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June 30, 2009

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, D.C. 20426

Subject: Tapoco Hydroelectric Project (FERC No. 2169) – License Compliance
Article 405 – Final Summary Report

Dear Secretary Bose:

In accordance with Article 405 of the Tapoco Project license, issued January 25, 2005, and effective March 1, 2005, Alcoa Power Generating Inc. (APGI) filed a plan to monitor the minimum flows from Santeetlah Dam into the Cheoah River bypass reach and the effects of the ramping rates via letter dated February 28, 2007. The license article required that the plan be developed in consultation with the North Carolina Department of Environment and Natural Resources (NCDENR), U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), the National Park Service (NPS), and the North Carolina Wildlife Resources Commission (NCWRC), collectively the Resource Agencies. The plan was approved by the Commission on April 4, 2007.

The order requires APGI to consult with the Resource Agencies on the monitoring of the minimum flows into the Cheoah River bypass reach and the effects of the ramping rates. Specifically, the order requires that a summary report of first year activities, a summary report of second year activities, and a final report be filed by April 1, 2008, April 1, 2009 and July 1, 2009, respectively. APGI filed a summary report of first year activities on April 1, 2008, which the Commission accepted by letter dated June 17, 2008. APGI filed a summary report of second year activities on March 27, 2009. The enclosed final report summarizes the first and second year activities performed by APGI and the Resource Agencies.

Please feel free to contact me at (704) 422-5622 or via email at marshall.olson@alcoa.com if you have any questions regarding the final summary report on the Cheoah River bypass reach.

Sincerely,

Marshall L Olson

Marshall Olson
Environmental and Natural Resources Manager

CC: Mark Cantrell – USFWS
Jason Farmer – USFS
Chris Goudreau – NCWRC
Jim Mead – NCDENR
Nancy Finley – NPS

Alcoa Power Generating, Inc.
Tapoco Division

Tapoco Project (FERC No. 2169)

SANTEETLAH DEVELOPMENT

ARTICLE 405 – Monitoring Plan for the Cheoah River Bypass Reach Minimum Flow and Ramping Rates

FINAL SUMMARY REPORT

June 2009

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Acronyms

APGI - Alcoa Power Generating Inc.

FERC - Federal Energy Regulatory Commission

HFE – High Flow Event

HSI – Habitat Suitability Indices

LIP - Low Inflow Protocol

NCDENR - North Carolina Department of Environment and Natural Resources

NCDWR - North Carolina Division of Water Resources

NCWRC - North Carolina Wildlife Resources Commission

PHABSIM – Physical Habitat Simulation

Resource Agencies – NCDENR, NCDWR, NCWRC, USFWS, USFS

USFS - United States Forest Service

USGS - United States Geological Survey

USFWS - United States Fish and Wildlife Service

WUA – Weighted Usable Area

YOY – Young of Year

1.0 Introduction

On January 25, 2005 (effective March 1, 2005), the Federal Energy Regulatory Commission (FERC) issued an order approving settlement and issuing Alcoa Power Generating Inc. (APGI) a new 40-year license for the Tapoco Hydroelectric Project (FERC No. 2169). License Article 405 required APGI to prepare a plan to monitor the minimum flows from Santeetlah Dam into the Cheoah River bypass reach and the effects of the ramping rates required by the North Carolina 401 Water Quality Certificate for the Project. On April 4, 2007, FERC issued an Order Modifying and Approving Monitoring Plan (Plan) under License Article 405. As part of the Commission's acceptance of the Plan, APGI was required to provide a summary report of first year activities by April 1, 2008 (issued April 1, 2008), a summary report of second year activities by April 1, 2009 (issued March 27, 2009) and a final report summarizing the results of the monitoring by July 1, 2009. This is the final report summarizing the results of the monitoring activities.

The first and second year activities included the successful installation and operation of the mini-gates, programming of the Tainter gates and mini-gates for ramping, continuous aquatic flows and high flow events and monitoring of aquatic habitats. High flow events proceeded as scheduled, as APGI actively monitored ramping and high flow events, and calibrated the Tainter gate discharges versus the readings at the United States Geological Survey (USGS) Bearpen Gap gage. Since sufficient inflow was available, the Low Inflow Protocol (LIP) was not implemented during 2007 or 2008.

2.0 Santeetlah Dam Flow Releases

2.1 Aquatic Base Flows

A continuous aquatic flow was provided via the four mini-gates installed in the two Tainter gates located closest to the Santeetlah gatehouse. The aquatic flow varied from month to month and was based on the current inflow tier, A or B, as described in Appendix A, Section 1.2.1 of the License.

The aquatic flow has been provided since September 1, 2005 in accordance with the License. During the interim period, prior to the installation and automation of the mini-gates, a continuous minimum aquatic discharge of 50 cfs was provided by one of the six Tainter gates. Starting in March 2007, tier A or B aquatic flows have been provided via the automated mini-gates.

Three minor deviations from the planned aquatic flows occurred in 2008 due to communications or programming logic issues. Only one of the three deviations resulted in less than the planned aquatic flow and it was a deviation of 10 cfs for a couple of hours. In each case, APGI staff corrected the problem and took steps to prevent similar events from happening in the future.

2.2 High Flow Events

Scheduled high flow events, to simulate periodic storm events and flushing of the river bed, are rotated based on the five-year schedule, as described in Appendix A, Section 1.2.2 of the License. APGI has provided High Flow Event (HFE) releases since September 2005 in accordance with the license. During the implementation period (prior to March 1, 2007), ramping of the HFE was not required. Upon completion of the mini-gate installation effort, all HFEs have been ramped (starting March 2007), at a rate of 2 inches per hour for flows between the aquatic base flow and 100 cfs.

Although there was one deviation in April 2006, where the Saturday and Sunday releases were reversed due to an incorrect gate opening position on Saturday, there were no deviations to the scheduled HFEs in 2007 and 2008. In early 2007 APGI completed upgrades to the Tainter gate operating system to facilitate the HFE releases. In 2007 and 2008, APGI operated the Tainter gates manually due to ongoing calibration activities and met its license commitments for all HFEs. Starting with the February 21-22, 2009 HFE, all releases have been automated.

In summary, variations from the License target flows do and will continue to exist due to gate/spillway irregularities, gate controller system limits, and/or reservoir elevation data. These variations do not adversely affect APGI’s ability to meet its license commitment. The average flow provided in 2008 during peak releases was 1,015 cfs versus the target flow of 1,000 cfs.

During the annual 2008 Cheoah River Planning Meeting held on September 29, 2008, the HFE releases were discussed in detail. The USFS noted that the deviations from 1,000 cfs were of concern to the USFS, who received numerous complaints from commercial rafting outfitters and others about lower than expected flows. The USFS said that the FERC License requires APGI to release 1,000 cfs in addition to inflow. However, it was noted by the meeting attendees that there were an equal number of remarks from the general public indicating that the flows were either adequate or higher than expected. The USFWS and NCWRC noted that the 2008 HFEs were generally within +/- 5% of 1,000 cfs, which is acceptable especially considering the USGS gage has a +/- 10% accuracy. The USFWS said that the variations were minimal for ecological purposes and the HFEs were within the range of what the USFWS expected for the prescribed flows.

2.3 Low Inflow Protocol

Inflow to the project during the 2007 and 2008 study years was sufficient to provide uninterrupted aquatic base flows, ramping flows, and high flows at Santeetlah. Therefore, the LIP was not implemented.

2.4 Maintenance and Emergency Protocol

There were no situations that warranted the implementation of the Maintenance and Emergency Protocol during 2007 and 2008.

3.0 Monitoring Compliance with Minimum Flows

3.1 Calibration and Maintenance Procedures

The mini-gate and Tainter gates are fully automated for aquatic base flows and HFEs. Reservoir elevation, gate position, and discharge are recorded on a 15-minute basis. Hourly, daily and monthly averages are calculated and stored for future reference. APGI continued to calibrate the Tainter gate discharges versus the readings at the USGS Bearpen Gap gage through 2008.

APGI periodically reviews the aquatic flow data versus the USGS gage data, and reviews the results of each HFE versus the USGS gage data. Based on the results of these reviews, APGI will perform periodic maintenance tasks and/or re-calibration of the programming to ensure that its license commitments are being met.

3.2 Verification of Operations and Aquatic Flow Releases

Discharge data is available to the public via APGI's website and is continually updated. No interruptions have been identified.

3.3 Project Operations Data Availability

Historical data is available via request from APGI.

3.4 Planning Periods and Deviations to Flow Releases

APGI has provided adequate notice of potential deviations to the flow releases. Corrective measures have been implemented to reduce the occurrences of deviations to aquatic flows, ramping flows and high flow events. The training of applicable APGI personnel and support staff, in addition to the posting of instructions for HFE and ramping rates is an ongoing practice.

3.5 Consultation with Resource Agencies Concerning the Results of Monitoring Minimum Flows

APGI conducted annual planning meetings with the Resource Agencies during October 2006, October 2007, and September 2008.

3.6 Ramping Rate Compliance

One deviation to the ramping has occurred since APGI began to ramp flows in March 2007. Ramping for the November 3, 2007 HFE did not occur as planned due to a timing problem in the mini-gate programming logic. APGI corrected the problem and no further ramping deviations have occurred.

3.7 Modified Aquatic Flow Releases and Ramping Rates

There has been no need for modifications to the aquatic flows for other purposes than minor maintenance (debris removal) during 2007 and 2008.

3.8 Record Keeping and Continuity of Aquatic Flow Releases

APGI continuously monitored and recorded all gate discharge data for aquatic and high flow releases. The mini-gate set positions were recorded every 15 minutes and an hourly average was calculated. All 15-minute and hourly data was stored at APGI's dispatcher office. The current hourly average was posted to the internet and is available to the public and Resource Agencies. All 15-minute recorded high flow release data and aquatic release data is available to the Resource Agencies upon request. The hourly, daily, and monthly data will be kept for the term of the license.

4.0 Monitoring the Impacts of Minimum Flows and Ramping Rates on Aquatic Resources

The Resource Agencies collected physical and biological data to investigate the effect of minimum flows and ramping rates on aquatic resources in the bypassed reach of the Cheoah River. Most physical and biological monitoring took place before, during and after high flow events in May and July 2007 and May 2008. Physical data collected included flow and temperature from the USGS gage; water depth (level logger) data at selected instream flow study transects used during relicensing; and resurveying the bottom profile of selected transects. Biological data included visual observations and photographs of fish nests; measurements of depth, velocity and size of fish nests; level logger data at fish nests; running the instream flow habitat model (PHABSIM) to assess the effects of ramping, and collection of larval fish in phytoplankton (drift) nets.

4.1 Aquatic Resources Monitoring Results

4.1.1 Physical Aspects

Flow and Temperature

In 2007 and 2008 APGI provided aquatic base flows and high flow events as called for in the FERC Project License (Figures 1 and 2). The monitoring field work was conducted during periods of normal releases from the dam.

An outage of Santeetlah's generators from late December 2007 through March 2008 resulted in uncharacteristically high flows during this time period as flow was released to the bypass from the spillway gates (Figures 1 through 4). During this time period instantaneous flows generally remained above 500 cfs and there were only seven days when flows were less than 200 cfs. There were six flow events with peak flows exceeding 2,000 cfs, three of which were greater than 4,000 cfs. These higher run-of-river flows during the winter of 2008 were also warmer than average (Figures 1 and 2), probably because the water was released from the surface of Santeetlah Reservoir.

The run-of-river flows in the normally bypassed reach of the Cheoah River during the winter of 2007-08 likely re-shaped channel morphology of the Cheoah River in some areas. Aquatic biota also may have been affected, benefiting some species and impacting others.

Stream Cross-section Transects

The PHABSIM model results of the Cheoah River Instream Flow Study were used to re-evaluate the effects of the ramping rates and scheduled flow events on aquatic habitat at selected transects. The model was run for all life stages/species originally evaluated, using simulation flows ranging from 50 to 1,200 cfs. The effects of the resulting velocities and depths on aquatic habitat for each simulation flow were then evaluated using the habitat suitability indices (HSI) for each life stage/species.

Before running the model, a re-survey of the selected cross sections was done to ensure that the channel geometry was about the same as when it was originally surveyed in 2000.

Documentation of a stable cross section would allow use of the calibrated model to estimate velocities and depths for flows of 50 to 1,200 cfs for analysis.

North Carolina Division of Water Resources (NCDWR) personnel selected transects for habitat types, and locations that would have the highest potential to demonstrate any velocity- or depth-related impacts from the ramping rate. Transects were selected from those in the upper half of the Cheoah River, between Santeetlah Dam and Yellow Creek. The selected transects represented shallow habitat types with a higher gradient; such as riffles, ledges, and runs.

Six cross sections were re-surveyed by NCDWR staff on November 5-7, 2007 (Appendix A). For the Santeetlah Dam to Cochran Creek section (the river reach nearest the dam), transects DC5 (ledge) and DC7 (ledge) were re-surveyed. Transects CY6 (steep run), CY8 (boulder run), and CY10 (ledge) were re-surveyed in the next section downstream (Cochran Creek to Yellow Creek). Transect YD1 (moderate gradient riffle) in the Yellow to Deep Creek section was also re-surveyed.

A comparison of the adjusted elevations indicates that the channel geometry did not change appreciably between 2000 and 2007 for five of the six transects. Only Transect YD1 had an unstable bottom profile with new adjusted elevations 1 to 2 feet higher in places than the original survey.

Water Depth

Water level probes were deployed at transects DC7, CY8 and CY10 during July 2007 to measure water depths under base flows, ramping flows and high flows (Figure 5). Depths increased about 0.3 – 0.5 feet from base flow to the ramping flow over a period of at least two hours (Table 1). In contrast to this gradual rise, depths increased about 1.3 – 2.2 feet in roughly 20 minutes as flow increased from the ramping flow to the high flow. This rapid rise is evident when calculated as an instantaneous (one minute) rate of change in depth (Figure 6).

4.1.2 Biological Aspects

Flow and temperature conditions during field observations in May and July 2007 and May 2008 were typical of base flow and high flow events required by the License (Figures 7 through 9). The Resource Agencies observed and photo documented the changes in the river channel and aquatic resources under the various flow regimes. The Resource Agencies also measured the size and shapes of fish nests of some common species (chub, sunfish/smallmouth bass), sampled using drift nets, and collected flow and level logger data.

In June 2008, field efforts were designed to measure differences in stream conditions between the base flow of 60 cfs and the ramping flow of 100 cfs required prior to a high flow event (Figure 10). To facilitate this evaluation, APGI temporarily re-positioned the mini-gates from the normal aquatic flow of 60 cfs to 100 cfs for one day.

Visual Observations and Photographs

Visual observations and photographs of the stream channel and fish nests were made before, during and after HFEs. During the rise and at peak flow, time-series photographs indicate changing habitat conditions and increased turbidity, but there was no appreciable difference in the overall appearance of the river channel before and after the HFEs (Appendix B).

Most chub nests also appeared to be unaltered by HFEs. The nests were not revisited after the HFE for several days, so if the nest was affected by the flow, chubs could have rebuilt the nest. However, as nearly all chub nests were associated with some structure in the channel which provided a velocity shelter, it did not appear that the scheduled HFE flows of approximately 1,000 cfs resulted in any physical damage while being observed by Resource Agency personnel.

Fry and small fish were found in the same locations before and after the HFE. It is not known if these were the same individuals before and after, but since most small fish were found in slack water associated with the stream margins, they could follow these conditions laterally as the water rose, and return as the stream receded.

Some sunfish/smallmouth bass nests appeared to be directly affected by high flow conditions, mainly by deposition of sand on top of the nest depression.

Some fish were observed stranded in 'potholes' in bedrock prior to the HFE. It is not known if these fish were stranded due to a previous scheduled HFE or a natural high flow.

Measurements of Nests

Measurements of nest diameter and height taken before and after HFEs showed little to no difference in size and shape of most chub nests. A few chub nests were 'flattened' slightly, making them larger in diameter. Some sunfish nests were larger in diameter, supporting the visual observation that deposition had occurred. It is not known if alteration of the nests resulted in mortality or loss of any eggs/larval fish in the nests.

A few chub nests were measured before and during the May 2007 HFE. For safety reasons, only those nests close to the bank could be assessed. Chub nest 1 experienced a significant change in water depth and velocity during the HFE. Depth increased from about 0.25 feet to 2.50 feet, while velocity increased from about 0.8 feet per second (fps) to about 3.60 fps. Two days after the HFE, the nest was somewhat larger in size. This increase was attributed to the continued use and construction of the nest by chubs. Visual observation confirmed that male chubs were adding gravel to the nest. Chub nest 2 also was slightly larger after the HFE and did not appear to have been damaged. Measurements could not be taken during the HFE for safety reasons. Nest 3 was smaller after the HFE, but was still under active construction. Nest 4 appeared to have been damaged by the investigators while attempting to take velocity measurements during the HFE.

Level loggers placed at two chub nests and one smallmouth bass nest during May 2007 indicated a rapid rise in depth (Figure 11) of a similar magnitude to that observed at the instream flow transects. The rate of change in depth (Figure 12) was also similar between the fish nests and the transects.

A direct comparison was made of fish nests at the base flow release (60 cfs during June) and the ramping flow release (100 cfs). At the USGS gage, approximately 7.5 miles downstream, the flow was measured as base flow (92 cfs) on June 10 and ramping flow (119 cfs) on June 11, for an increase of 27 cfs instead of the expected 40 cfs increase. This smaller difference was likely due to a slightly higher base flow than required, a slightly lower ramping flow than requested and/or the reduction in runoff directly into the river downstream of the dam. Even so, the experiment provided a good comparison to understand the effects of the ramping flow.

Measurements of depth, mean column velocity and nose velocity were made at 23 chub nests, 8 sunfish nests and 9 groups of fish fry. On average, depths at the chub nests increased about 0.3 feet, while mean column velocities and nose velocities increased on average about 0.1 fps (Table 2). Similar small increases in depth, mean column velocity and nose velocity were also found for sunfish nests (Table 3) and fish fry (Table 4).

PHABSIM Analysis

The PHABSIM model for the Cheoah River was run for transects DC5, DC7, CY6, CY8, and CY10 for flows from 50 to 1,200 cfs. All species and life stages were modeled (Appendix C), but analysis focused on organisms with no or limited swimming ability. As flow increased from base flow to the ramping flow, available habitat increased somewhat or greatly for 14 species/life stages, while habitat decreased somewhat or greatly for 9 species/life stages (Table 5). The remaining 17 species/life stages showed little change in habitat. However, as flow increased from 100 cfs to 1,000 cfs, the model showed that 20 species/life stages would experience less available habitat, while 11 species/life stages would have more habitat (Table 6).

Transects CY6 and CY8 often showed a different habitat response than the other transects. This is most likely explained by the types of habitat they represent. CY6 and CY8 are runs while the other transects are ledges.

The PHABSIM model was also used to evaluate the relative contribution of the five selected transects to the total weighted usable area available for a study reach for a given life stage/species at a given flow. Six of the ten organisms shown on Tables 5 and 6 were used for this analysis: Northern Hogsucker young of year (YOY) and juvenile; smallmouth bass spawning, fry and juvenile; and mayfly. Central stoneroller and mottled sculpin were not evaluated because of their minimal or positive changes in habitat in response to increases in flow at the five selected transects.

For the dam to Cochran Creek reach, transects DC5 and DC7 provided an average of 6% and 7%, respectively, of the available weighted usable area for each of these six organisms for the range of flows from 50 to 100 cfs. Transects CY8 and CY10 provided an average of 11% and 21%, respectively, of the available weighted usable area in the Cochran Creek to Yellow Creek study reach for each of these six organisms for the range of flows from 50 to 100 cfs. Transect CY6 provided an average of only 3% of the available habitat for each organism.

Drift Nets

A total of 15 samples were taken during base flow conditions, 3 samples under ramping flow (100 cfs) conditions, and 11 samples under high flow conditions. Most of the nets were deployed off of bridges for safety reasons, particularly during high flow events. However, several nets were positioned just downstream of chub nests to determine if HFEs dislodged fry. One sample at a chub nest was compromised when the HFE reached the net before sampling was complete. Also, retrieval of the drift net at one chub nest during the HFE damaged the nest, and likely dislodged larval fish.

