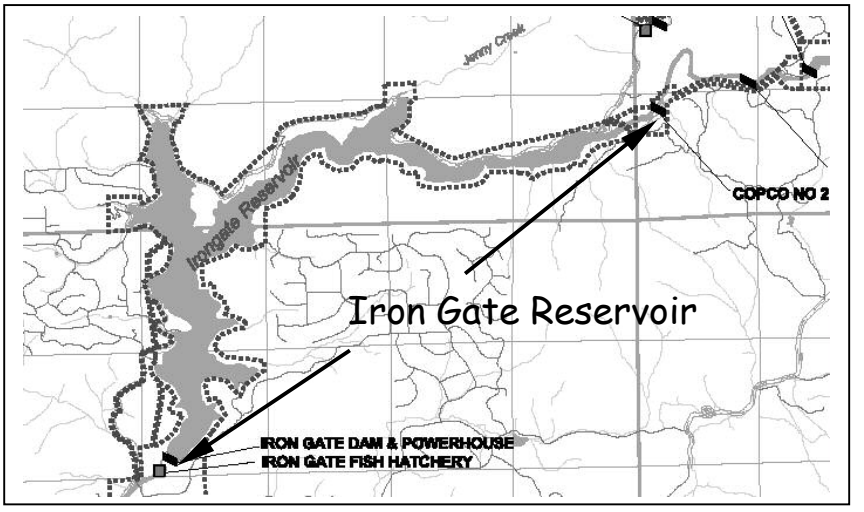
9. Iron Gate Reservoir

Reservoir Location and Characteristics

The Iron Gate reservoir includes the portion of the mainstem Klamath River from Iron Gate dam (RM 190) to the upper end of the Iron Gate reservoir at about RM 196.8.



Iron Gate Reservoir Physical and Operational Characteristics			
Impoundment length (miles)	6.8	Normal full pool elevation (ft msl)	2328.0
Impoundment length (RM)	190-196.8	Normal minimum pool elevation (ft msl)	2324.0
Surface area (acres)	944	Normal annual operating fluctuation (ft)	4.0
Maximum / mean depth (ft)	167 / 62	Average daily operating fluctuation (ft)	0.5
Total storage capacity (ac-ft)	58,794	Normal active storage capacity (ac-ft)	3,790
Total retention time (days)		Active storage retention time (days)	
At 710 cfs	42	At 710 cfs	2.7
At 1600 cfs (□mean flow)	16	At 1600 cfs (□mean flow)	1.0
At 10,000 cfs (extreme event)	3	At 10,000 cfs (extreme event)	0.2

Dam Characteristics and Flow Control Structures

- Iron Gate Reservoir physical and operational characteristics are listed in the table above. Dam characteristics are listed in the table below.
- Diversion intake withdraws water from about the top (surface) 35 feet of reservoir.
- Spill occurs primarily when reservoir inflows exceed about 1,735 cfs (i.e., hydraulic turbine capacity).
- Iron Gate dam is not equipped with fish passage facilities.
- Water supply for the Iron Gate fish hatchery is provided from a lower level intake at elevation 2253 ft. The hatchery uses roughly 50 cfs during the warmer portion of the year, or about 10,000 acre-feet of Iron Gate reservoir – a large portion of the cold water in the reservoir during summer stratification. This water requires aeration prior to use due to its low oxygen content.

- There is a second hatchery intake at elevation 2309 ft that is infrequently used. There are no additional outlets from Iron Gate dam.

