and/or amphibious animals due to extremely close proximity of source springs (in circa 1 acre wetland) to Eagle Canyon canal, and the isolated, open nature of earthen ponds.	Blue and green herons were present in the immediate vicinity of the earthen ponds. Source spring is a wetland that undoubtedly harbors individual animals that may contact Eagle Canyon canal waters. Facility likely could not be completely disinfected due to earthen nature and nature of source springs/wetland.
Jeffcot East Battle Creek Watershed; water supply springs are perhaps 100 to 200 feet east of Eagle Canyon Canal, approx. 1.3 miles due south of EC Diversion Dam and about 1500 feet S of North Fork Battle Creek; facility discharges directly into EC canal.	Toured water supply, spawning sheds, concrete raceways, some buildings, discharge site into Eagle Canyon canal	High potential connectivity with environment from birds, terrestrial animals and/or amphibians due to close proximity of source springs and discharge to Eagle Canyon canal.	This facility includes perhaps 33% of the MLTF brood stock. Most of the facility is indoors. 90% of source springs have been capped with plastic and gravel. Possible that the facility could be disinfected, though probably not the source springs.

Table O-3. Continued

Facility and Location	Type of Visit	Potential Connection to Restoration Project	Comments
Volta Battle Creek Watershed; water supply is a diversion from Brush Creek, likely upstream of anadromous fish passage (not verified) but within perhaps 1500 feet of the anadromous section of North Fork of Battle Creek, discharges back into Brush Creek.	Toured earthen ponds, water supply from Brush Creek, discharge to Brush Creek	Unknown level of potential connectivity. Mr. Mackey felt that this facility was at relatively low risk (they have had no otter problems, though bears have raided the ponds), but it is directly connected to surface water and is also connected to Battle Creek by a riparian corridor; would be impossible to isolate from surface water.	
Battle Creek Battle Creek Watershed; water supply is springs that feed upper Ripley Creek (probably above anadromous reach – need to verify), earthen ponds are within 100 feet of X-C canal; facility discharges directly to X-C canal, facility is about 5000 feet from nearest segment of South Fork Battle Creek.	Toured water supply, circular tanks, earthen ponds, discharge to X-C canal, exterior of buildings	Extremely high potential connectivity with environment from birds, terrestrial animals, and/or amphibians due to extremely close proximity of facilities to X-C canal.	Currently, Ripley Creek water runs through this facility into X-C canal. Would this water be available for adaptive management? Who has rights to the water discharged into canal, what about the rest of upper Ripley Creek not used by MLTF?
Meadow Brook Paynes Creek Watershed; at confluence with Plum Creek; approximately 5.5 air miles S. of nearest segment of South Fork Battle Creek.	Toured water supply, exterior concrete raceways, exterior of buildings, office	Low potential connectivity with environment due to distance from Battle Creek. However, anecdotes suggest some overlap in bird populations between Battle Creek and Paynes Creek. Facility already is either indoors or under bird nets.	Mr. Mackey told of an increased number of bird vectors that showed up here when CDFG excluded birds from Darrah Springs Hatchery. Also gave anecdotal evidence of hatchery-habituated birds (some birds wouldn't leave, and instead nearly starved, when bird exclusion nets were installed here).
Dales Paynes Creek Watershed; approximately 7.0 air miles S. of nearest segment of Battle Creek in vicinity of CNFH.	Self-tour of exterior raceways, did not see water supply	Low risk due to distance from Battle Creek. However, anecdotes suggest some overlap in bird populations between Battle Creek and Paynes Creek.	

Level/description of potential connection between facility and natural environment/Battle Creek through animal vectors and/or hydrologic connection

Appendix P

Memorandum of Agreement among the Bureau of Reclamation, the Federal Energy Regulatory Commission and the California State Historic Preservation Officer Regarding the Battle Creek Salmon and Steelhead Restoration Project, Shasta and Tehama Counties, California

MEMORANDUM OF AGREEMENT AMONG THE BUREAU OF RECLAMATION, THE FEDERAL ENERGY REGULATORY COMMISSION AND THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER REGARDING THE BATTLE CREEK SALMON AND STEELHEAD RESTORATION PROJECT, SHASTA AND TEHAMA COUNTIES, CALIFORNIA