Larval fish or eggs were collected in 3 of the base flow samples and 3 of the high flow samples. The fish were identified to family or genus, as Moxostoma (redhorse - Catostimid), Centrarchid, or Cyprinid. Moxostoma larvae are typically pelagic or demersal, and have limited swimming ability at early larval stages. The short length of the bypass reach may have implications for restoration, colonization and persistence of redhorse under these flow conditions. The presence of the Centrarchid larvae could reflect the change in microhabitat conditions at sunfish nests. Though unquantified, while monitoring mussels, agency staff observed Centrarchid nests were mostly along stream edges, behind boulders, or under undercut banks. Most all nets contained some insects, both aquatic and terrestrial. Insects were not enumerated or identified. Although sampling was limited, there was no strong indication that the high flows were flushing large numbers of small fish or eggs. Species assemblage, population levels and distributions may be a better indicator or overall effects of flows.

4.1.3 Summary

Article 405 of the January 25, 2005 FERC Order (110 FERC ¶ 61,056) required development of a plan for, and monitoring to determine the effects of, ramping on aquatic resources in the bypass reach. However, it was difficult to discern any effect of ramping because the HFE that immediately followed ramping tended to obscure or obliterate conditions experienced during ramping. The conditions, and any beneficial effects of the ramping, were very temporary. This resulted in the analysis having to assess the combined effects of the ramping and the HFE.

An increase in flow from base flows to the ramping flow level had little measurable effect on small fish, chub nests and sunfish nests. This was also supported by the results of the PHABSIM analysis and level logger data. The ramping may provide a physical, hydraulic cue to small fish that stream levels are rising; allowing them to move to cover, but this was not assessed in this study.

The increase from the ramping flow level to the peak flow level resulted in more measurable changes in conditions for aquatic organisms. Depths and velocities increased significantly at nest and fry locations, and generally for all habitats. The PHABSIM analysis showed similar results. This rapid change was typically accompanied by a noticeable, initial increase in turbidity that dissipated within a few hours.

Sunfish nests appear to be more vulnerable to the effects of an HFE than chub nests. However, nest guarding species, like sunfish, should be able to clean small amounts of sediment from their nests by fanning their nests. Alternatively, large amounts of sand deposition may smother the nest and cause the adult fish to abandon the nest.

While the changes in magnitude (e.g., depth) of the HFEs are fairly large, more important may be the rate at which those changes in depth and velocity occur. The rapid changes in hydraulic conditions are accompanied by an initial flush of turbidity by suspended sediments and debris. Shaping the high flow events in a more natural way could further reduce any potential impacts on the aquatic and riparian resources of the Cheoah River (Figure 13).

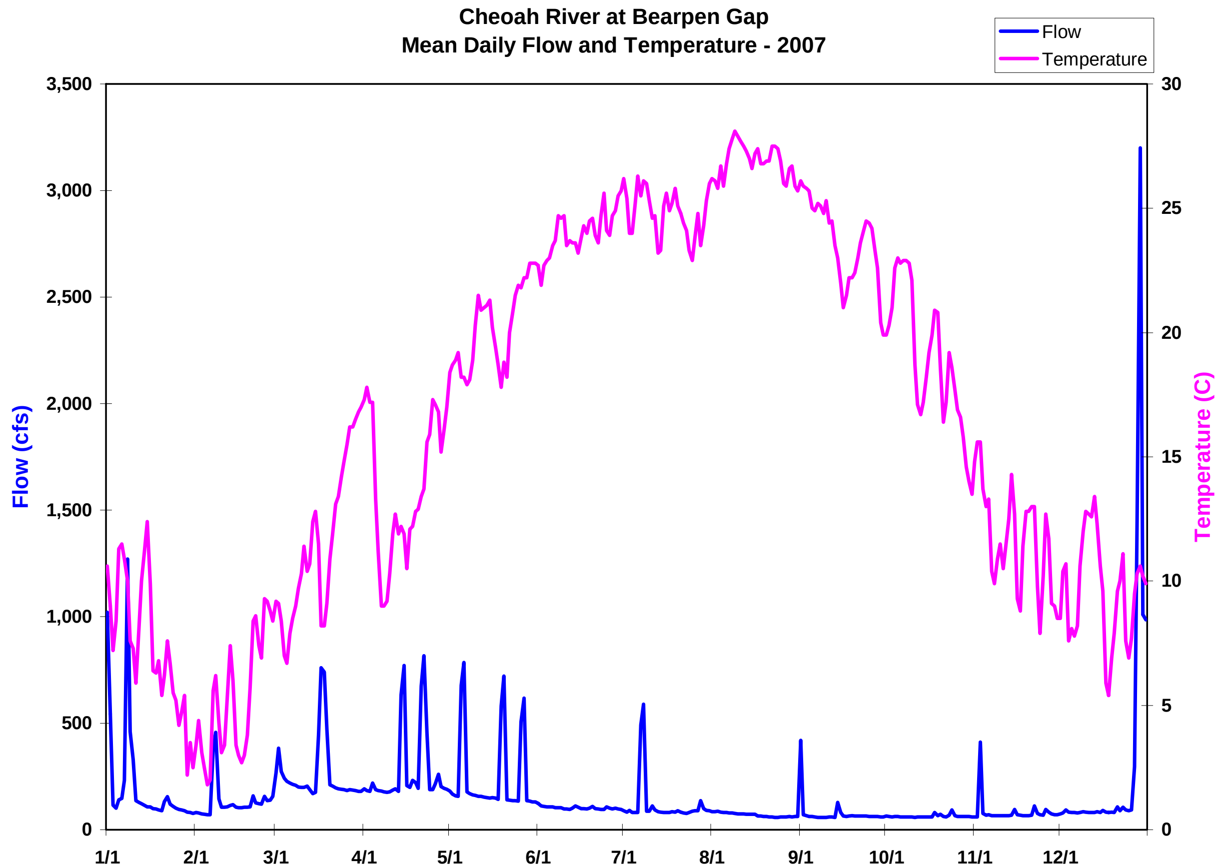


Figure 1. Mean daily flow (cfs) and temperature (C) of Cheoah River during 2007.

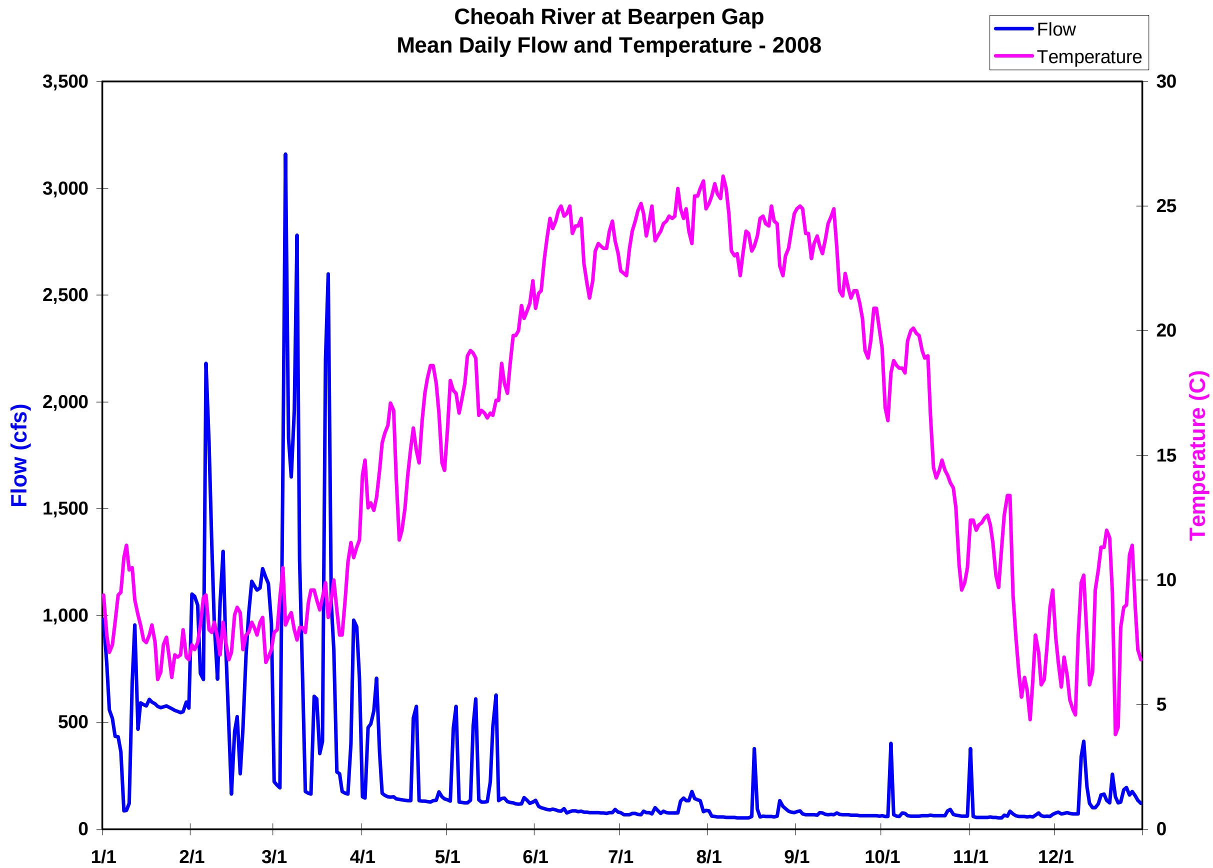


Figure 2. Mean daily flow (cfs) and temperature (C) of Cheoah River during 2008.

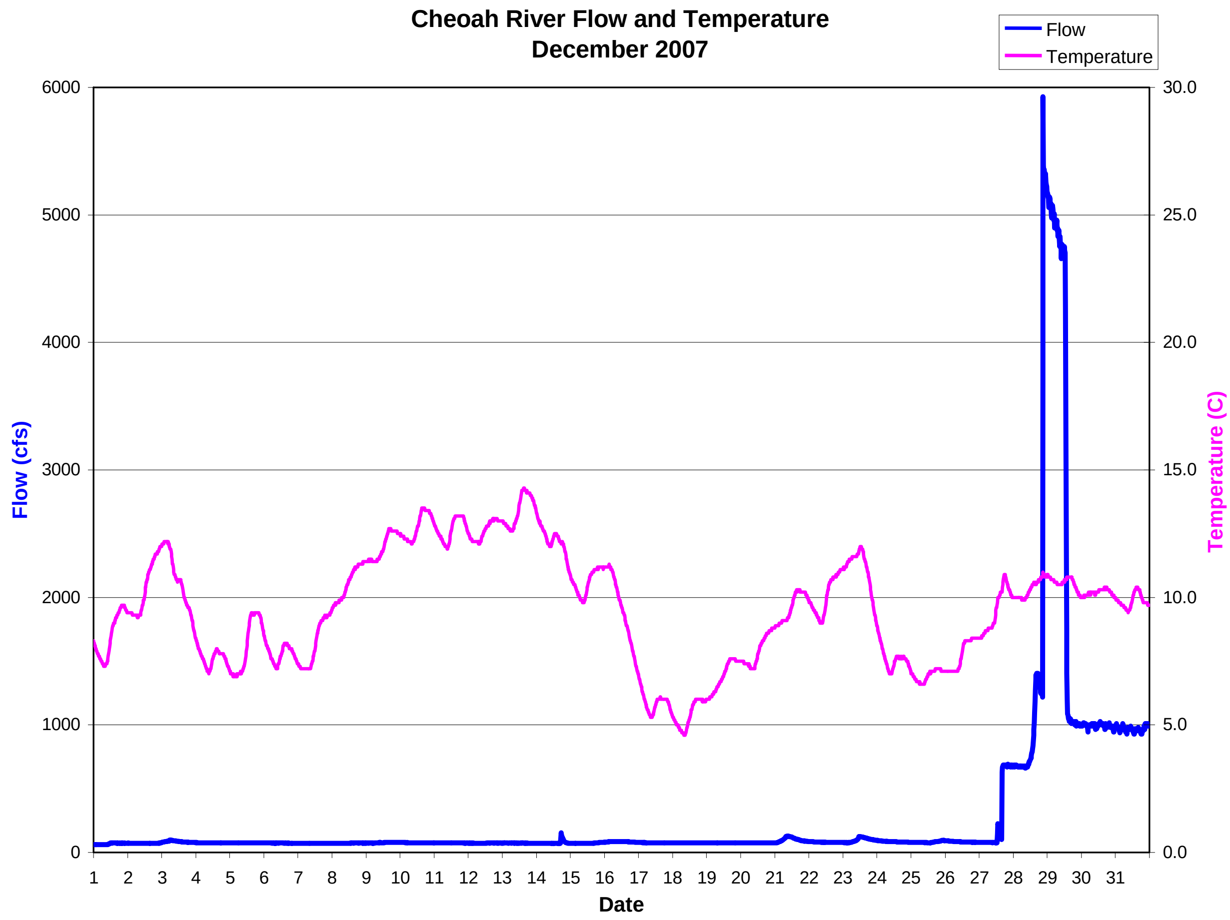


Figure 3. Instantaneous (15-minute) flow (cfs) and temperature (C) of Cheoah River during December 2007 showing effects of spill released into the bypass from Santeetlah Dam due to generator outages.

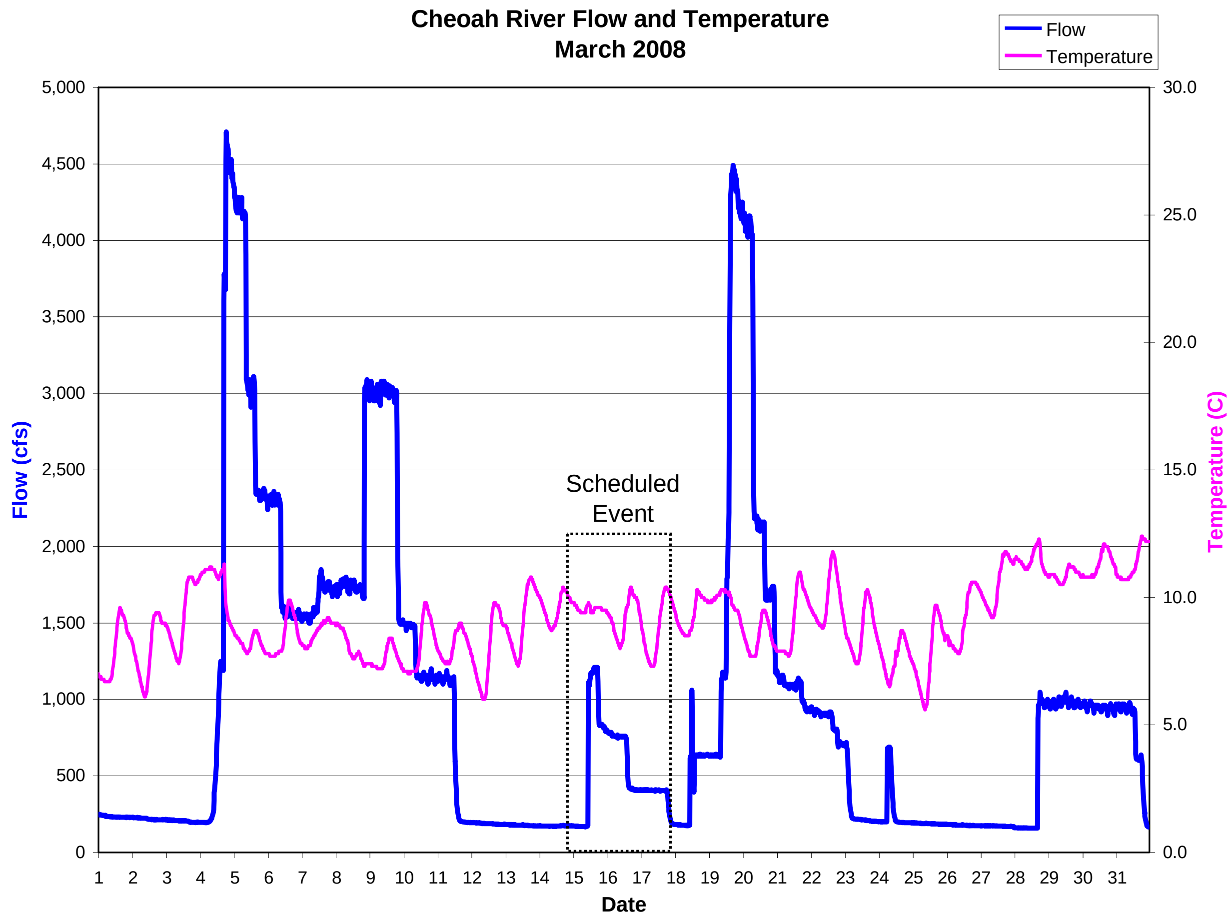


Figure 4. Instantaneous (15-minute) flow (cfs) and temperature (C) of Cheoah River during March 2008 showing effects of spill released into the bypass from Santeetlah Dam due to generator outages. Note that the flow magnitude of the normal high flow event is considerably smaller than the run-of-river spill flows.

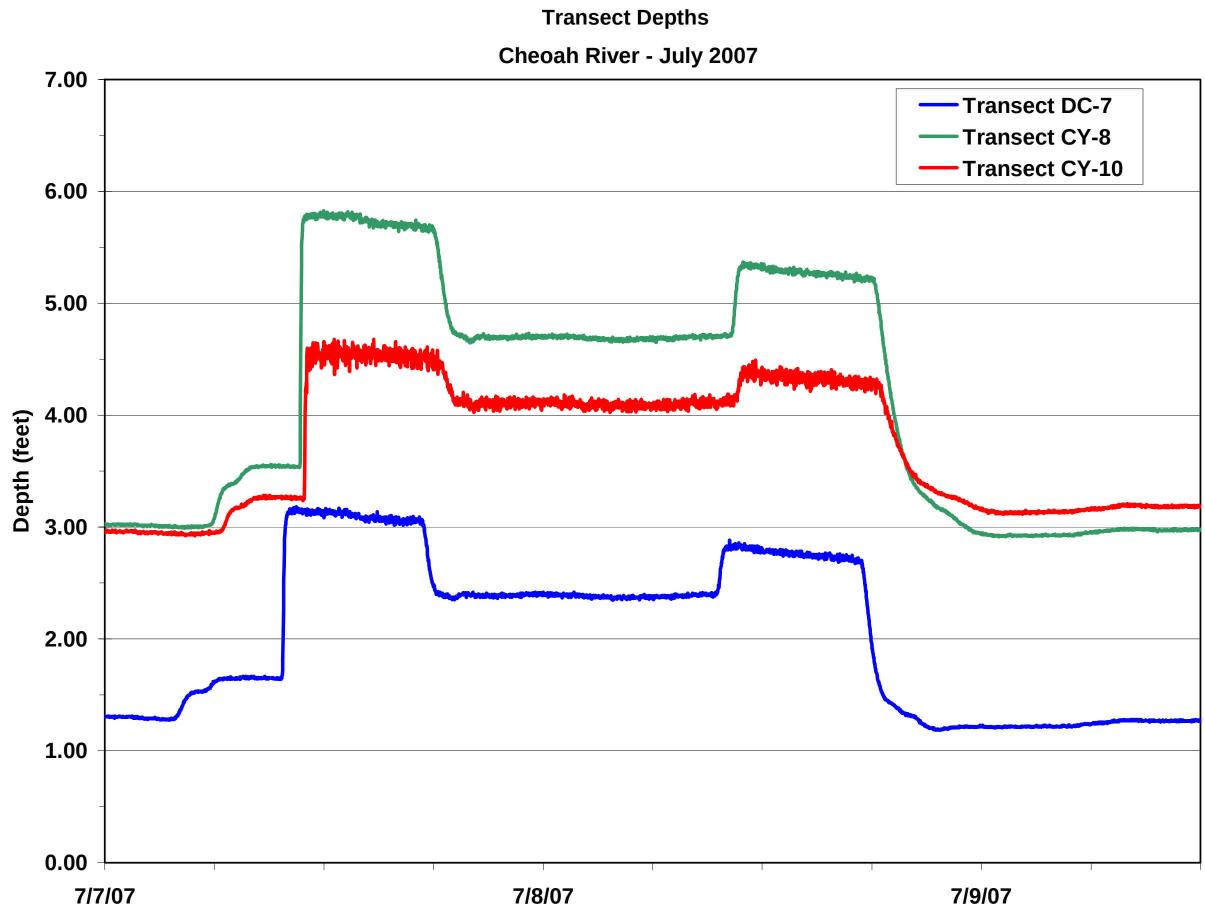


Figure 5. Water depth (feet) at instream flow transects in Cheoah River during scheduled high flow event in July 2007.