Iron Gate Dam Characteristics	
Dam type: *Rock-fill with compacted clay core and concrete cut-off wall*	
Dam overall length (ft)	750
Dam crest elevation (ft msl)	2343
Dam height (ft)	173
Spillway type: *Ungated concrete ogee with sluice gate*	
Spillway length (ft)	730
Spillway crest elevation (ft msl)	2328
Sluice gate width (ft)	9.5
Sluice sill elevation	2322
Diversion intake type: *Wheel-mounted surface intake gate; single 17.5 ft wide opening*	
Diversion intake crest elevation (ft msl)	2293
Diversion intake full pool depth (ft)	35
Diversion intake min. pool depth (ft)	31

Operations

- Iron Gate reservoir operates for control of flows and waters surface elevations for power generation, and to provide stable flows in the Klamath River downstream of Iron Gate dam (re-regulating peaking flows from Copco). Iron Gate reservoir typically fluctuates about 8 feet annually between normal minimum and full pool elevations (Figure 9-1). Because of relatively small active storage, Iron Gate reservoir has little or no effect on the annual hydrograph (Figure 9-1).
- Iron Gate is generally operated in a relatively constant generation mode to provide stable flows below Iron Gate dam. Spill generally occurs during the winter and spring months when river flows exceed the turbine hydraulic capacity (about 1,735 cfs) (Figures 9-2).
- Normal operations typically result in about a 0.5-foot reservoir water level fluctuation (Figures 9-3 and 9-4).
- The principal operating constraints imposed on the Iron Gate reservoir and powerhouse are the available inflow, required instream flow releases, and changes in flow rate (i.e., ramp rate). There are no specific requirements for reservoir fluctuations.

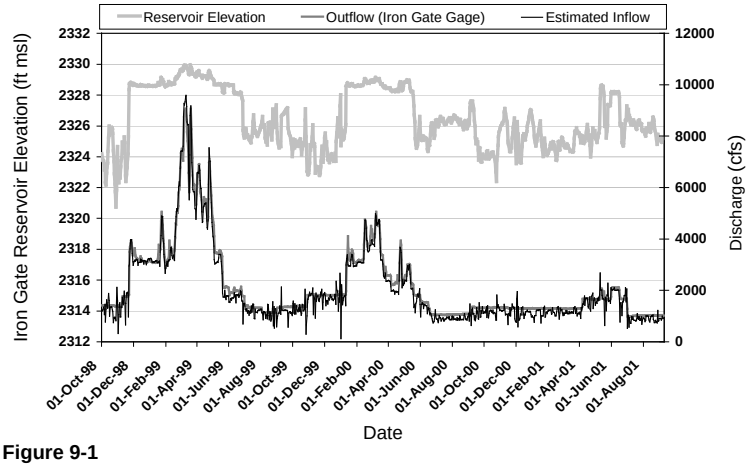


Figure 9-1
Daily Average Iron Gate Reservoir Elevation, and Estimated Inflow and Outflow Discharge for WYs 1999-2001

- FERC-stipulated minimum flow requirements are 1,300 cfs from September through April, 1,000 cfs in May and August, and 710 cfs in June and July. However, since 1996, USBR's annual Project Operations Plans have dictated instream flow releases. These releases have generally exceeded the required FERC instream flows.

- FERC-stipulated changes in flow rate (i.e., ramp rate) caused by releases at Iron Gate dam and powerhouse are limited to the lesser of a 3-inch-per-hour or 250-cfs-per-hour.

Limnological Description and Water Quality Trends

- Iron Gate reservoir has flow retention rates of about 16 days at average flow, and about 42 days at low flow. Like many moderate - flushing mainstem reservoirs, Copco 1 reservoir probably exhibits attributes of both short and long retention time systems.
- Iron Gate reservoir exhibits strong vertical stratification of water temperatures during summer, when surface waters are 12-18°C warmer than bottom temperatures (Figure 9-5).
- During summer stratification, dissolved oxygen progressively decreases until the bottom 50 ft of the Iron Gate reservoir becomes hypoxic (Figure 9-5).
- Values of pH exceed 7 in most of the reservoir. Algal primary production presumably contributes to higher pH values in reservoir surface waters (Figure 9-5).
- Continuous water temperature recorders placed in the river just upstream and downstream

