

## Guadalupe Temperature/Flow Profile

The Guadalupe River is unique among all Texas Rivers because it can support rainbow and brown trout year-round. How is this possible for these fish to live in Texas when they are native to cold, mountain streams? Although Texas is generally hot, in the winter, the waters of Canyon Lake cool to about 54 degrees. The surface of the lake warms during the summer, the cold, dense layer of winter-chilled water lies insulated underneath. The outflow that empties the lake into the Guadalupe River is at the very deepest point, so this supply of winter-stored water continues to chill the river, even in the middle of summer, with water temperatures that are close to those in February.

Once the water is released from the dam, it is exposed to various heat sources such as solar radiation and ambient temperature (heat from the atmosphere). The most significant is solar radiation which is measured in watts per square meter and reaches the maximum intensity on the first day of summer. Released from the dam, the water absorbs this heat, and in about 36 hours, warms to its 'natural' temperature.

The Guadalupe River is a fast flowing stream. The speed of the water coursing downstream is directly proportional to the flow rate from Canyon Dam. At higher release rates, water will travel a lot farther during the 36 hour window of the warming period than at lower rates. The trout fishery can only live within the 36 hour window where water remains the coldest because natural water temperatures are too warm to support trout here in Texas.

The minimum mandated release rate is 90 cfs (cubic feet per second) when the lake is not in flood. During droughts, flow rates can be reduced even below that level. GRTU and the Guadalupe-Blanco River Authority signed a [contract](#) in 2001 that guarantees a 200 cfs flow rate during the May thru September period in non-drought years. This will increase the range where trout live from about 4 miles to at least to 10 miles (down to the 3rd Crossing). Other factors can increase this distance depending on flood control releases managed by the Corps of Engineers.

Good trout habitat should have water temperatures averaging no more than 70 degrees. TPWD biologists have been recording water temperature data at 5 stations below Canyon Dam since 1998. These are from recording devices placed in the river and they record the temperature twice an hour. The data is downloaded into a computer. The flow and temperatures are matched and a profile of water temperatures to flow rate is created. The following links are to tables showing average water temperature and flow rate profiles for various stations below Canyon Dam:

- [Dam: Mile 0](#)
- [Highway 306 Crossing: Mile 4.0](#)
- [Ponderosa Crossing: Mile 7.4](#)
- [3rd Crossing: Mile 10.5](#)
- [2nd Crossing: Mile 13.8](#)

Discussion: Thousands of temperature and flow measurements collected over 5 years were averaged into flow slots at two week intervals during the May 1 to September 30 period of the flow protection agreement. During the period, there are ever changing variables that effect how fast water warms, so a two week generalization was in order. Slots in the table that are blank did not have temperature recorded. Some temperature recorders were lost, stolen or vandalized so some stations are more complete than others. Even though the data was collected over a 5 year span, the water temperature is extremely consistent at Canyon Dam- year after year- a variation of less than +/- 2 degrees. The downstream most stations such as 3rd Crossing and 2nd Crossing are very consistent- although the variables that cause the water to warm have greater influence the farther downstream you go. On the average, May and June are the two rainiest months of the year, followed by two dry months. Flows tend to run a lot lower during August, so most to the releases made during that month were at the minimum rate, until 2003 when the flow agreement kept the rate above 200 cfs.

Conclusion: The tables show how water temperature is highly influenced by the flow rate and distance from Canyon Dam. Although there are blanks in the table, the picture is clear: water temperatures at the 3rd Crossing will remain low enough when the flow agreement is triggered to sustain the trout fishery over summer. It is indeed possible that the flow agreement will sustain the trout fishery to the 2nd Crossing.

Averages are important, but they don't show us what's happening in a particular 24 hour time span. On a daily basis, water temperatures respond greatly to weather conditions. A cloudy, rainy day will reduce the solar heating of the water, and consequently maximum water temperatures will remain several degrees cooler.

The following link presents historical, daily water temperature/flow graphs from May 1 to September 30 for the years 1998 through 2003 for the 5 monitoring stations. Simply select the "Start" and "End" dates at the top of the page. Flow rates were also included as an important perspective on water temperatures, although they do not 'fit' on a temperature chart. The "FLOW-CFS" increases the scale, and detail is diminished. To view only water temperatures on a more detailed scale, select the individual temperature 'sensors' on the right hand column and do not select "FLOW-CFS". The temperatures are charted at hourly intervals- 24 hours a day. There are days where data is missing.

#### [Detailed Daily Temperature and Flow Graphs](#)

Conclusion: The graphs show the details of warming from the sun at various distances from the dam. Some days the warming is less, probably the result of cloud cover. The downstream-most "2nd Crossing" has the warmest temperature spikes and a rather large fluctuation in daily temperature. Even when the average temperature of this station does not exceed 71, temperature spikes can reach as high as 76 degrees and that is very stressful for trout. Possibly the wide variation at 2nd Crossing is the result of "The Chute" just above, which is a narrow channel coursing through a wide shelf of rock in the riverbed, but emerged from the water during low flows. The rock acts as a heat sink and conductor of heat directly into the water. The 3RD Crossing shows less variation in

temperature- obviously the placement of the recorder is influencing the readings. The river will vary in temperature from the warmer surface to cooler, deeper pockets. In fishing in the summer, you might want to avoid afternoons when water temperature spikes to stressful levels.

How about the period before May 1 and after September 30- Will water temperatures remain low enough to sustain trout once the flow agreement period is ended? The following link is a chart of the water temperature profile during the severe drought of 2000. Flow rates at the Dam fell from 85 cfs to 55 cfs in June because of drought restrictions. The lowest station at the 2nd Crossing probably represents how warm the river would be if there were no Canyon Dam.

### [Year 2000 Drought Water Temperature Chart](#)

Discussion: This chart shows water temperatures for 4 sampling stations for the May 1 to September 30 period of the year 2000. That year was an severe drought with record breaking temperatures. The drought caused severe curtailment in the releases from Canyon Dam of less than 55 cfs for most of the period. Even under these most extreme conditions, water temperatures in early May and late September showed a clear moderating effect due to shorter day lengths. In a normal year and no water release restriction, the normal minimum flow should be sufficient to protect the trout fishery before May 1 and after September 30.

Conclusion: A drought like the one in the year 2000 would be devastating to the trout fishery. All 4 stations exceeded the temperature limit of mortality for trout. Only trout living within the first 2 miles below the dam would survive.

The Guadalupe River lost much of its native fish populations below Canyon Dam as a result of the cold-water discharge. (USFWS defines a loss as a reduction in population of 50%). The trout fishery was envisioned as part of the Canyon Dam Project even before construction on the dam began. At the time it was expected that 10 miles of river would have a trout fishery with expected 200 cfs release rate. Because of water issues, the consistency of the 200 cfs release rate never happened, which meant the tailrace could maintain neither warm water or cold water species. Water became a much sought after commodity in recent years. According to the original Canyon water right, all flows entering the lake that were less than 550 cfs must not be stored there, but passed through. However, in the 1990's GBRA adopted a policy of not honoring this pass-through requirement. They could do this because they were depriving more senior water rights that they owned. The only mandated minimum flow became the Federal Energy Regulatory Commission [Permit](#) which required a minimum flow of only 90 cfs. In 1999, GBRA applied for a new water permit that would reduce the outflows from Canyon Dam. GRTU negotiated for minimum flows to protect the trout fishery, and the agreement was implemented in 2003.