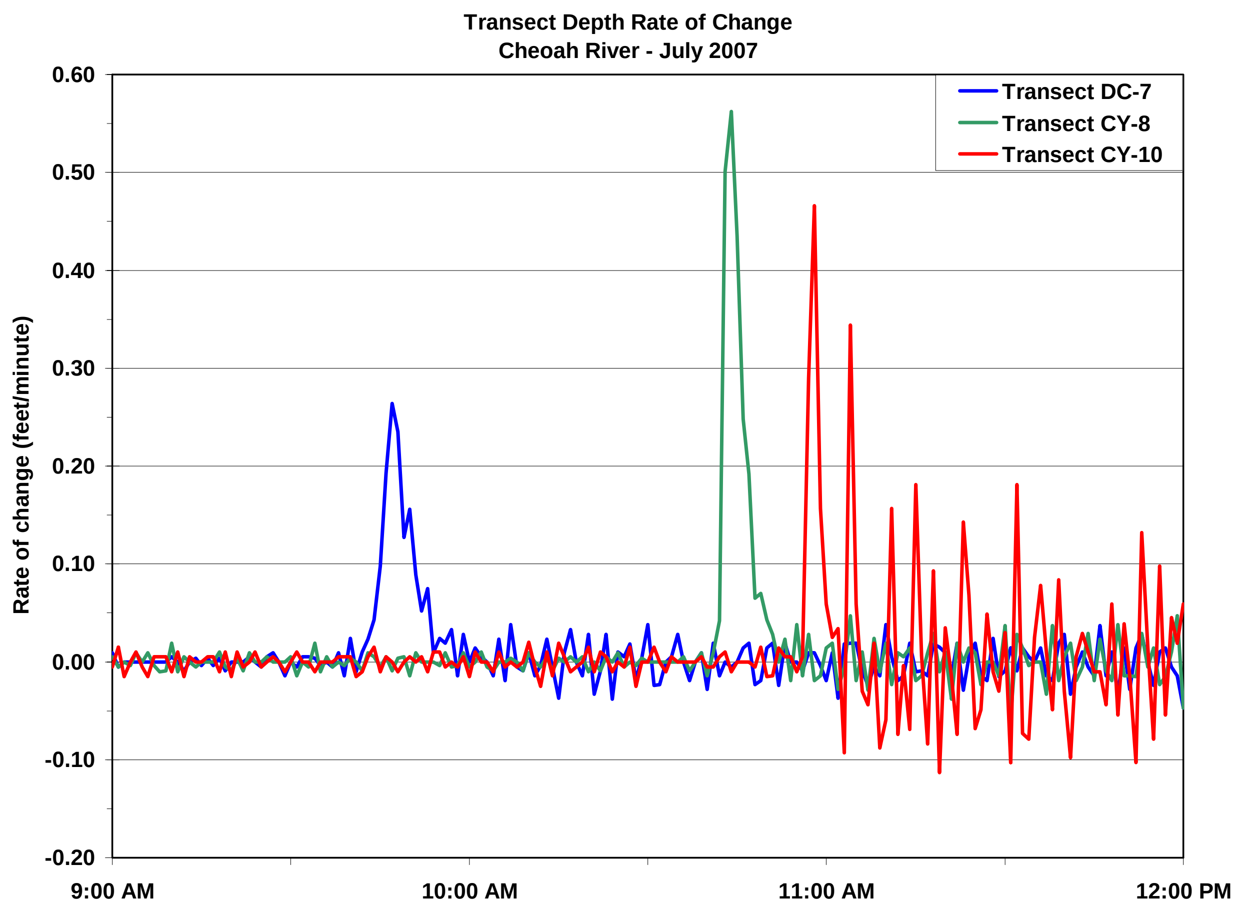


Figure 6. Rate of change in water depth (feet per minute) at instream flow transects in Cheoah River during arrival of scheduled high flow event on July 7, 2007.

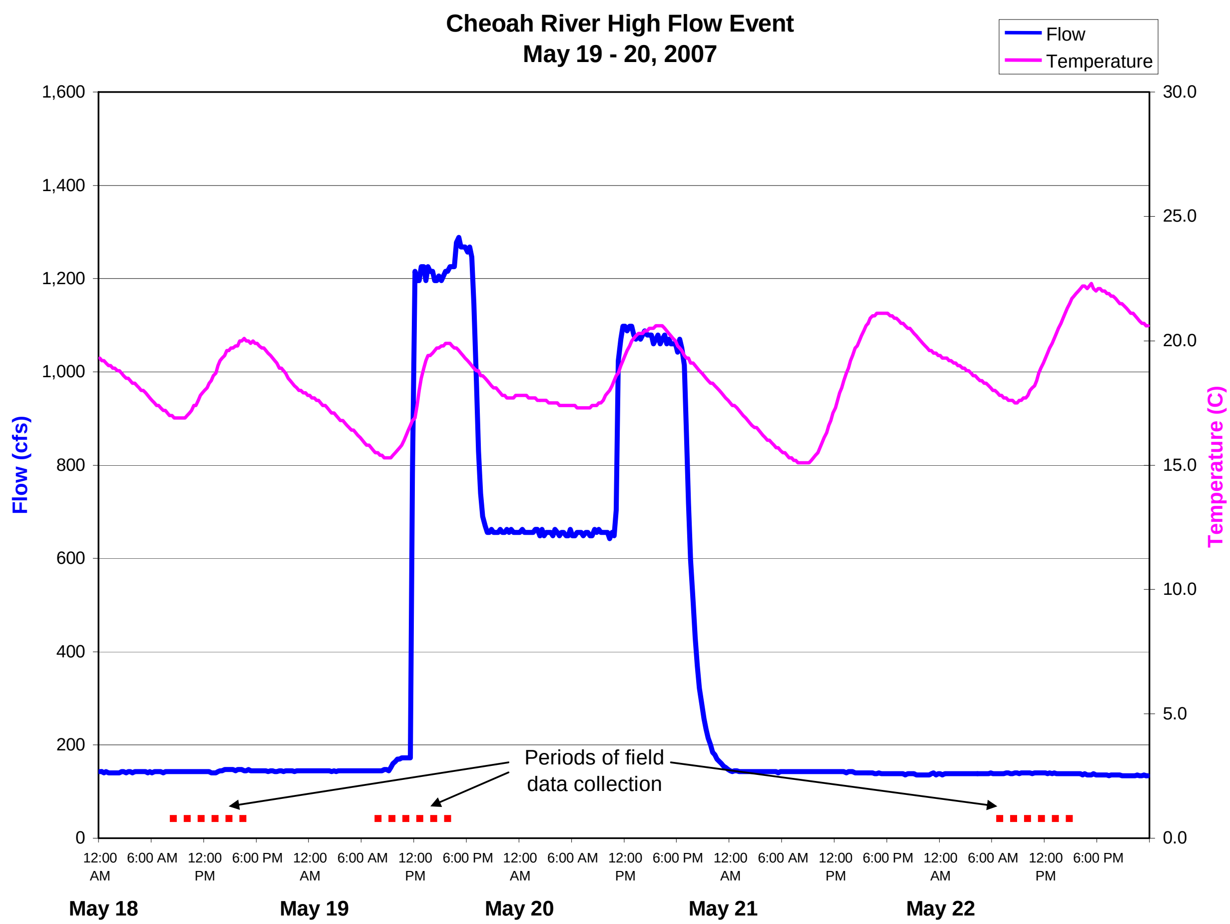


Figure 7. Instantaneous (15-minute) flow (cfs) and temperature (C) of Cheoah River during field data collections associated with May 2007 scheduled high flow event.

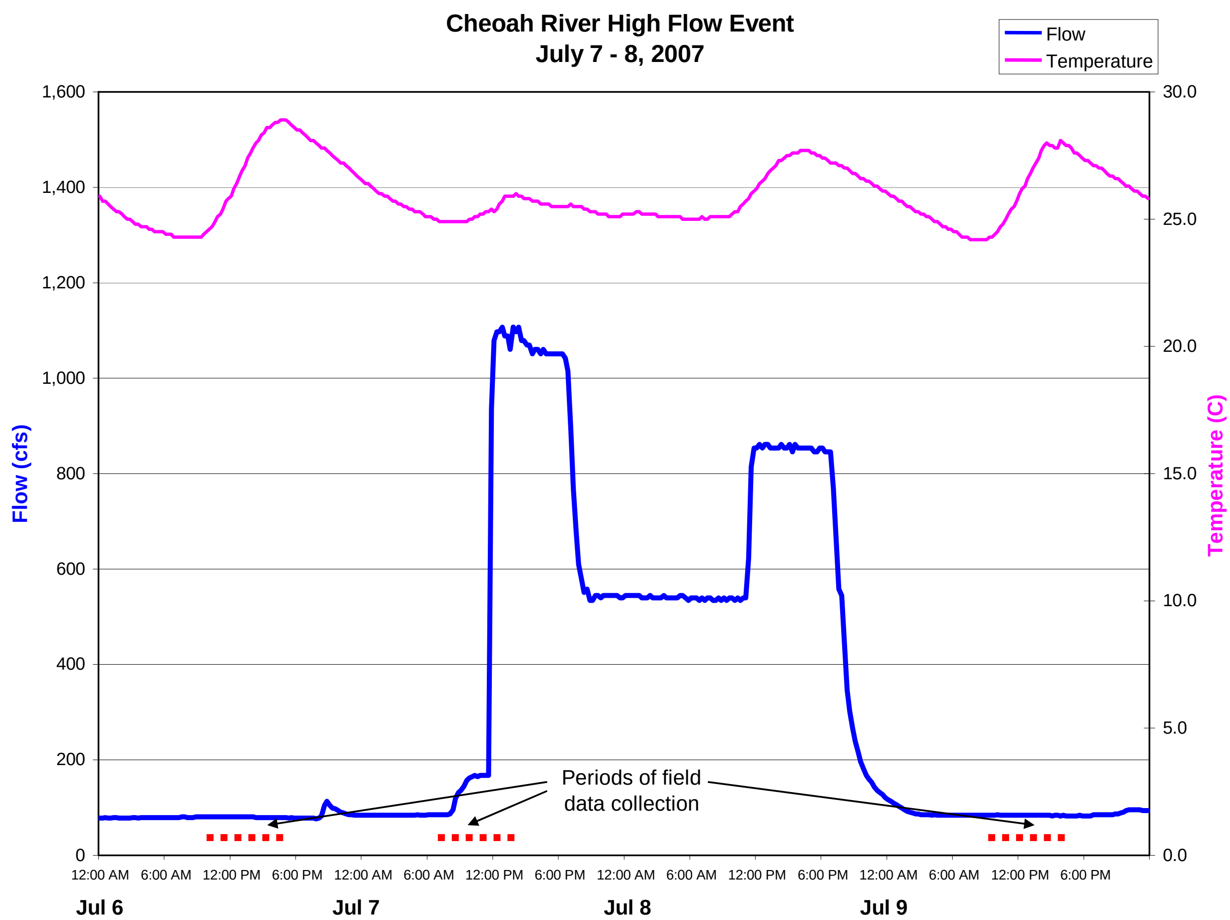


Figure 8. Instantaneous (15-minute) flow (cfs) and temperature (C) of Cheoah River during field data collections associated with July 2007 scheduled high flow event.

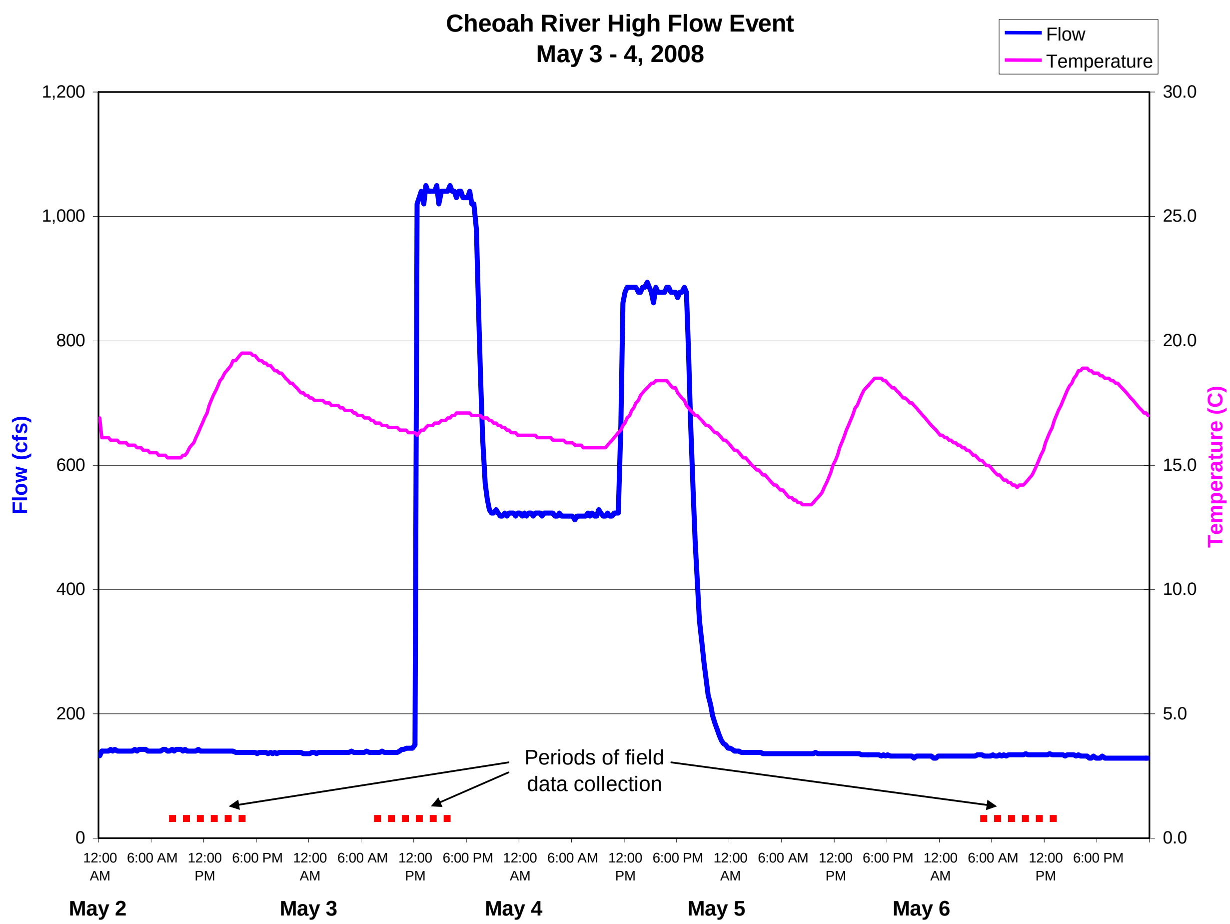


Figure 9. Instantaneous (15-minute) flow (cfs) and temperature (C) of Cheoah River during field data collections associated with May 2008 scheduled high flow event.

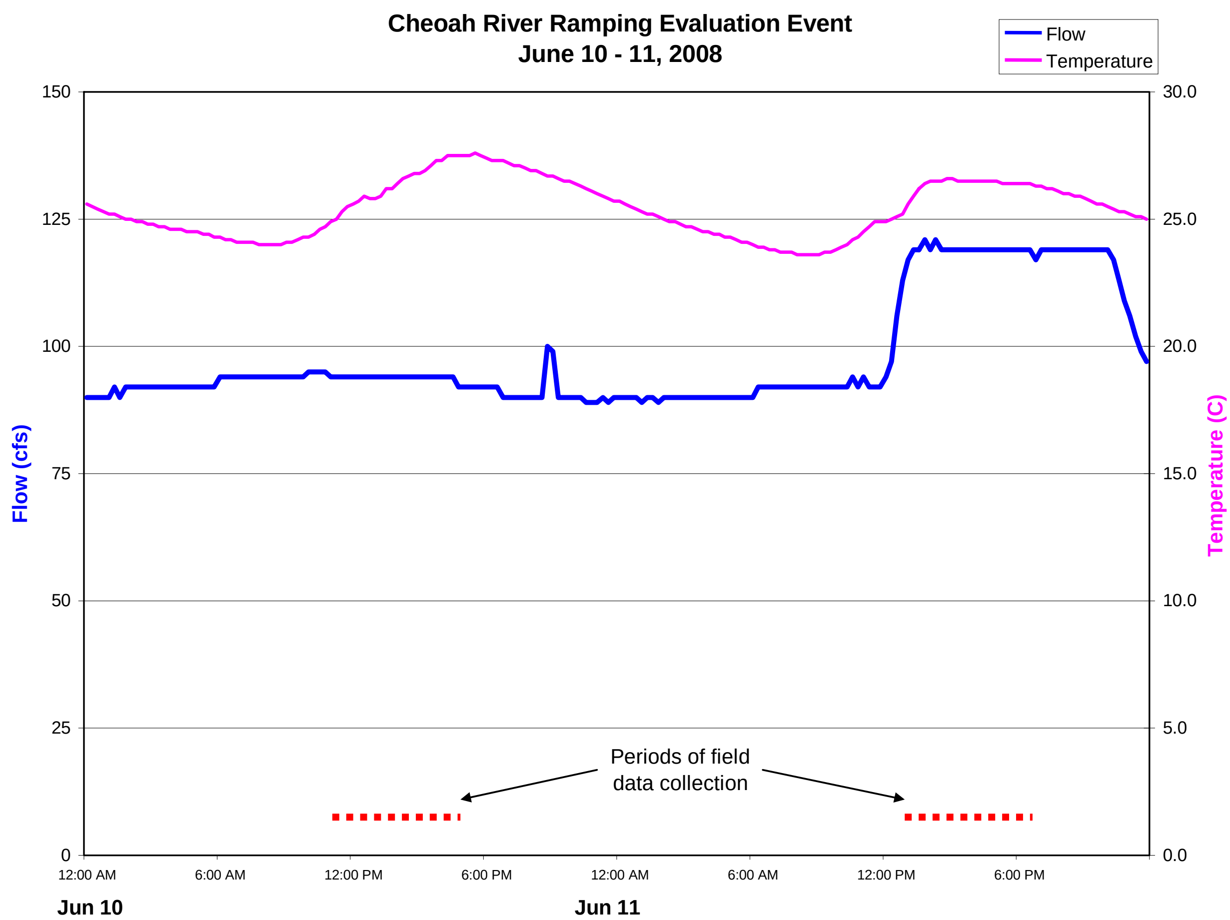


Figure 10. Instantaneous (15-minute) flow (cfs) and temperature (C) of Cheoah River during field data collections associated with June 2008 ramping release.

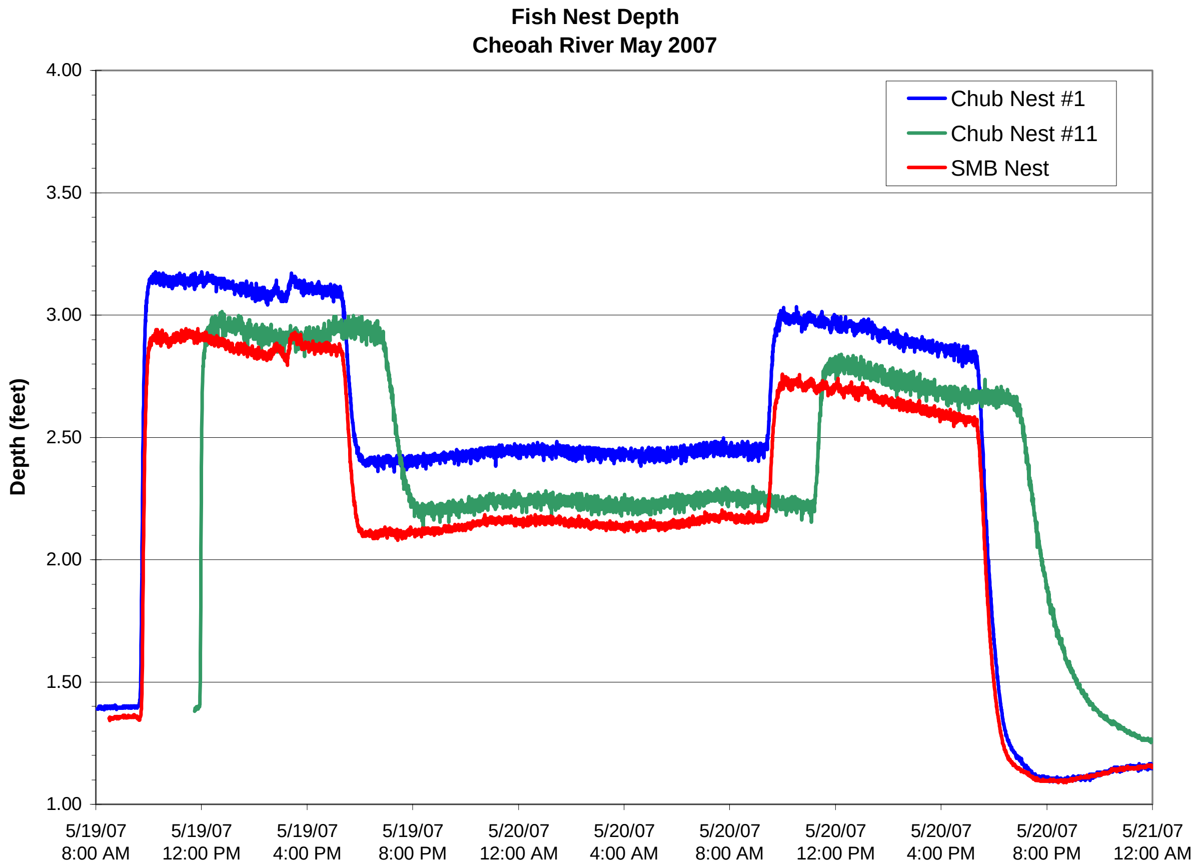


Figure 11. Water depth (feet) over fish nests in Cheoah River during high flow event in May 2007.