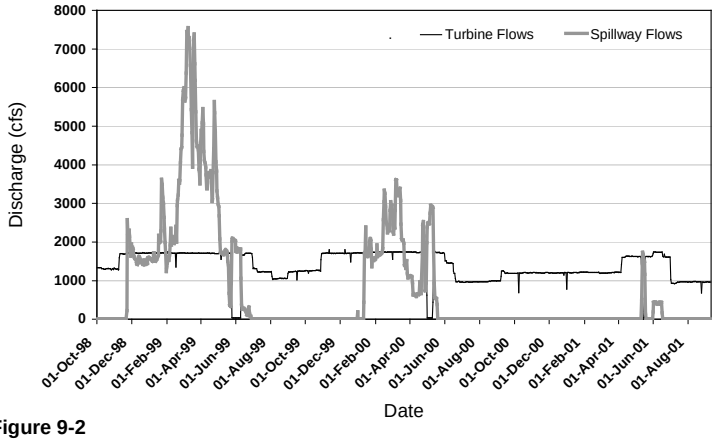


Figure 9-2
Daily Average Spillway and Turbine Discharges from the Iron Gate Dam and Powerhouse for WYs 1999-2001

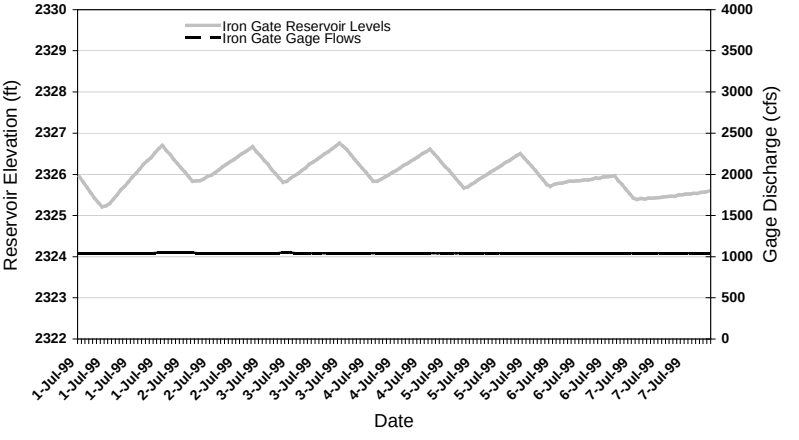


Figure 9-3
Hourly Iron Gate Reservoir Elevations, and Estimated Iron Gate Outflow During July 1-7, 1999

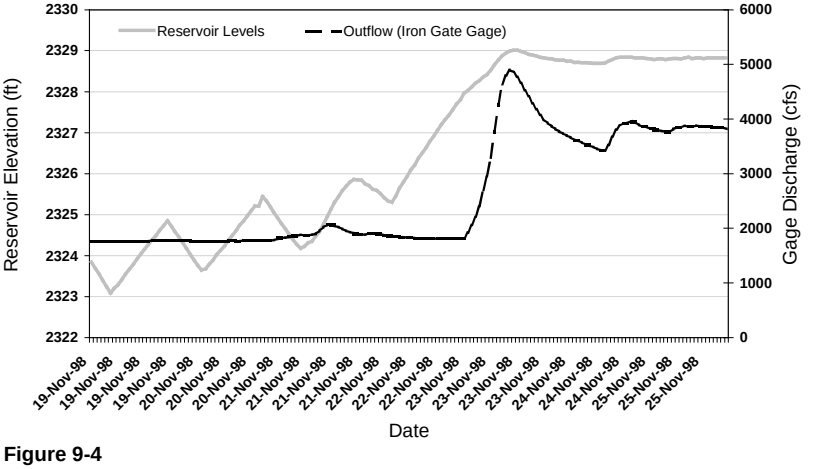


Figure 9-4
Hourly Iron Gate Reservoir Elevations, and Estimated Iron Gate Outflow During November 19-25, 1998

of Iron Gate reservoir during summer 2001 indicates that the reservoir acts to moderate the daily fluctuation of water temperatures during summer (Figure 9-6).