Whereas, the Bureau of Reclamation (Reclamation) and the Federal Energy Regulatory Commission (Commission) have determined that implementation of the Battle Creek Salmon and Steelhead Restoration Project (Undertaking) in Shasta and Tehama Counties, California, will have an adverse effect on Inskip, Coleman, Eagle Canyon, and Wildcat Canyon Dams, properties determined eligible for inclusion in the National Register of Historic Places (historic properties), have consulted with the California State Historic Preservation Officer (SHPO) pursuant to 36 CFR Part 800, regulations effective January 11, 2001, implementing Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470f), and have notified the Advisory Council on Historic Preservation (Council) of the adverse effect pursuant to 36 CFR § 800.6(a)(1); and

Whereas, Pacific Gas and Electric Company (PG&E Company) which owns, operates and manages these historic properties and other structures and facilities associated with hydroelectric power generation within the Battle Creek Drainage in accordance with a license issued by the Federal Energy Regulatory Commission, FERC No. 1121, participated in the consultation and has been invited to concur in this Memorandum of Agreement (MOA);

Now, Therefore, Reclamation, the Commission and the SHPO agree that if the Undertaking proceeds, the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertaking on historic properties, and further agree that these stipulations shall govern the Undertaking and all of its parts until this MOA expires or is terminated.

Stipulations

Reclamation will ensure that the following measures are carried out:

1. Recordation

Reclamation will ensure that each historic property is documented as follows:

a. The National Park Service (NPS) prepared Historic American Engineering Record (HAER) documentation for the former South, Inskip, and Coleman hydroelectric power generating stations. This documentation provides a historic context for the four historic properties covered by this MOA. Reclamation will ensure that a combined historic context report (Report) for these four historic properties is prepared, utilizing the HAER documentation prepared by NPS.

b. Both color and black and white 35mm photographs of each dam that show elevations, profiles, and the context of each dam will be prepared. The black and white photographs will be archivally processed and catalogued consistent with HAER standards. Color photographs will be incorporated into the body of the Report.

c. An "Index to Photographs" will be prepared and such index will include a "photo key" showing the location and direction of each photographic view.

d. Research will be conducted to seek historic photographs that depict the operation of each dam, and if such photographs exist, they will be included in the Report.

e. Original drawings and contemporary drawings, as available and free from copyright restrictions, for each dam will be included in the Report.

f. Interviews and the summary report of the Battle Creek Conservancy Historical Study will be included as an appendix in CD form. This study includes oral histories from individuals associated with the Battle Creek Hydroelectric System.

2. Report Dissemination

Reclamation will ensure that within 2 years following execution of this MOA, a copy of the Report cited in Stipulation 1. above, is sent to the SHPO, the Northeast Information Center, Battle Creek Conservancy, Shasta County Historical Society, FERC, California State Department of Water Resources, and to other archives that may be designated by Reclamation or the SHPO.

3. Notice to Proceed

When Reclamation, in consultation with the SHPO and the Commission, determines that all field work needed to fulfill the terms of Stipulation 1., above, has been satisfactorily completed, Reclamation may thereafter authorize construction-related activities to proceed.

4. Resolving Objections

a. Should any party to this MOA object to the manner in which the terms of this MOA are implemented, to any action carried out or proposed with respect to implementation of the MOA, or to any documentation prepared in accordance with and subject to the terms of this MOA, Reclamation shall immediately notify the other parties to this MOA of the objection and consult with the objecting party and with the other parties to this MOA for no more than 14 days to resolve the objection. Reclamation shall reasonably determine when this consultation will commence. If the objection is resolved through such consultation, the action subject to dispute may proceed in accordance with the terms of that resolution. If, after initiating such consultation, Reclamation determines that the objection cannot be resolved through consultation, Reclamation shall forward all documentation relevant to the objection to the Council, including Reclamation's proposed response to the objection, with the expectation that the Council will within thirty (30) days after receipt of such documentation:

(1) Advise Reclamation that the Council concurs in Reclamation's proposed response to the objection, whereupon Reclamation will respond to the objection accordingly; or

(2) Provide Reclamation with recommendations, which Reclamation will take into account in reaching a final decision regarding its response to the objection; or

(3) Notify Reclamation that the objection will be referred for comment pursuant to 36 CFR § 800.7(c), and proceed to refer the objection and comment. Reclamation shall take the resulting comment into account in accordance with 36 CFR 800.7(c)(4) and Section 110(l) of the NHPA.

b. Should the Council not exercise one of the above options within 30 days after receipt of all pertinent documentation, Reclamation may assume the Council's concurrence in its proposed response to the objection.