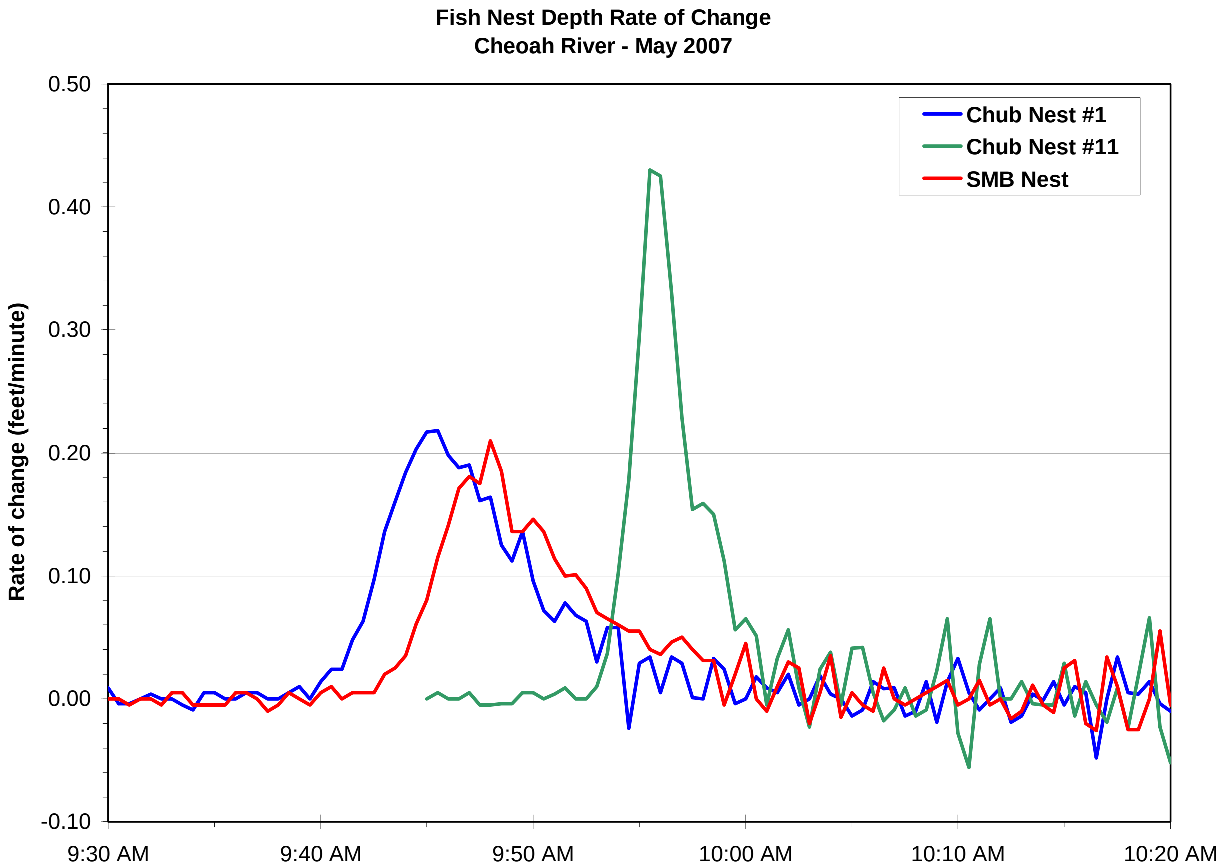


Figure 12. Rate of change in water depth (feet per minute) over fish nests in Cheoah River during arrival of high flow event on May 19, 2007. Note: Data for chub nest #11 were shifted 3 hours earlier than actual time in order to fit on graph.

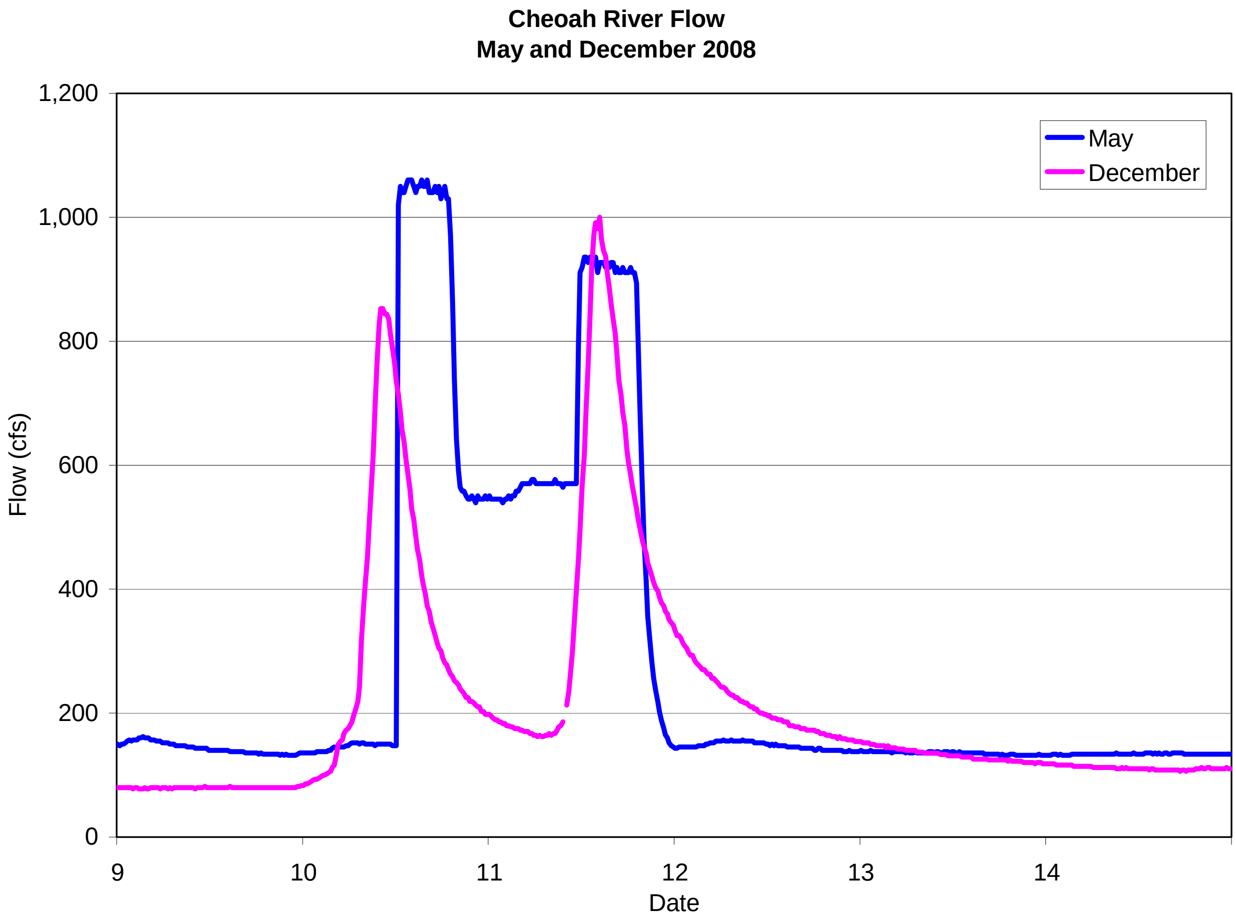


Figure 13. Instantaneous (15-minute) flow of Cheoah River during 2008 comparing the hydrograph shape of a regulated high flow event (May) and a similar magnitude natural high flow event (December).

Table 1. Comparison of rate of rise in water level as flow increases from base flow to ramping flow (100 cfs) and from ramping flow to peak flow (~1,000 cfs) in Cheoah River. Data collected July 7, 2007.

	Base Flow to Ramping Flow		Ramping Flow to Peak Flow	
Transect	Depth Increase (ft)	Elapsed Time (hr:min)	Depth Increase (ft)	Elapsed Time (hr:min)
DC-7	0.37	2:42	1.49	0:24
CY-8	0.52	2:26	2.24	0:24
CY-10	0.31	1:58	1.28	0:12

Table 2. Comparison of chub nest habitat conditions under base flow and ramping flow in Cheoah River. Data collected June 10-11, 2008.

	Base Flow			Ramping Flow		
nest	depth (ft)	mean v (ft/sec)	nose v (ft/sec)	depth (ft)	mean v (ft/sec)	nose v (ft/sec)
1	0.05	0.005	0.005	0.25	0.824	0.824
2	0.30	1.616	1.616	0.45	1.400	1.592
3	1.39	0.593	0.626	1.56	0.872	0.920
4	2.80	0.593	0.429	3.00	0.655	0.411
7	1.82	0.824	0.406	1.90	0.872	0.463
7-B	1.70	1.007	0.501	1.95	1.280	0.679
26	0.15	0.466	0.466	0.34	0.489	0.489
27	0.55	1.085	1.015	0.82	1.064	1.160
28-C	0.10	0.547	0.547	0.41	0.593	0.476
29	0.60	0.511	0.500	0.75	0.992	0.968
30	1.45	1.063	0.319	1.58	0.570	0.466
30-B	1.15	1.019	0.555	1.48	1.178	0.220
30-C	0.65	0.000	0.000	1.37	0.354	0.283
101	1.74	1.088	0.992	2.00	1.112	1.040
102	1.33	0.184	0.078	1.70	0.456	0.073
103-A	2.99	0.752	0.711	3.24	0.660	0.428
103-B	2.52	1.064	0.679	2.78	1.379	1.145
104	0.69	0.489	0.476	0.92	0.711	0.593
105-A	0.45	0.511	0.476	0.69	0.703	0.804
105-B	0.42	0.872	0.757	0.61	0.898	0.804
150	0.90	0.671	0.531	1.41	0.515	0.568
152	0.15	0.671	0.671	0.36	0.829	0.829
153	0.40	0.331	0.188	0.73	0.255	0.351
mean	1.03	0.69	0.56	1.32	0.81	0.68
s.d.	0.85	0.37	0.34	0.87	0.32	0.36

Table 3. Comparison of sunfish nest habitat conditions under base flow and ramping flow in Cheoah River. Data collected June 10-11, 2008.

nest	Base Flow			Ramping Flow		
	depth (ft)	mean v (ft/sec)	nose v (ft/sec)	depth (ft)	mean v (ft/sec)	nose v (ft/sec)
2	0.95	0.000	0.000	1.44	0.108	0.174
3	0.44	0.000	0.000	0.61	0.000	0.000
4	1.19	0.000	0.000	1.45	0.167	0.000
5	1.88	0.237	0.154	2.00	0.247	0.111
10	1.10	0.000	0.000	1.72	0.520	0.000
101	1.30	0.055	0.260	1.49	0.202	0.406
102	0.76	0.000	0.000	0.95	0.000	0.000
103	0.88	0.640	0.617	1.05	0.703	0.420
mean	1.06	0.12	0.13	1.34	0.24	0.14
s.d.	0.43	0.23	0.22	0.45	0.25	0.18

Table 4. Comparison of fry habitat conditions under base flow and ramping flow in Cheoah River. Data collected June 10-11, 2008.

nest	Base Flow			Ramping Flow		
	depth (ft)	mean v (ft/sec)	nose v (ft/sec)	depth (ft)	mean v (ft/sec)	nose v (ft/sec)
1-A	0.85	0.091		1.20	0.306	
1-B	1.10	0.000		1.45	0.287	
1-C	1.00	0.000		1.20	0.143	
1-D	0.40	0.000		0.60	0.162	
02	1.15	0.000	0.000	1.25	0.000	0.000
03	2.40	0.896	0.453	2.65	1.160	0.752
09	2.35	0.640		2.55	0.776	0.146
101	0.18	0.214	0.214	0.41	0.168	0.168
102	0.55	0.453	0.443	0.78	0.328	0.429
mean	1.11	0.25	0.28	1.34	0.37	0.30
s.d.	0.79	0.33	0.22	0.79	0.37	0.30

Table 5. General change in available habitat for selected species as flow increases from 50 cfs to 100 cfs. Habitat change shown as much greater (++), greater (+), about the same (o), less (–), and much less (– –). Blank cells indicate life stage had zero habitat at a given transect under all flow conditions.

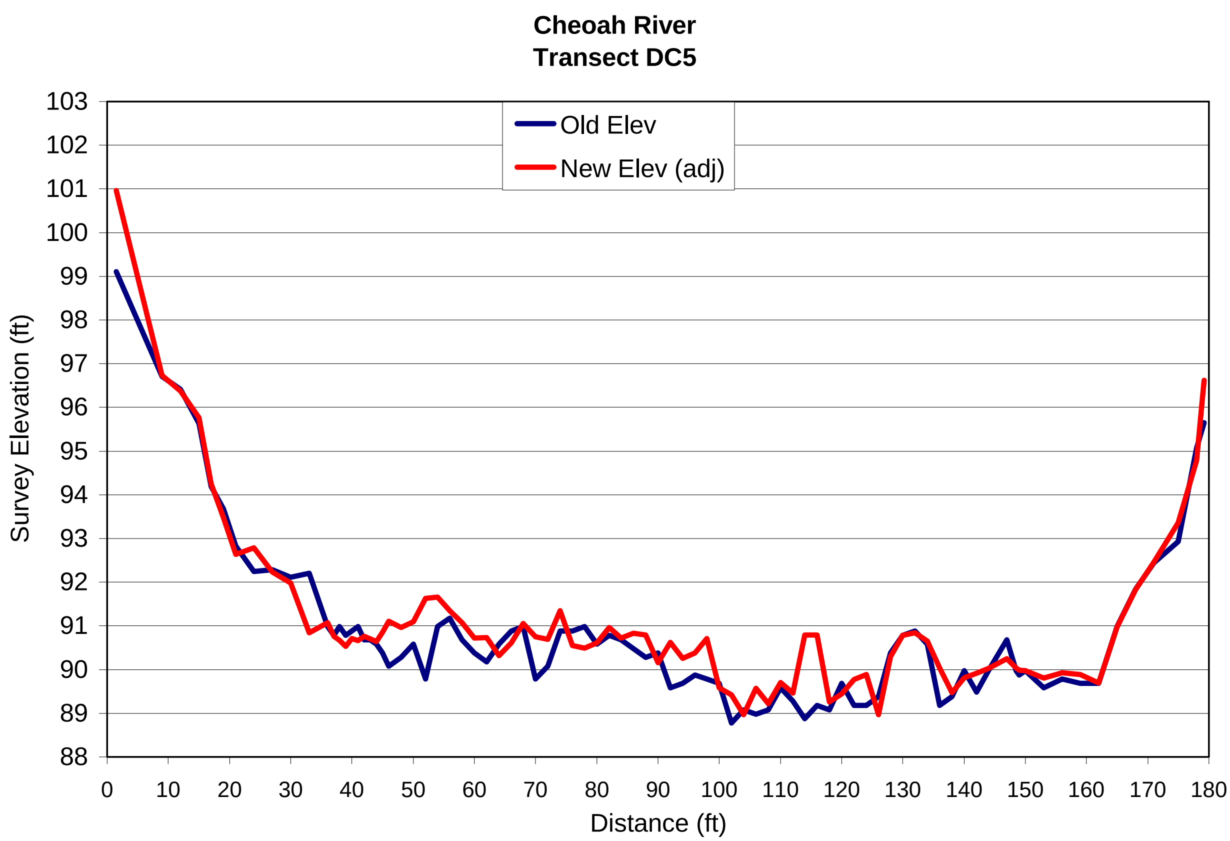
		Transect				
Species	Life stage	DC5	DC7	CY6	CY8	CY10
North Hog Sucker	YOY	–	o	+	–	–
	Juvenile	o	o	o	o	+
Mottled Sculpin	Spawning	o	o			
	Fry	+	+	+	+	++
Central Stoneroller	Spawning		o			
	Juvenile	o	o			
Smallmouth bass	Spawning	+	o	o	o	o
	Fry	o	–	++	– –	– –
	Juvenile	+	+	+	–	–
Mayfly		+	+	o	–	o

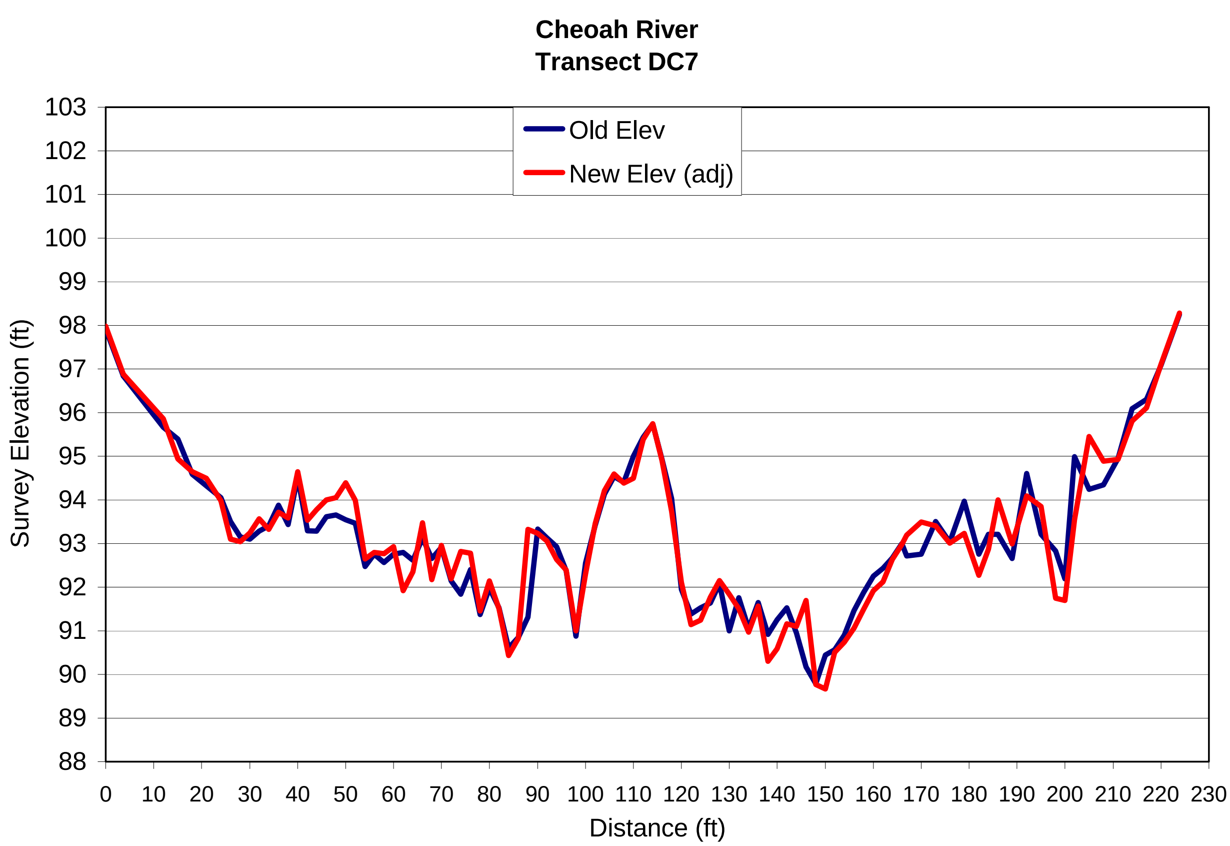
Table 6. General change in available habitat for selected species as flow increases from 100 cfs to 1,000 cfs. Habitat change shown as much greater (++), greater (+), about the same (o), less (–), and much less (– –).