- Nutrient values in Iron Gate reservoir are relatively high (Figure 9-7), but nitrogen is in short supply relative to phosphorus, according to the needs of phytoplankton. These conditions are consistent with a highly productive system dominated by cyanophytes (blue-green algae).
- Nutrient samples collected in Iron Gate reservoir from 1980 through 1999 suggest distinct seasonal differences in nutrient concentrations (Figures 9-8 and 9-9).
- Nutrient samples in Iron Gate reservoir from 1980 through 1999 were collected from near the surface (surface) and from below the thermocline during the same sampling event. Nitrate nitrogen and ammonia nitrogen show a noticeable difference between samples collected above and below the thermocline (Figure 9-10).
- The portion of the Klamath River that includes the Iron Gate reservoir is 303(d)-listed for water temperature, dissolved oxygen, and nutrients.

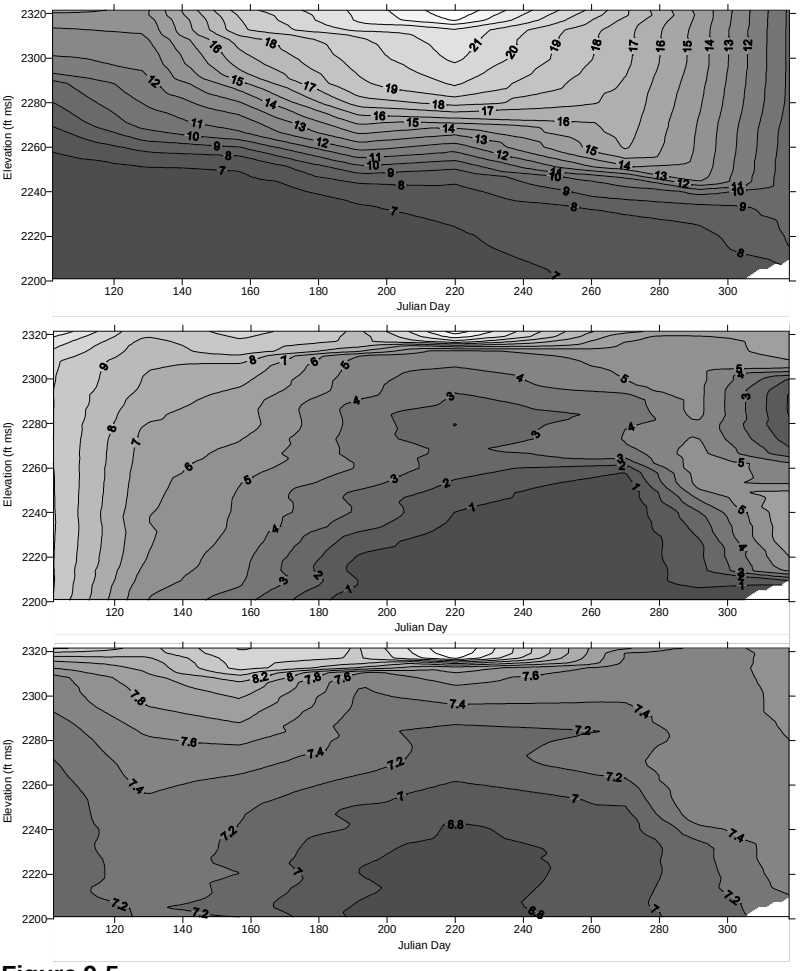


Figure 9-5
Iron Gate Reservoir Temperature (Top), Dissolved Oxygen (Middle), and pH (Bottom) Isolpleths: April – November 2000.

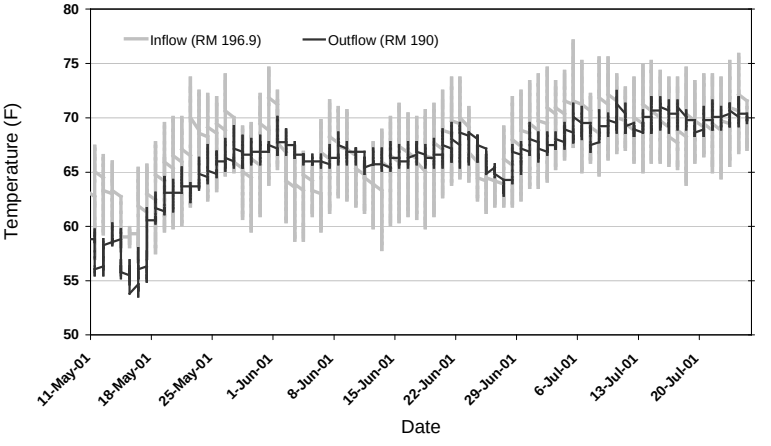


Figure 9-6
Daily Range Of Hourly Water Temperatures At Inflow To and Outflow From Iron Gate Reservoir During May - July 2001