c. Reclamation shall take into account any Council recommendation or comment provided in accordance with this stipulation with reference only to the subject of the objection. Reclamation's responsibility to carry out all actions under this MOA that are not the subjects of the objection will remain unchanged.

d. At any time during implementation of the measures stipulated in this MOA should an objection pertaining to such implementation be raised by a member of the public, Reclamation shall notify the parties to the MOA and take the objection into account, consulting with the objector and, should the objector so request, with any of the parties to this MOA to address the objection.

e. Reclamation shall provide all parties to this MOA, the Council when Council comments have been issued hereunder, and any parties that have objected pursuant to paragraph D.4., with a copy of its final written decision regarding any objection addressed pursuant to this stipulation.

f. Reclamation may authorize any action subject to objection under this stipulation to proceed after the objection has been resolved in accordance with the terms of this stipulation.

5. Amendments

Any party to this MOA may propose that this MOA be amended, whereupon the parties to this MOA will consult for no more than 30 days to consider such amendment. The amendment process shall comply with 36 CFR §§ 800.6(c)(1) and 800.6(c)(7). This MOA may be amended only upon the written agreement of the signatory parties. If it is not amended, this MOA may be terminated by any signatory party in accordance with Stipulation 6., below.

6. Termination

a. If this MOA is not amended as provided for in Stipulation 5., above, or if any signatory party proposes termination of this MOA for other reasons, the signatory party proposing termination shall, in writing, notify the other parties to this MOA, explain the reasons for proposing termination, and consult with the other parties for at least 30 days to seek alternatives to termination. Should such consultation result in an agreement on an alternative to termination, then the parties shall proceed in accordance with the terms of that agreement.

b. Should such consultation fail, the signatory party proposing termination may terminate this MOA by promptly notifying the other parties to this MOA in writing. Termination hereunder shall render this MOA null and void.

c. If this MOA is terminated hereunder and if Reclamation determines that the Undertaking will nonetheless proceed, then Reclamation shall either consult in accordance with 36 CFR § 800.6 to develop a new MOA or request the comments of the Council pursuant to 36 CFR Part 800.

7. Duration of the MOA

a. Unless terminated pursuant to Stipulation 6. above, or unless it is superceded by an amended MOA, this MOA will be in effect until Reclamation, in consultation with the other parties to this MOA, determines that all of its stipulations have been satisfactorily fulfilled. Upon a determination by Reclamation that all of the terms of this MOA have been satisfactorily fulfilled, this MOA will terminate and have no further force or effect. Reclamation will promptly provide the other parties to this MOA with written notice of its determination and of the termination of this MOA. Following provision of such notice, this MOA will be considered null and void.

b. The terms of this MOA shall be satisfactorily fulfilled within 5 years following the date of execution. If Reclamation determines that this requirement cannot be met, the parties to this MOA will consult to reconsider its terms. Reconsideration may include the continuation of the MOA as originally executed, amendment of the MOA, or termination of the MOA.

8. Effective Date of this MOA

This MOA will take effect on the date that it has been executed by Reclamation, the Commission and the SHPO.

EXECUTION of this MOA by Reclamation, the Commission and the SHPO, its transmittal by Reclamation to the Council in accordance with 36 CFR § 800.6(b)(1)(iv), and subsequent implementation of its terms, shall evidence, pursuant to 36 CFR § 800.6(c), that this MOA is an agreement with the Council for purposes of Section 110(l) of the NHPA, and shall further evidence that Reclamation and the Commission have afforded the Council an opportunity to comment on the Undertaking and its effects on historic properties, and that Reclamation and the Commission have taken into account the effects of the Undertaking on historic properties.

SIGNATORY PARTIES:

BUREAU OF RECLAMATION

By: ______________________ Date: 12/11/02

FEDERAL ENERGY REGULATORY COMMISSION

By: Joseph D Morgan Date: 1/23-03

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

By: ______________________ DSHPO Date: 2/25/03

CONCURRING PARTY:

PACIFIC GAS AND ELECTRIC COMPANY

By: ______________________ Date: 12/18/02

RANDAL S. LIVINGSTON

Appendix Q

DRAFT—Fish and Wildlife Coordination Act Report

(Also available on the web site for the U.S. Fish and Wildlife Service's Sacramento Office, at http://sacramento.fws.gov/, under the section titled "Of Special Interest.")