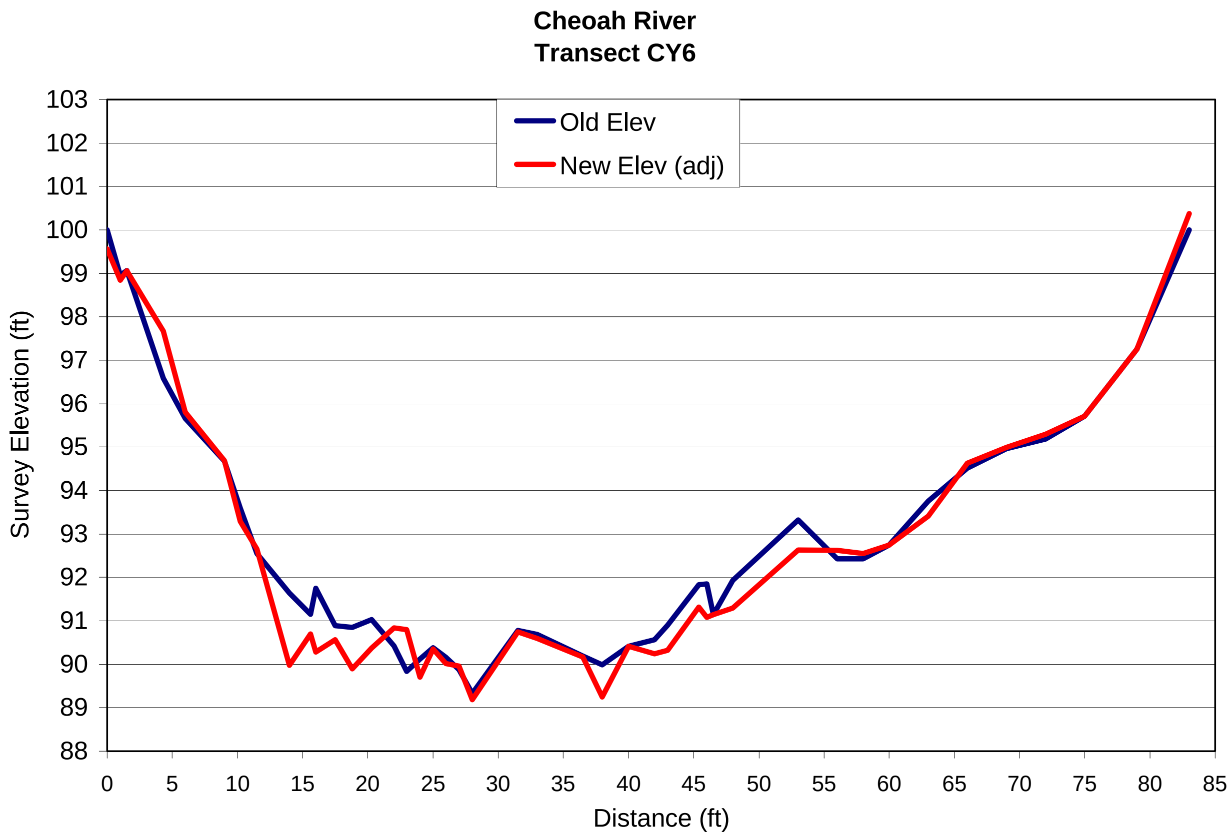
		Transect				
Species	Life stage	DC5	DC7	CY6	CY8	CY10
North Hog Sucker	YOY	–	–	o	o	– –
	Juvenile	++	++	– –	– –	– –
Mottled Sculpin	Spawning	++	++			
	Fry	++	++	++	++	++
Central Stoneroller	Spawning		+			
	Juvenile	o	o			
Smallmouth bass	Spawning	o	–	–	o	o
	Fry	– –	– –	– –	+	– –
	Juvenile	– –	– –	– –	o	– –
Mayfly		–	o	– –	– –	– –

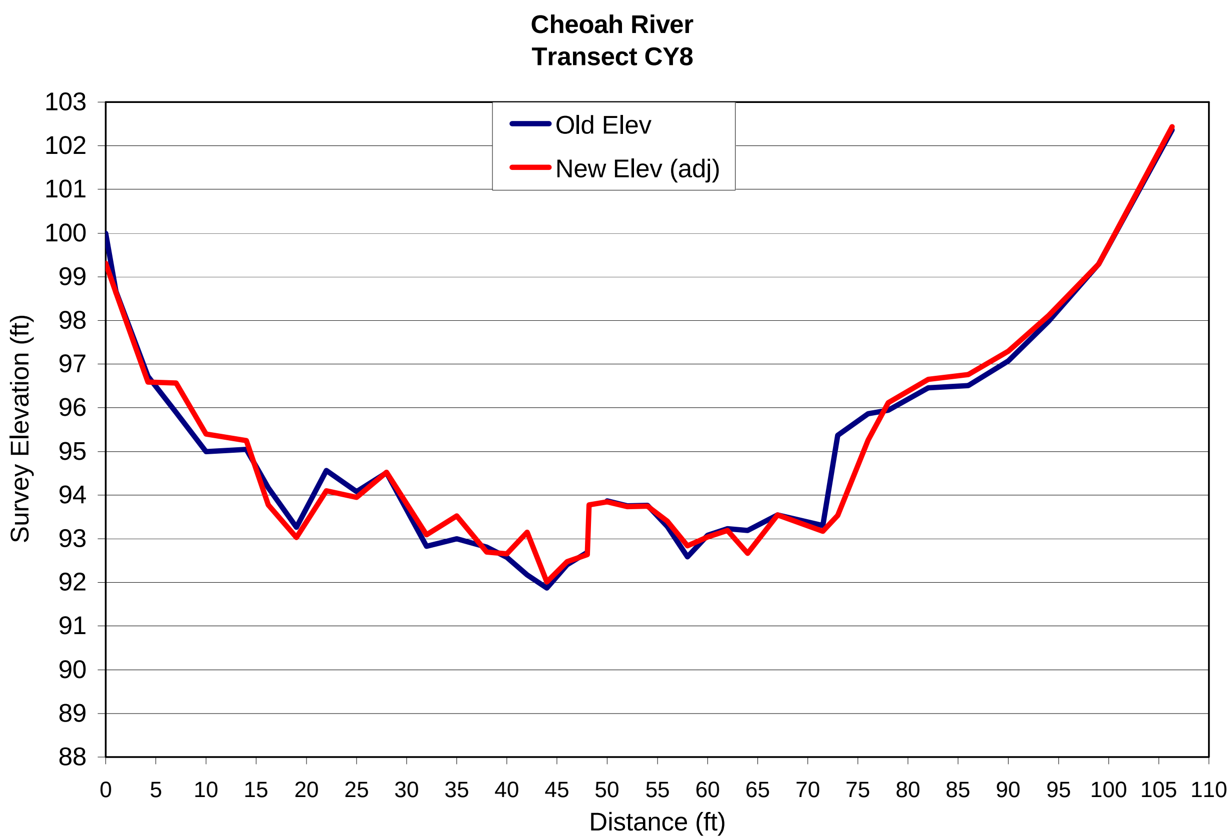
Appendix A

Instream Flow Transects

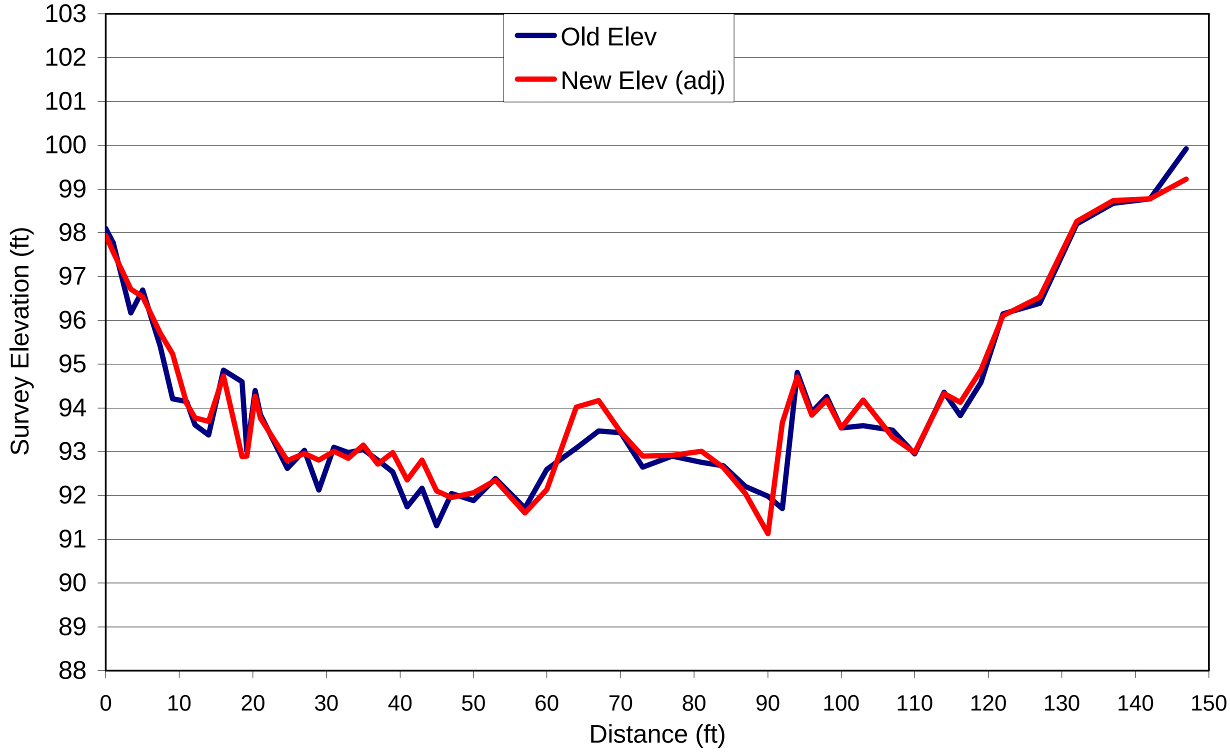

Cheoah River
Transect DC5
Old Elev
New Elev (adj)
Survey Elevation (ft)
Distance (ft)
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180


Cheoah River
Transect DC7
Old Elev
New Elev (adj)
Survey Elevation (ft)
Distance (ft)
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

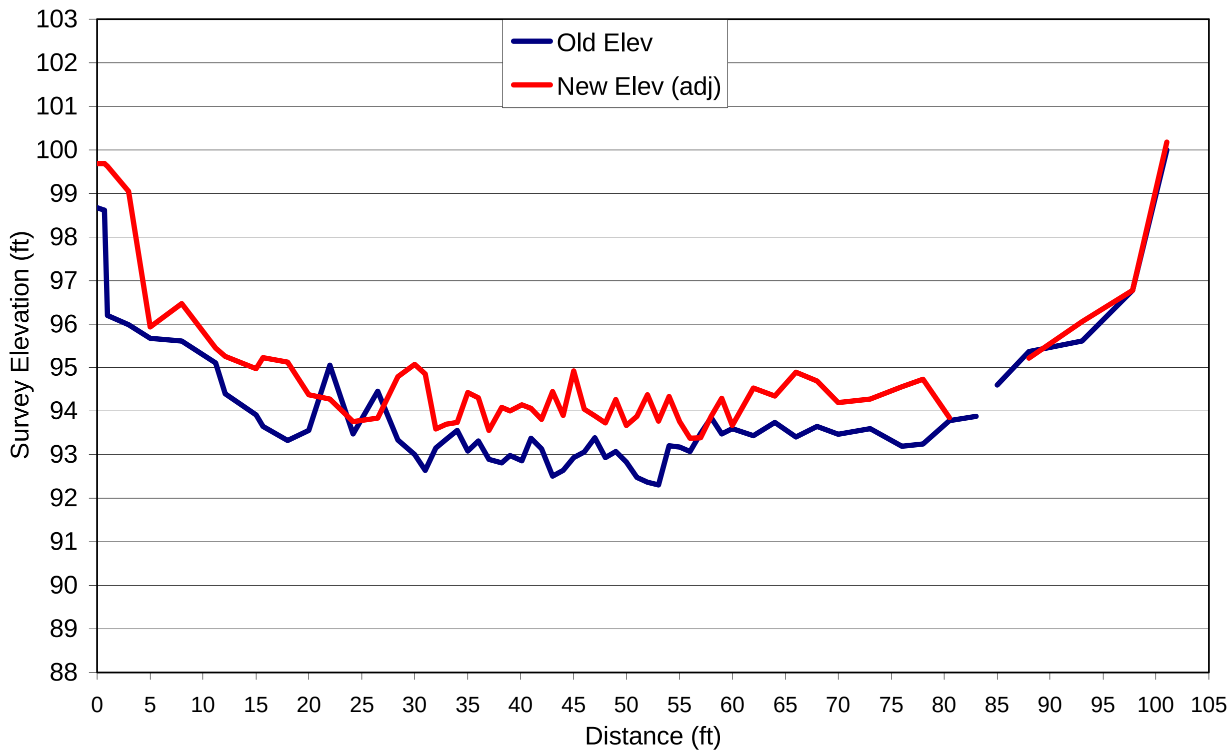

Cheoah River
Transect CY6
Old Elev
New Elev (adj)
Survey Elevation (ft)
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Distance (ft)


Cheoah River
Transect CY8
Old Elev
New Elev (adj)
Survey Elevation (ft)
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
Distance (ft)

Cheoah River
Transect CY10



Cheoah River
Transect YD1



Appendix B

Photos

2007 – Joyce Kilmer Bridge before/after; chub nest #9; chub nest #10; chub nest #11; nest A; nest B; side channel u/s; side channel d/s