303(d) Listed Water Quality Parameters

- Water temperature
- Dissolved oxygen
- Nutrients

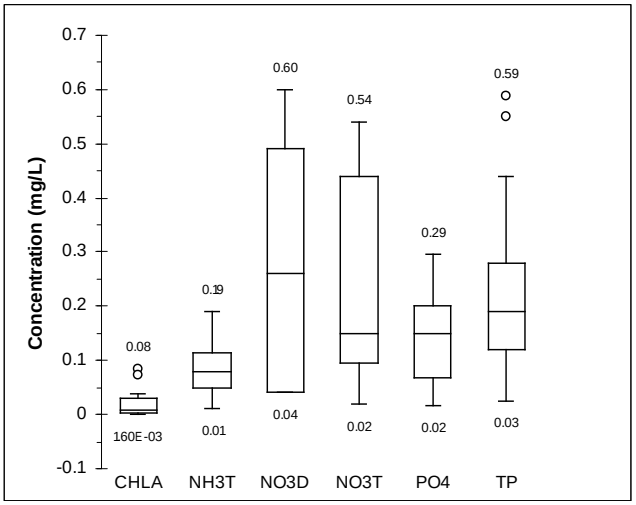


Figure 9-7
Box Plot Showing The Range Of Values For Various Constituents For All Sites Sampled In Iron Gate Reservoir Between 1980 And 1999. CHLA = chlorophyll a; NH3T = total ammonia nitrogen, as N (unfiltered); NO3D = dissolved nitrate nitrogen, as N (filtered); NO3T = total nitrate nitrogen, as N (unfiltered); PO4 = total orthophosphate, as P (unfiltered); TP = total phosphorus, as P (unfiltered).

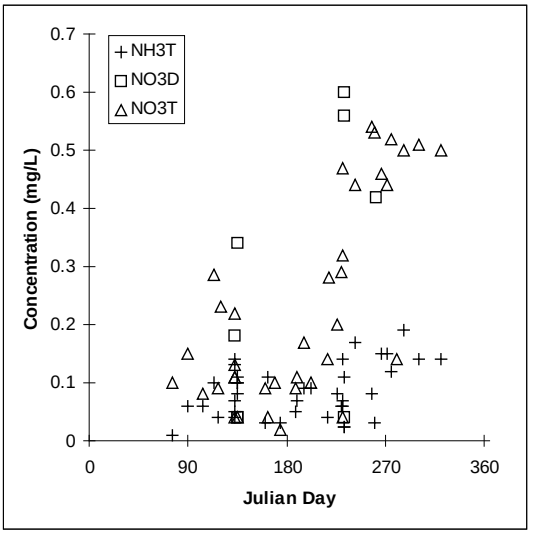


Figure 9-8
Scatterplot Diagram Of Nitrogen Species Measured In Samples Collected From 1980 Through 1999 In Iron Gate Reservoir

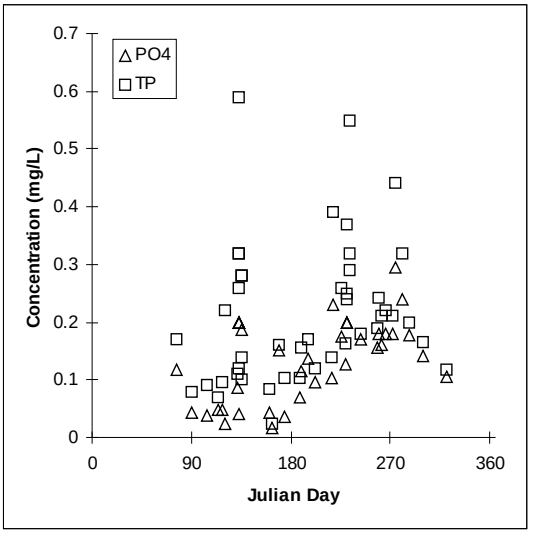


Figure 9-9
Scatterplot Diagram Of Phosphorus Species Measured In Samples Collected From 1980 Through 1999 In Iron Gate Reservoir