2008 – Joyce Kilmer Bridge u/s; Joyce Kilmer Bridge d/s; nest #4 series

May 2007
From Joyce Kilmer Bridge – Looking Downstream

May 2007
From Joyce Kilmer Bridge – Looking Upstream

May 2007
Nest #9 – Near Santeetlah Church

May 2007
Nest #10 – Near Santeetlah Church

May 2007
Nest #11 – Under USGS Gage Bridge

July 2007
Nest A

Before – 50 cfs

Before – 50 cfs

Before – 100 cfs

After – 50 cfs

After – 50 cfs

After – 50 cfs

July 2007
Nest B

Before – 50 cfs

After – 50 cfs

Before – 50 cfs

After – 50 cfs

July 2007
Side Channel Looking Upstream


Before – 50 cfs


During Rise 1


During Rise 2


During Rise 3


During Rise 4


During Rise 5


During Rise 6


After – 50 cfs

July 2007
Side Channel Looking Downstream

Before – 50 cfs

During Rise 1

During Rise 2

During Rise 3

During Rise 4

After – 50 cfs

May 2008
Kilmer Bridge Looking Downstream During Rise

Before – 0841 hrs

During – 0937 hrs

During – 0938 hrs

During – 0939 hrs

During – 0940 hrs

During – 0941 hrs

During – 0942 hrs

During – 0943 hrs

During – 0944 hrs

Peak – 1030 hrs

May 2008
Kilmer Bridge Looking Upstream During Rise


Before – 0841 hrs


During – 0937 hrs


During – 0938 hrs


During – 0939 hrs


During – 0940 hrs


During – 0941 hrs


During – 0942 hrs


During – 0943 hrs


During – 0944 hrs


Peak – 1030 hrs

May 2008
Nest 4 During Rise

Before – 1133 hrs

During – 1159 hrs

During – 1200 hrs

During – 1201 hrs

During – 1202 hrs

During – 1203 hrs

During – 1204 hrs

During – 1205 hrs

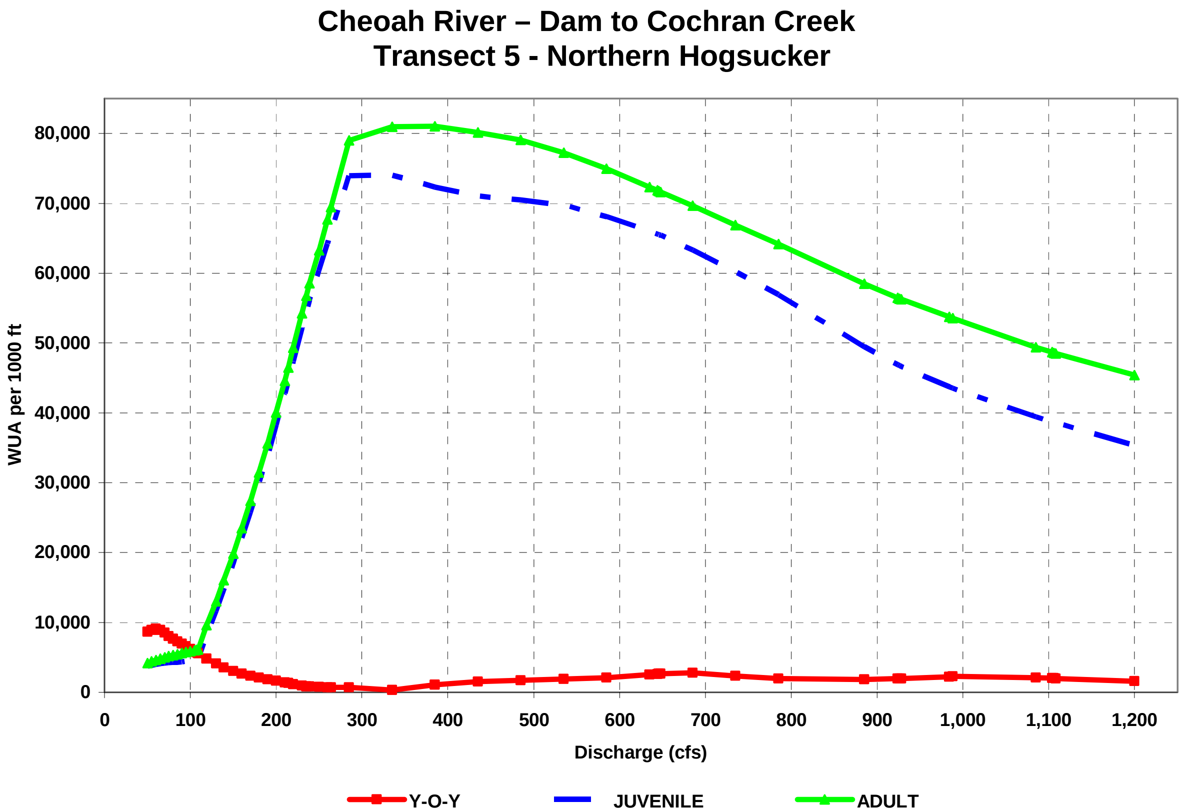
During – 1206 hrs

During – 1207 hrs

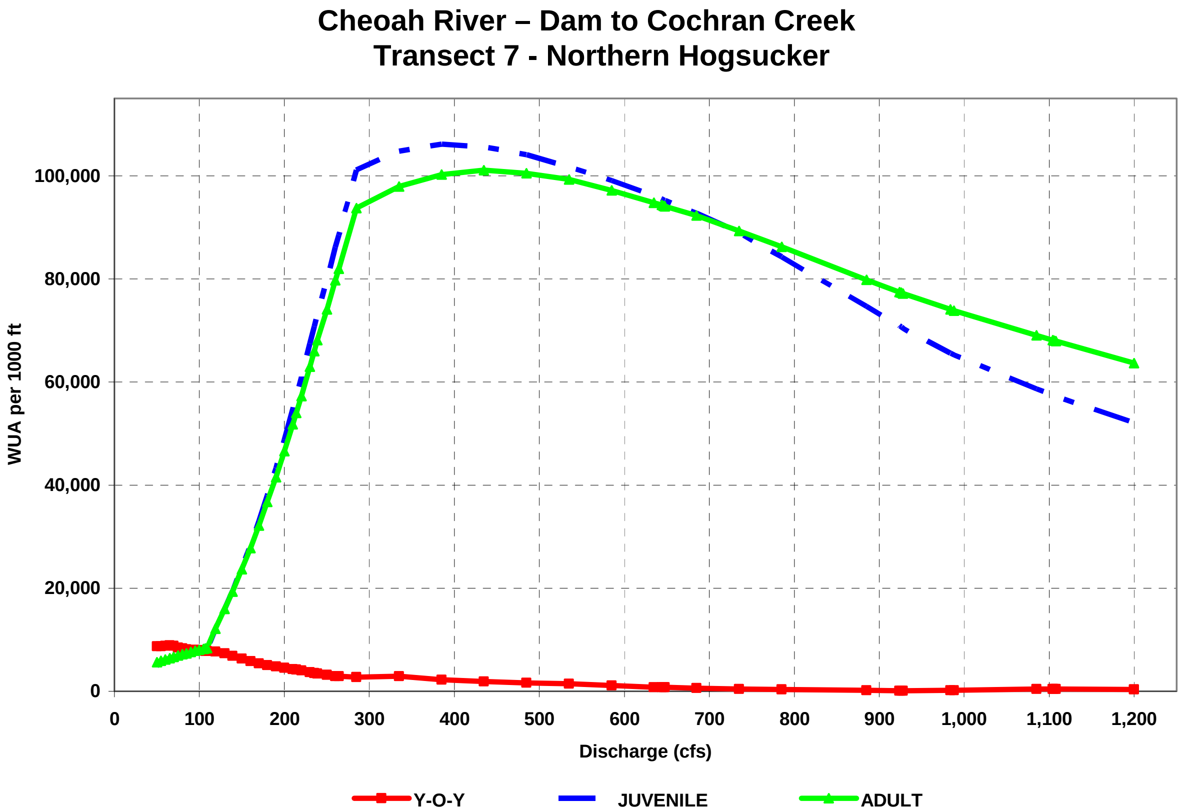
During – 1208 hrs

Appendix C

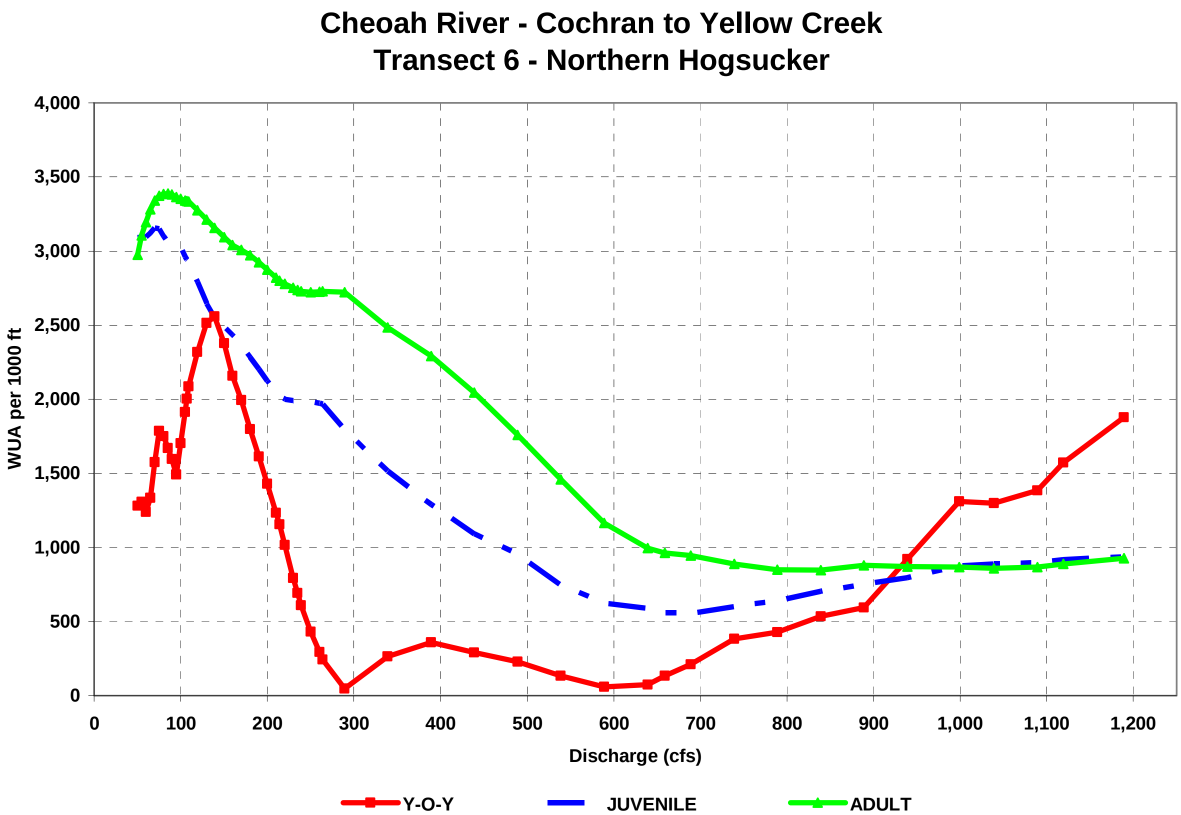
PHABSIM Results

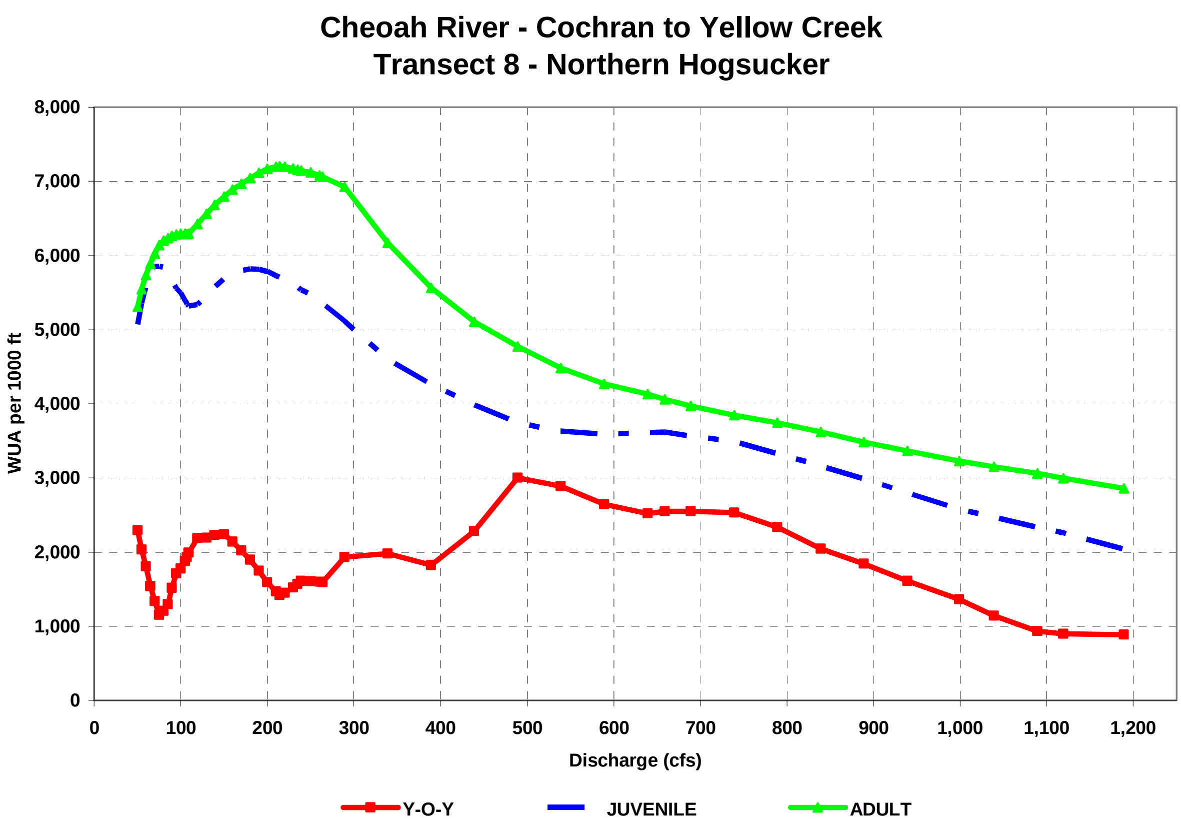


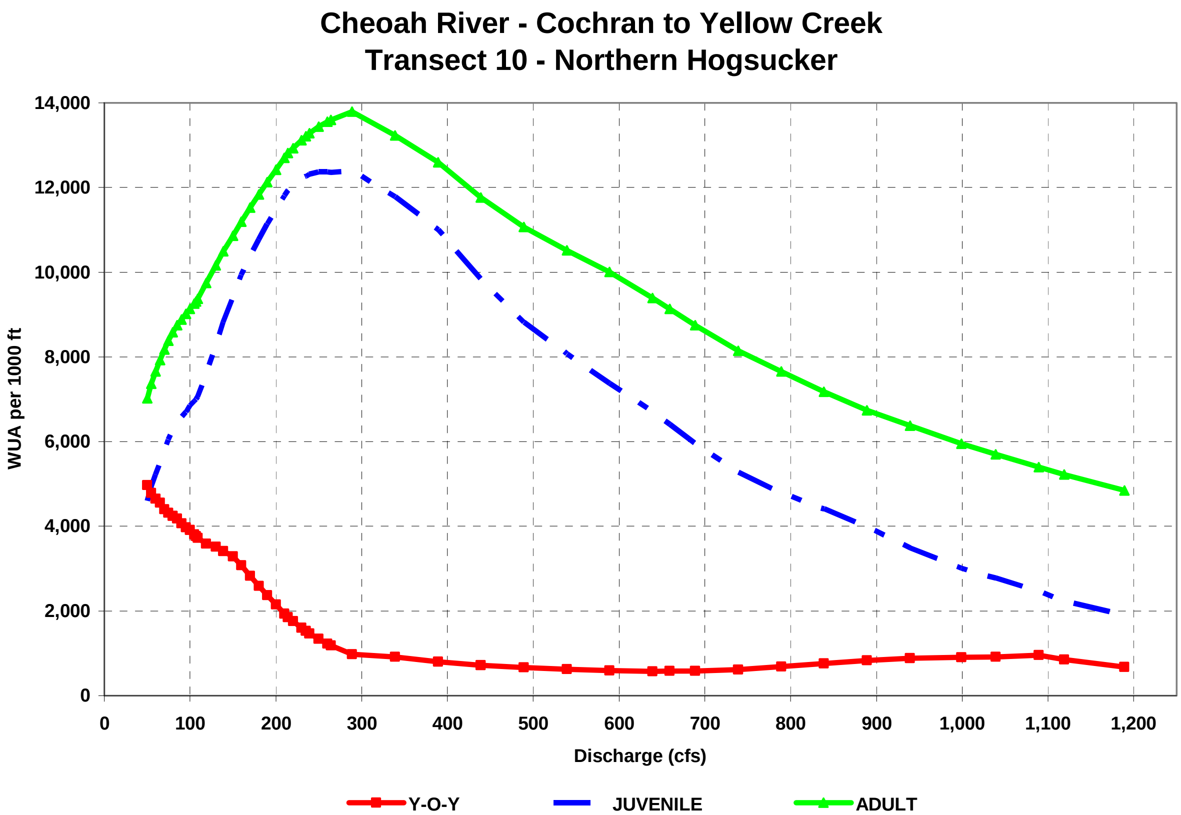
Cheoah River – Dam to Cochran Creek
Transect 5 - Northern Hogsucker
WUA per 1000 ft
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
Y-O-Y
JUVENILE
ADULT



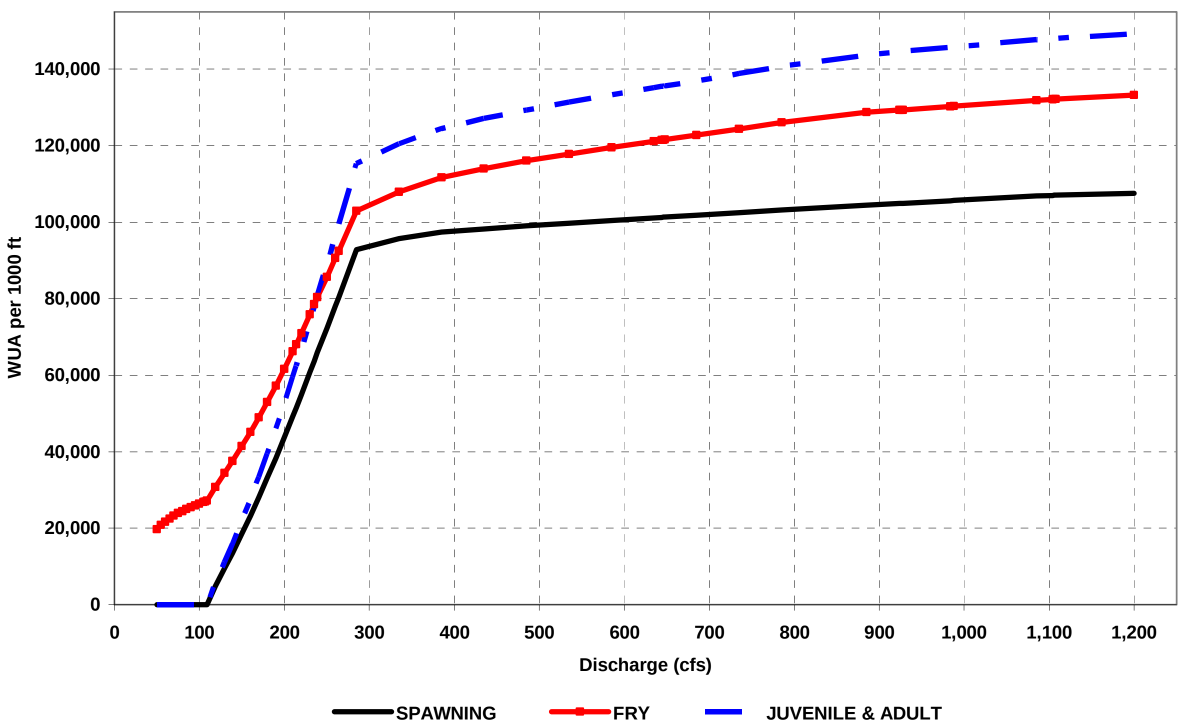
Cheoah River – Dam to Cochran Creek
Transect 7 - Northern Hogsucker
WUA per 1000 ft
100,000
80,000
60,000
40,000
20,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
Y-O-Y
JUVENILE
ADULT


Cheoah River - Cochran to Yellow Creek
Transect 6 - Northern Hogsucker
WUA per 1000 ft
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
Y-O-Y
JUVENILE
ADULT

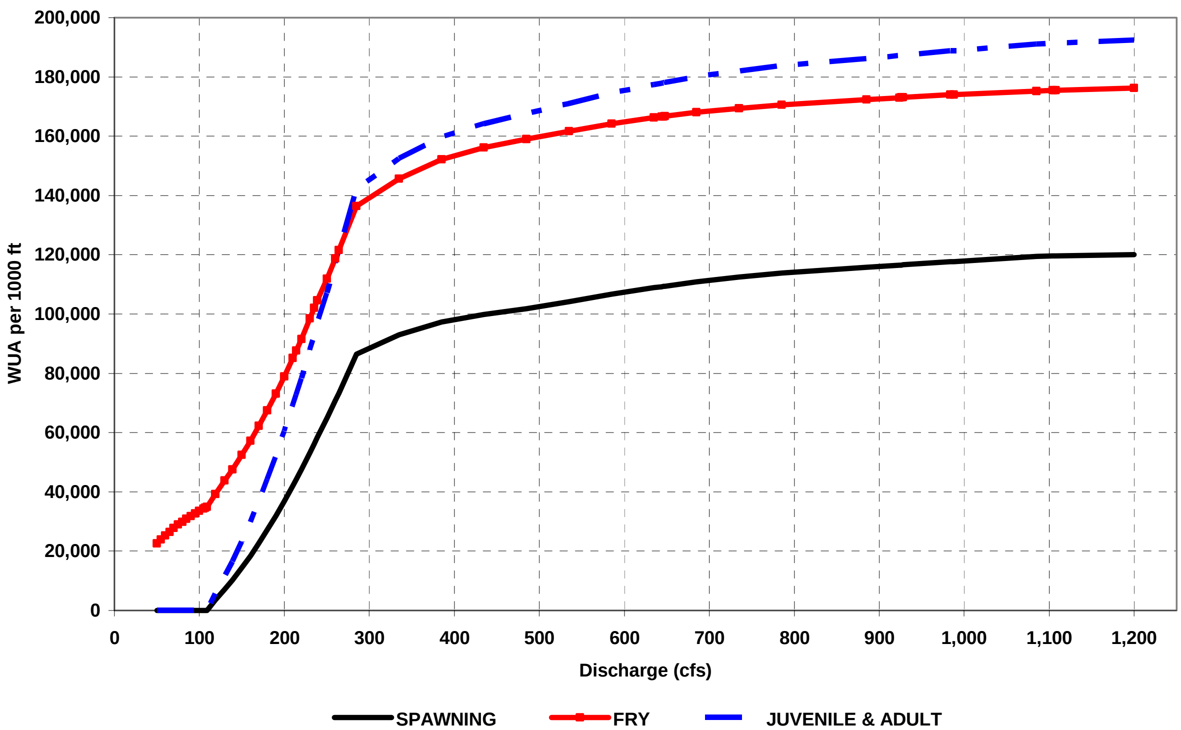

Cheoah River - Cochran to Yellow Creek
Transect 8 - Northern Hogsucker
WUA per 1000 ft
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
Y-O-Y
JUVENILE
ADULT

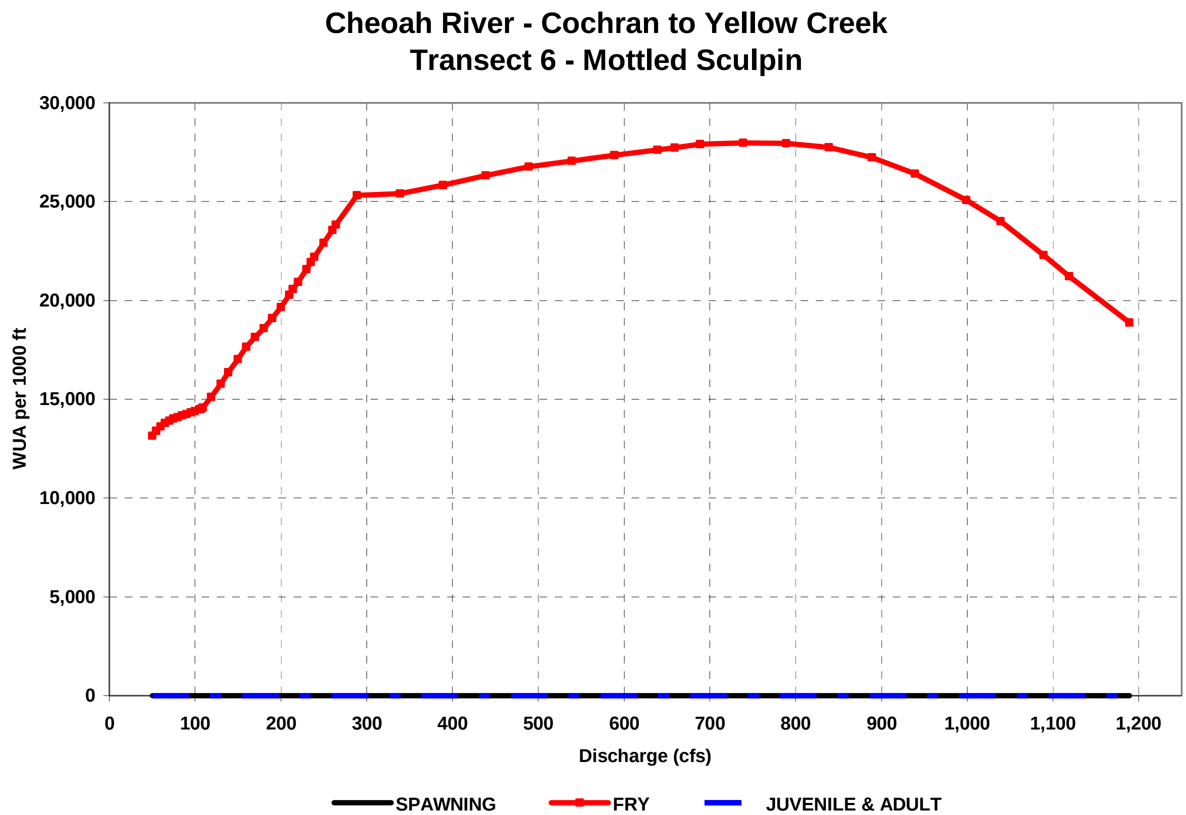

Cheoah River - Cochran to Yellow Creek
Transect 10 - Northern Hogsucker
WUA per 1000 ft
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
Y-O-Y
JUVENILE
ADULT