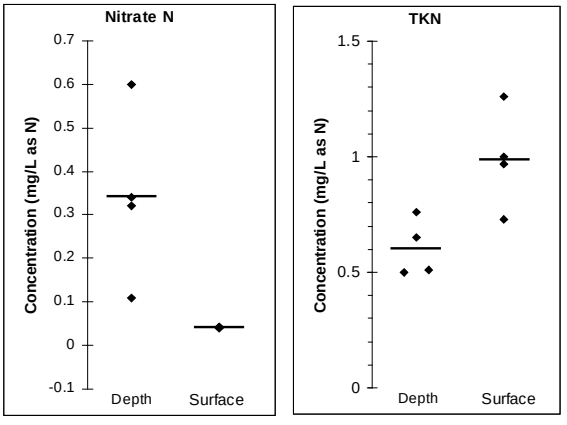


Figure 9-10
Scatterplot diagram showing nitrate N and total Kjeldahl nitrogen (TKN) concentrations measured on surface and deep samples collected at the same site and date in Irongate Reservoir between 1980 and 1999. The horizontal bar denotes the mean of the sample values.

Available Data and Information

- **Previous WQ Monitoring (1980 to 1998)**. Monthly data was collected upstream, within, and downstream of the Iron Gate reservoir in 1984-85 as part of studies conducted by the City of Klamath Falls for the proposed Salt Caves Project. Additional data are available from STORET and from studies conducted by the USGS and the NCRWQCB. See table below.

Reach	Site Name	Sample Count	Min Date	Max Date	Source
8	Copco Dam outflow	36	04/05/96	10/08/97	STORET
9	Iron Gate Reservoir - surface	6	04/16/84	09/09/84	CITY OF K FALLS
9	Iron Gate Reservoir - above bottom	6	04/16/84	09/09/84	CITY OF K FALLS
9	Iron Gate - 1B	2	05/13/97	08/19/97	NCWQCB
9	Iron Gate - 1S	2	05/13/97	08/19/97	NCWQCB
9	Iron Gate - 5	2	05/13/97	08/19/97	NCWQCB
9	Iron Gate 1 Below Thermocline	2	05/15/96	08/21/96	NCWQCB
9	Iron Gate 1 Surface	2	05/15/96	08/21/96	NCWQCB
9	Iron Gate 3 Surface	1	05/15/96	05/15/96	NCWQCB
9	Iron Gate 5 Surface	2	05/15/96	08/21/96	KRIS
9	IronGate -E	31	04/24/96	11/17/98	STORET
9	IRONGATE RES NR HORNBROOK	4	05/22/85	10/01/86	STORET
10	Iron Gate Dam outflow	36	04/05/96	10/08/97	USGS

- **Recent WQ Monitoring (1998 to Present)**. In 1998 the USBS-Biological Resources Division (USGS-BRD) implemented a basin-wide monitoring program with support from USBR. Data were collected from Klamath Falls to below the Trinity River, as well as in the Klamath Reclamation Project and selected tributaries. This program was repeated in 1999. Throughout this period PacifiCorp monitored physical parameters in mainstem reservoirs, including Iron Gate reservoir. During 2000 PacifiCorp expanded monthly physical profile monitoring to include deployment of thermistors as well as grab sampling for nutrients and BOD. Thermistors provide temperature profile data near the dam. Monthly profile monitoring during April - November have been obtained for temperature, pH, dissolved oxygen, and specific conductance, and grab samples obtained from near the surface (1 meter) and near the bottom are analyzed for nitrogen, phosphorus, BOD, chlorophyll, and phytoplankton.