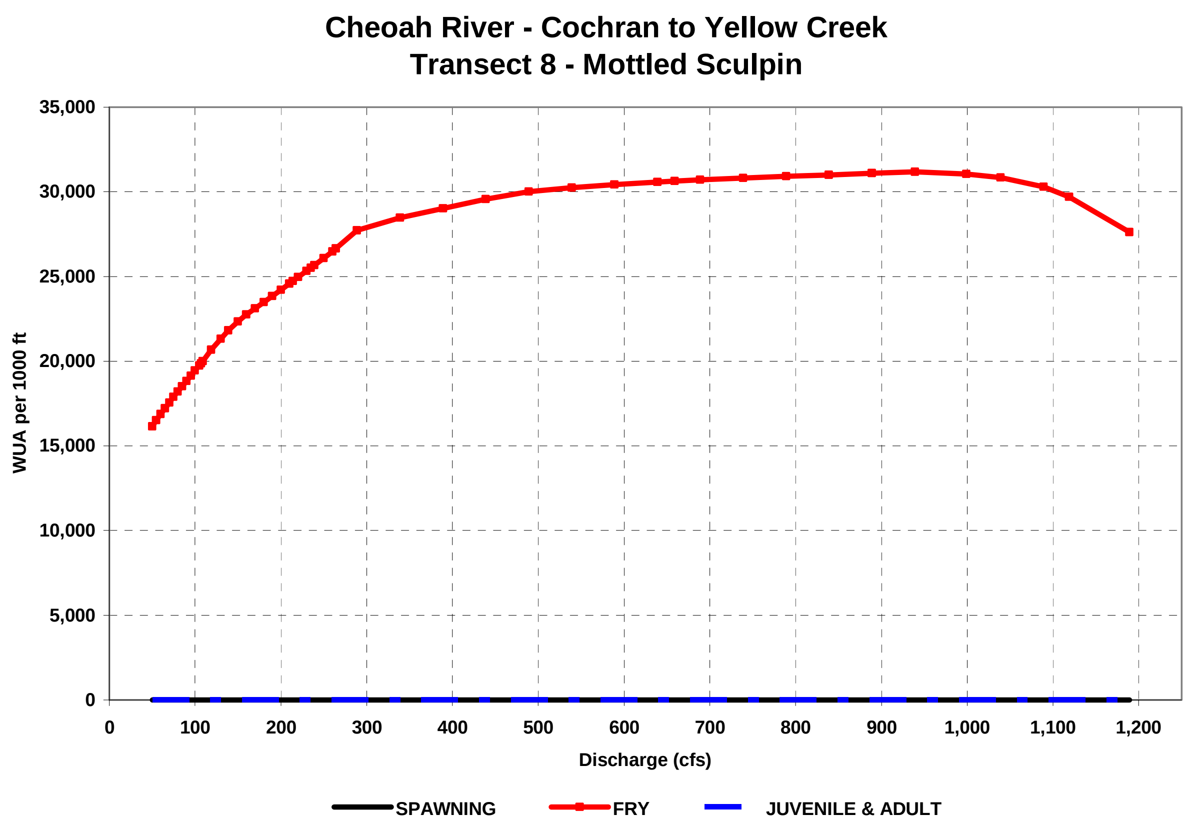
Cheoah River – Dam to Cochran Creek
Transect 5 - Mottled Sculpin

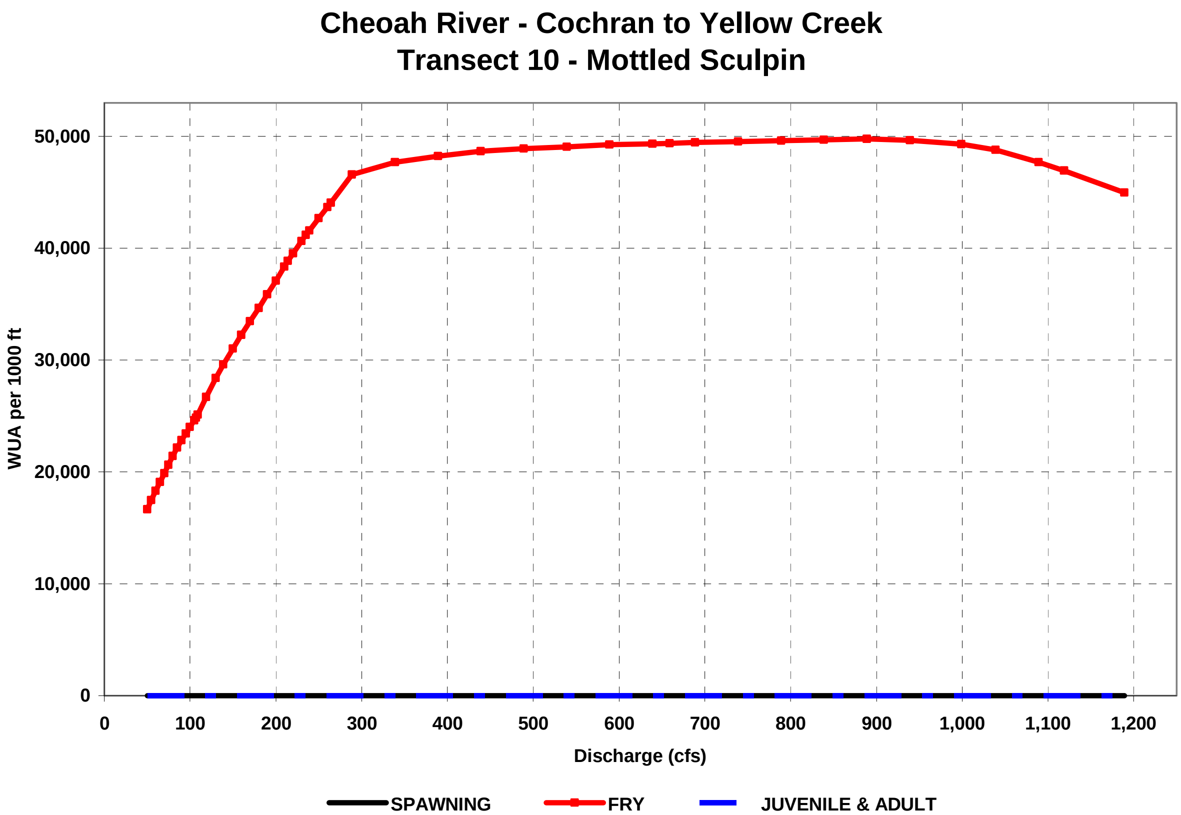


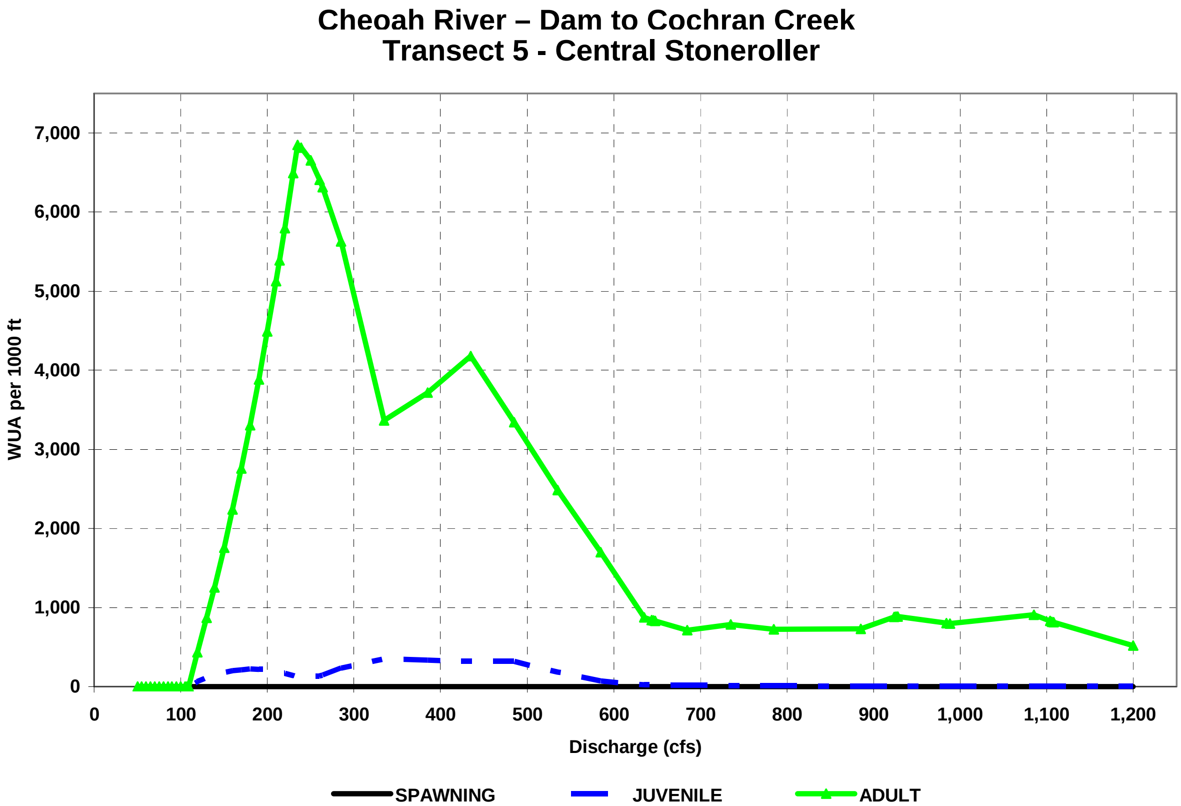
Cheoah River – Dam to Cochran Creek
Transect 7 - Mottled Sculpin

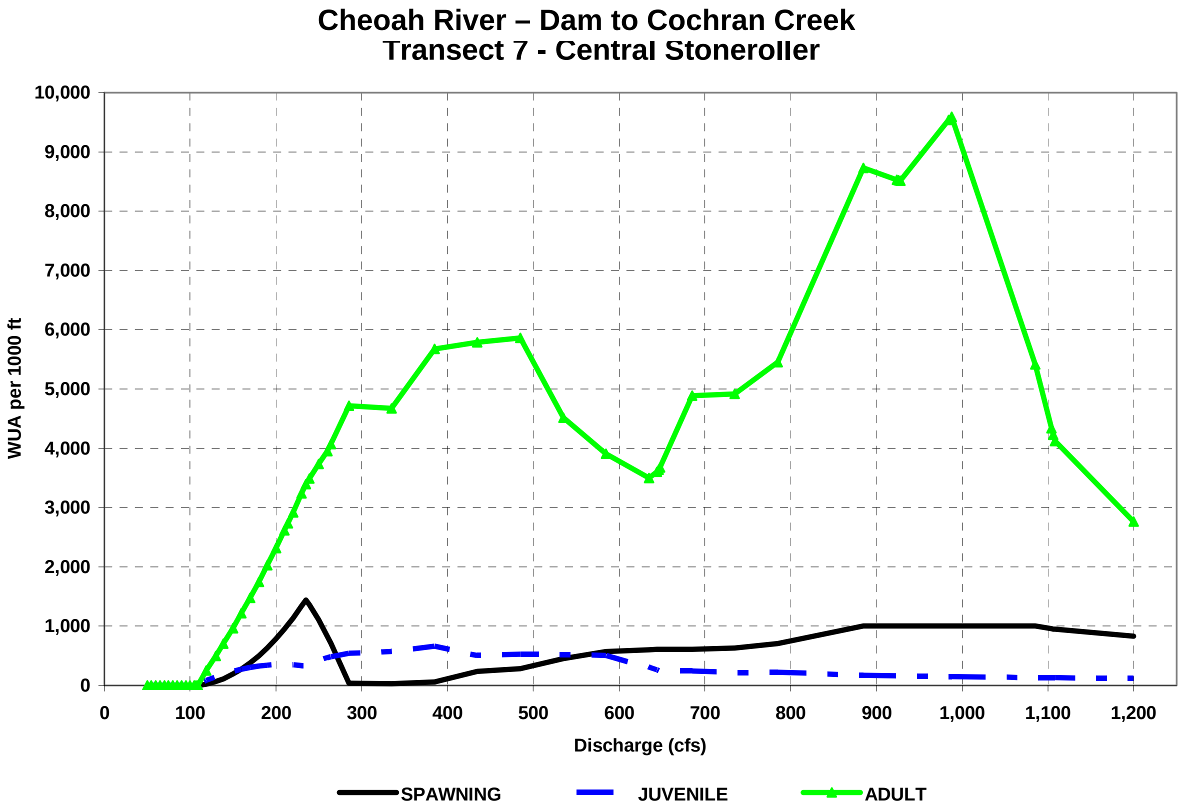


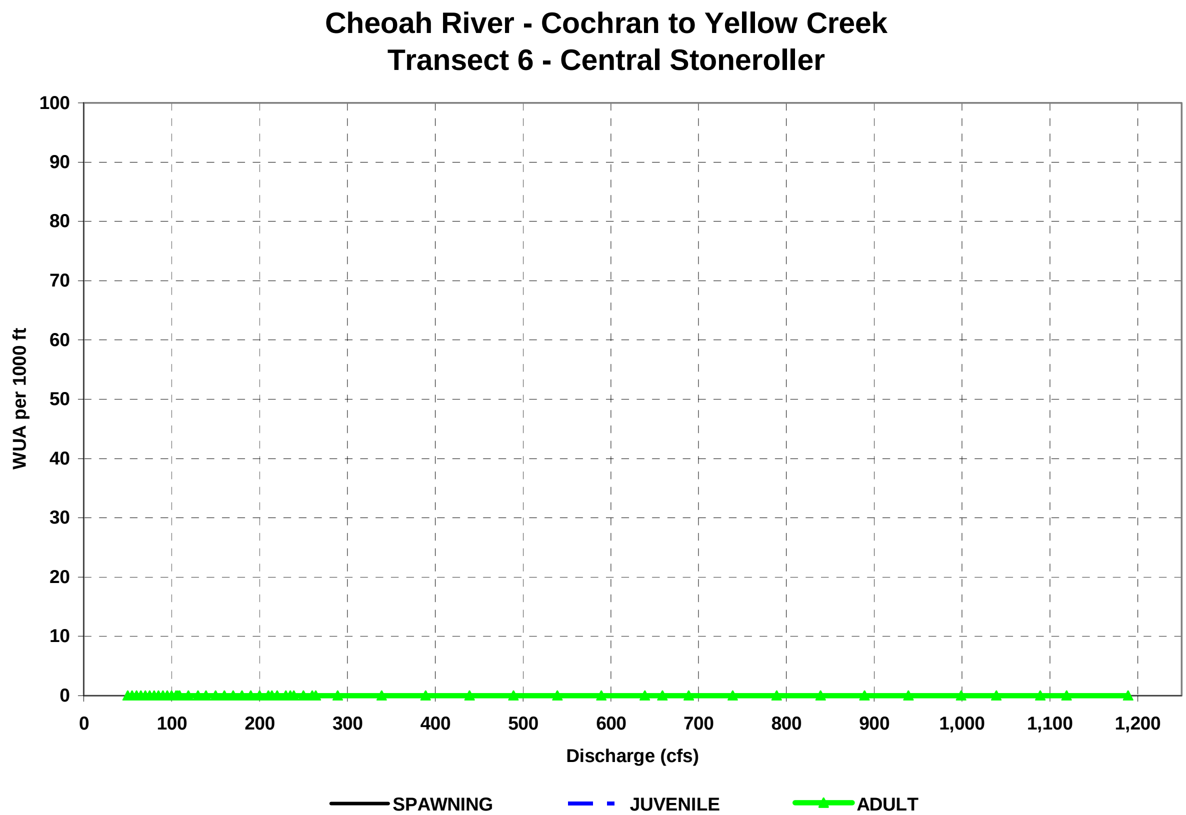

Cheoah River - Cochran to Yellow Creek
Transect 6 - Mottled Sculpin
30,000
25,000
20,000
15,000
10,000
5,000
0
WUA per 1000 ft
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE & ADULT

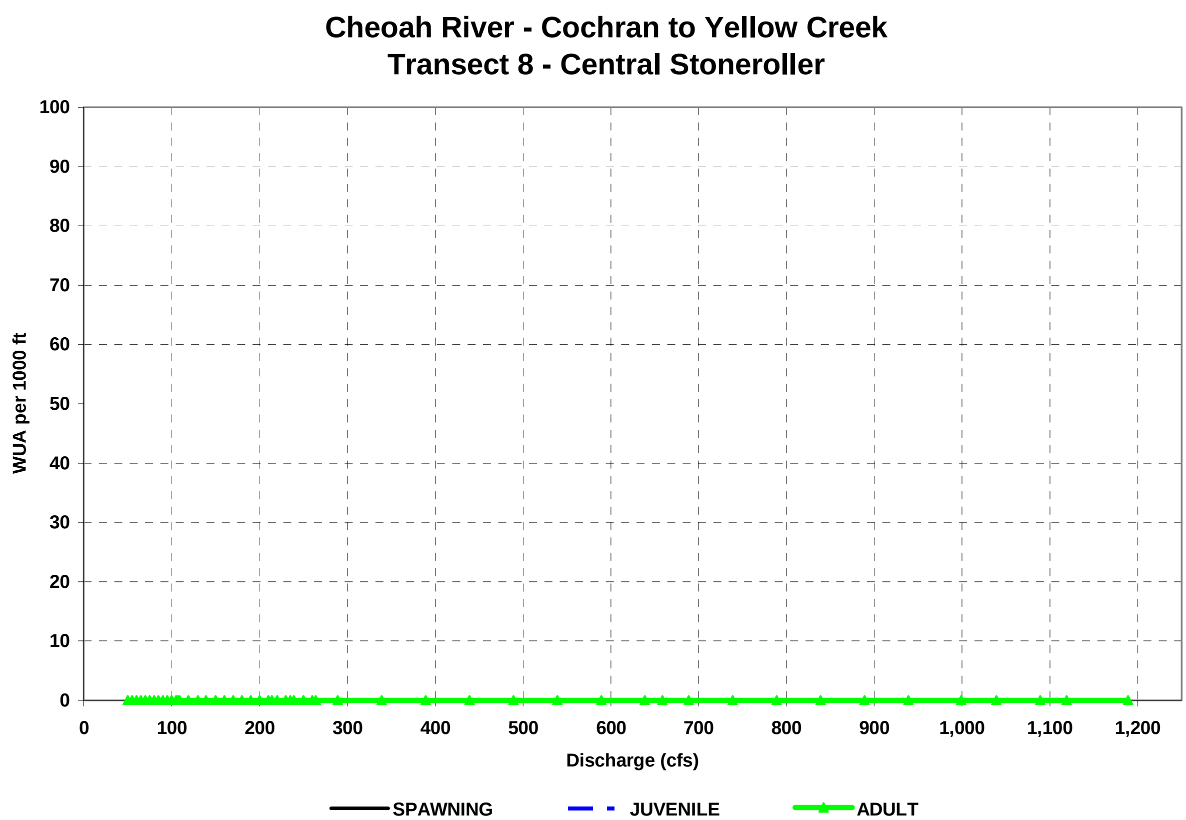

Cheoah River - Cochran to Yellow Creek
Transect 8 - Mottled Sculpin
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
WUA per 1000 ft
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE & ADULT

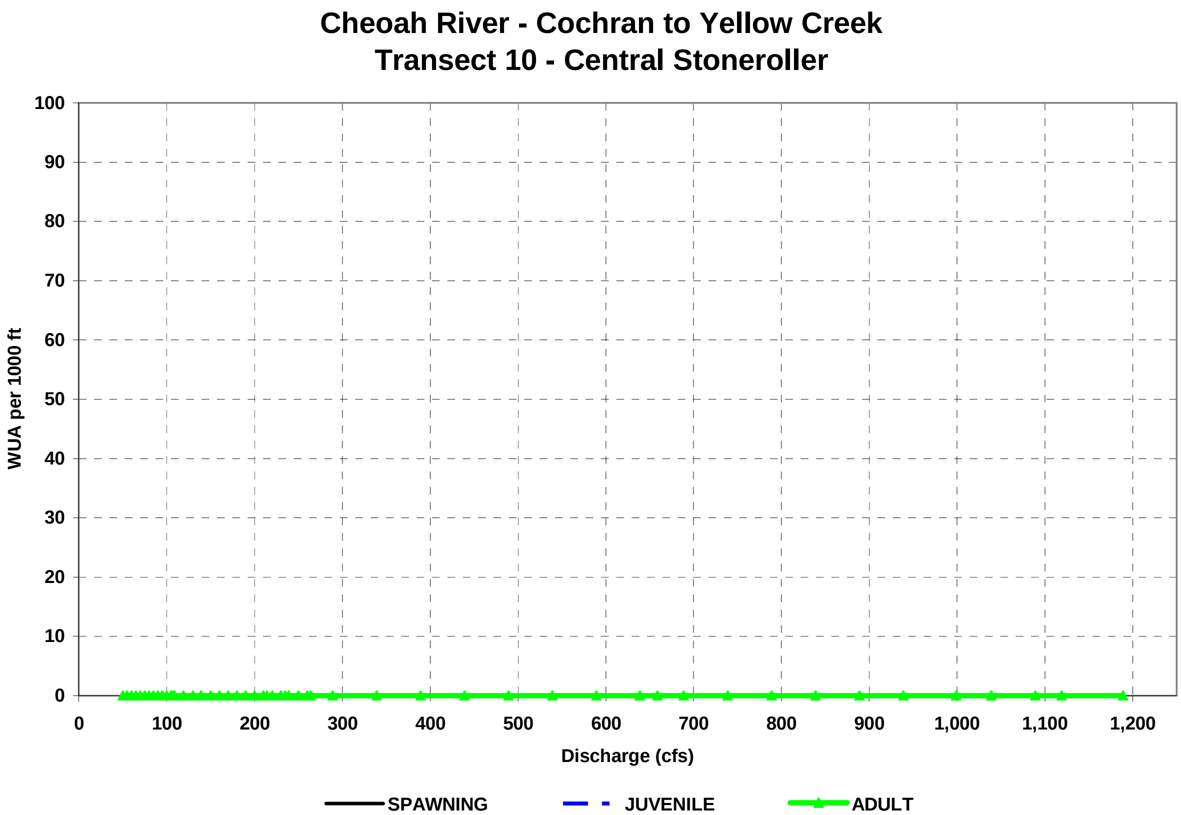

Cheoah River - Cochran to Yellow Creek
Transect 10 - Mottled Sculpin
WUA per 1000 ft
50,000
40,000
30,000
20,000
10,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE & ADULT

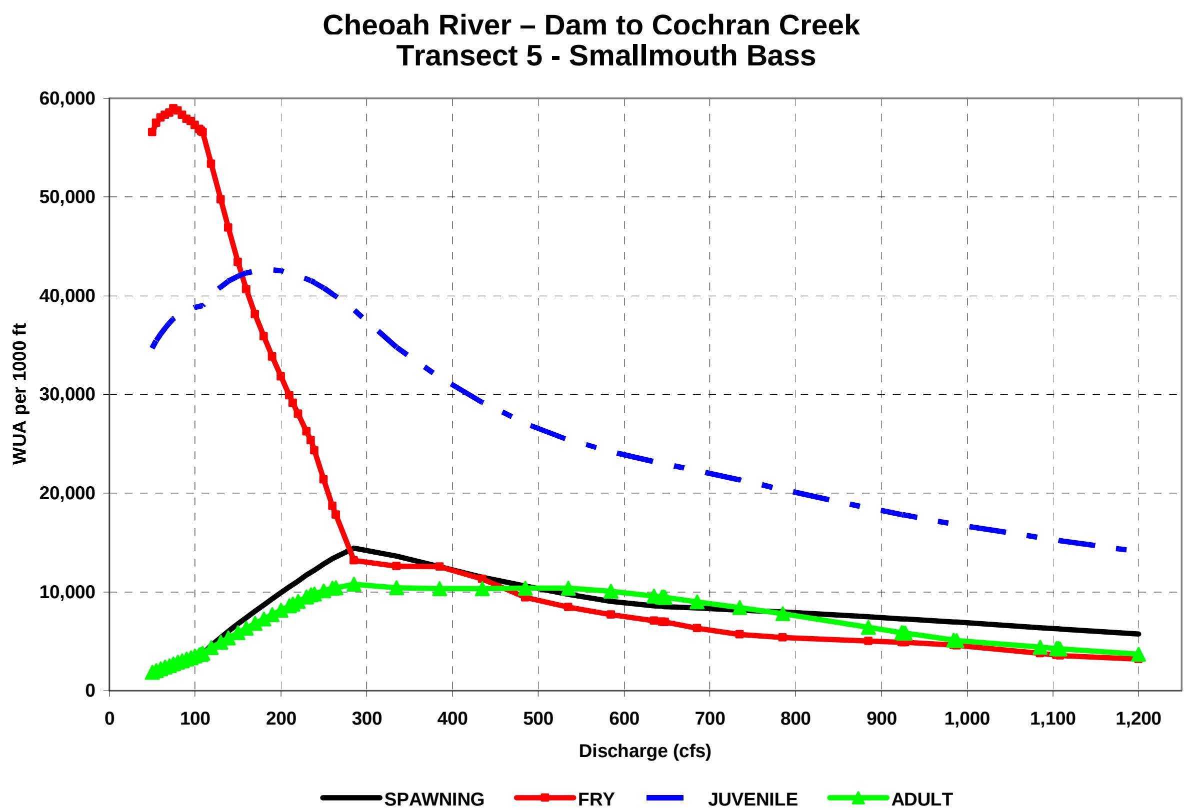

Cheoah River – Dam to Cochran Creek
Transect 5 - Central Stoneroller
WUA per 1000 ft
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
JUVENILE
ADULT

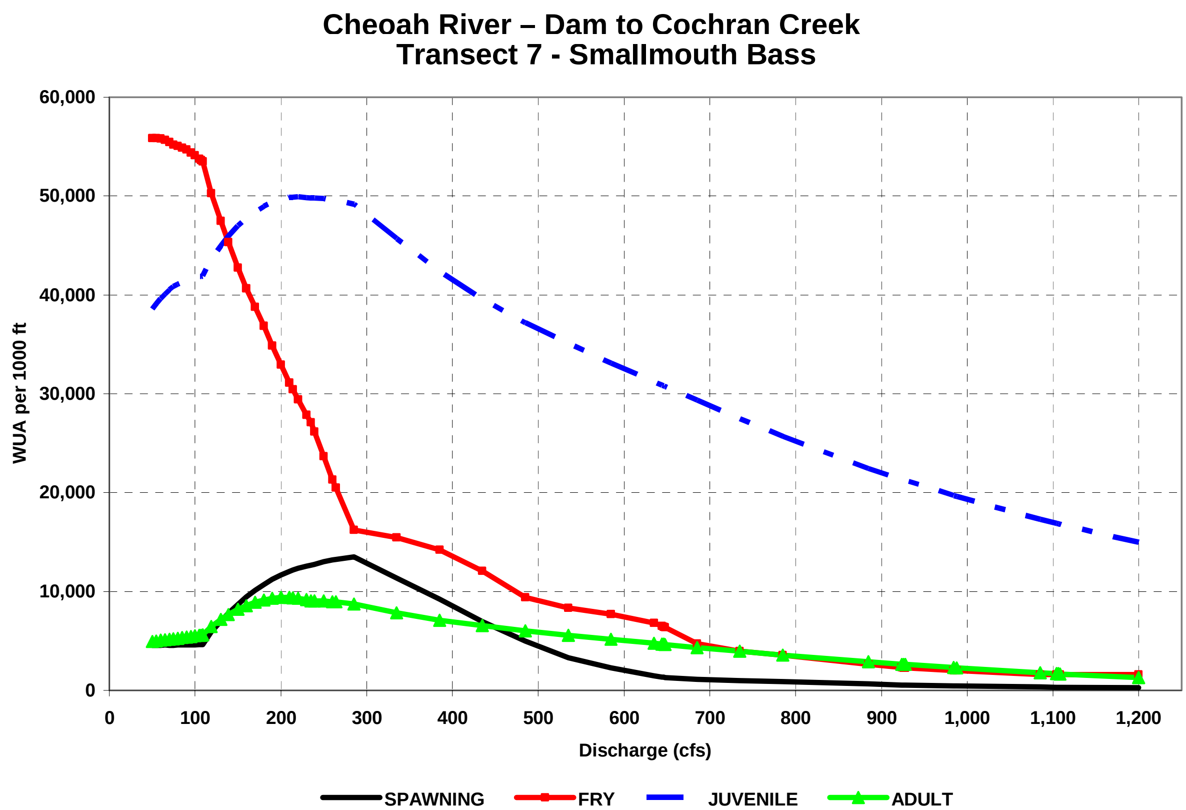

Cheoah River – Dam to Cochran Creek
Transect 7 - Central Stoneroller
WUA per 1000 ft
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
JUVENILE
ADULT

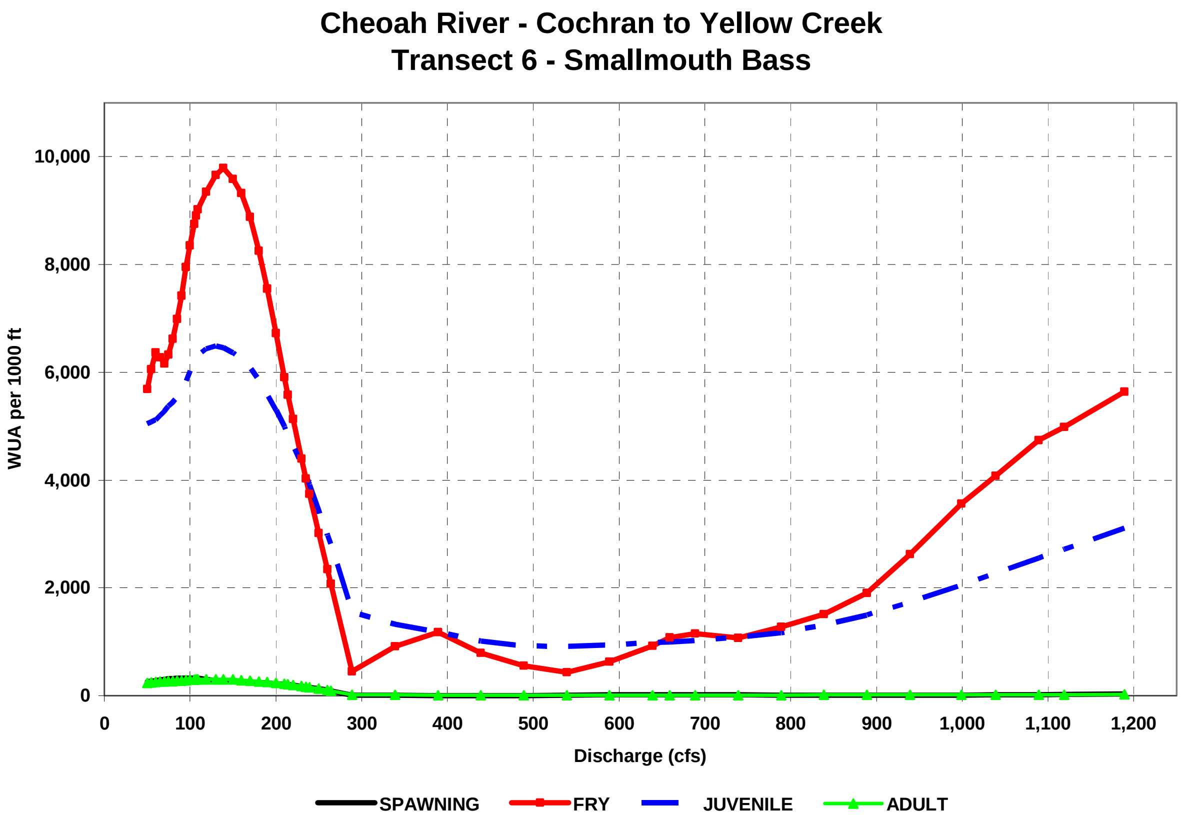

Cheoah River - Cochran to Yellow Creek
Transect 6 - Central Stoneroller
WUA per 1000 ft
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
JUVENILE
ADULT

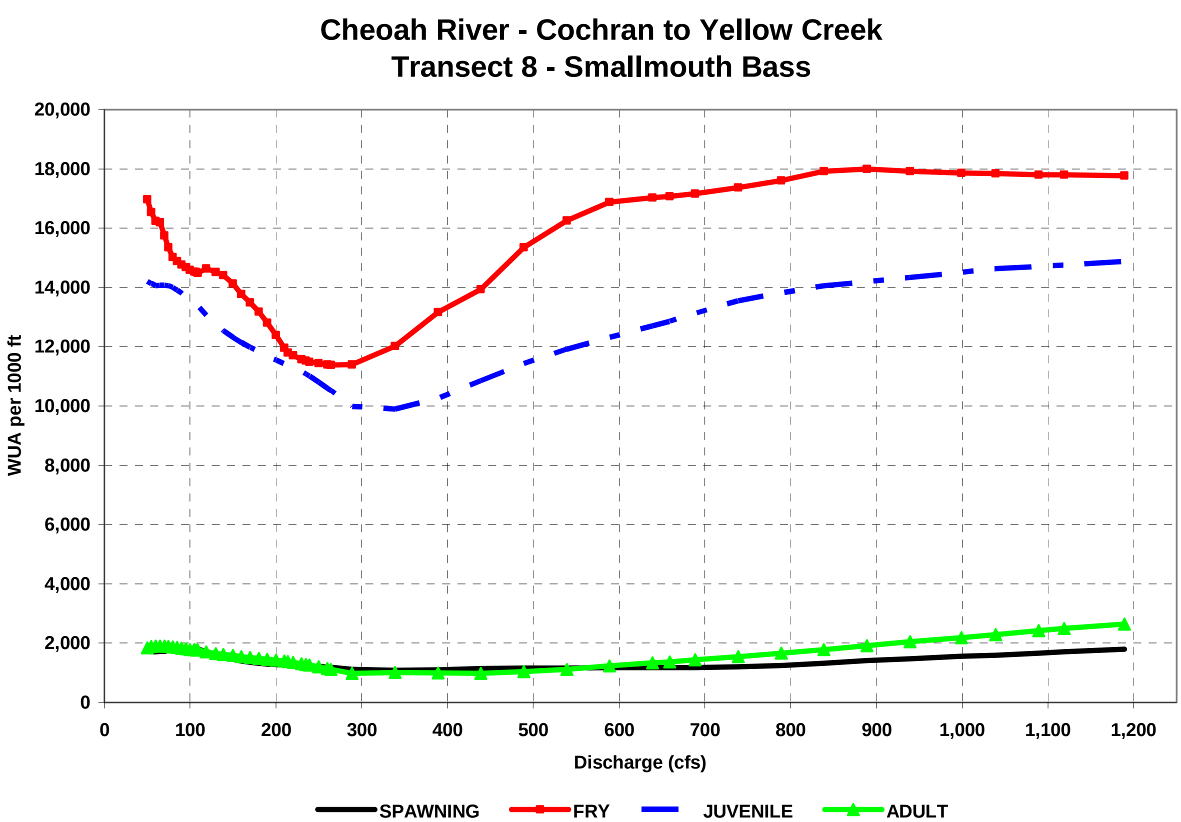

Cheoah River - Cochran to Yellow Creek
Transect 8 - Central Stoneroller
WUA per 1000 ft
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
JUVENILE
ADULT

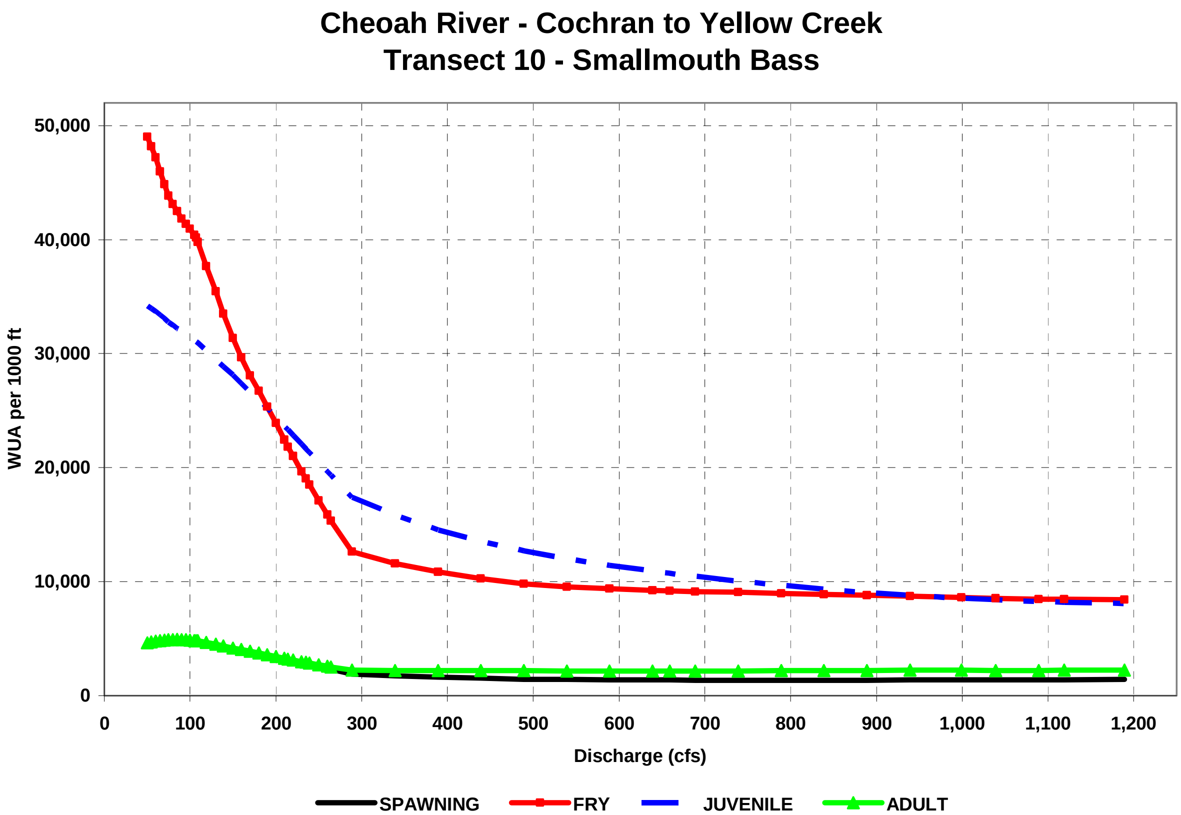

Cheoah River - Cochran to Yellow Creek
Transect 10 - Central Stoneroller
WUA per 1000 ft
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
JUVENILE
ADULT

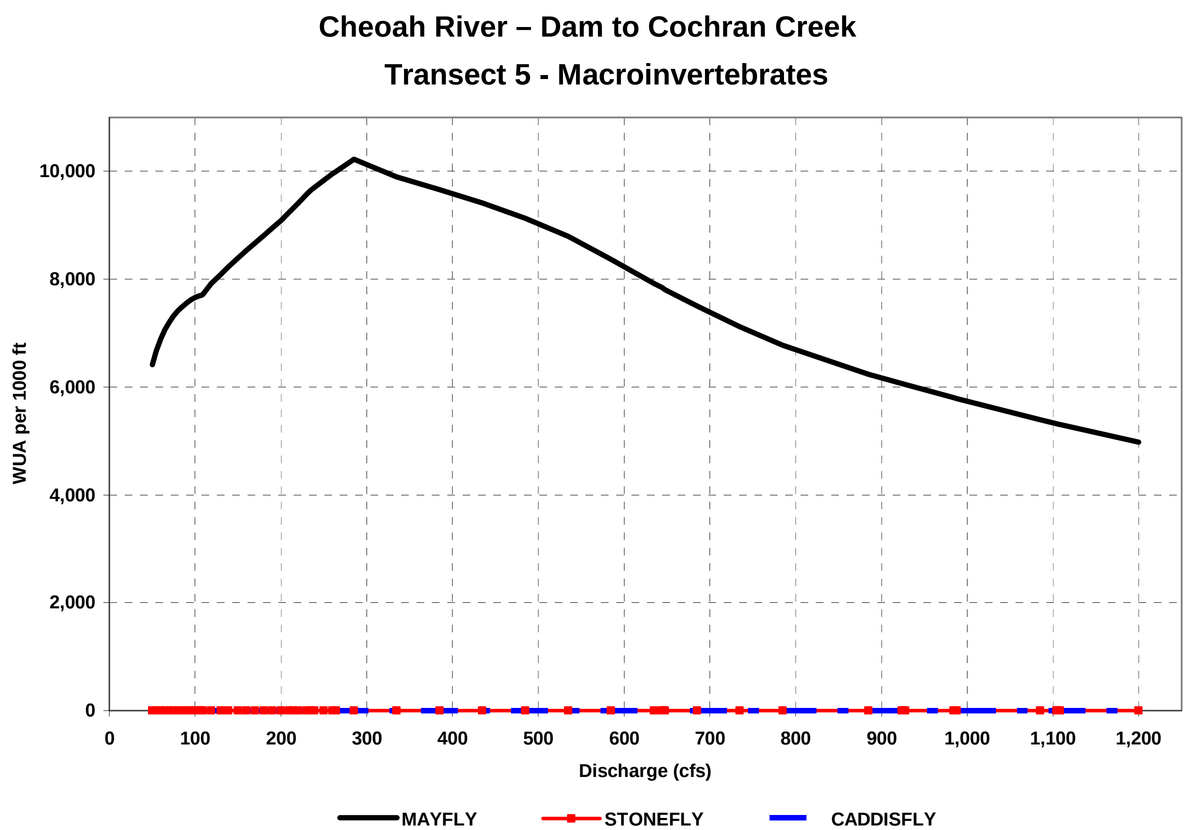

Cheoah River – Dam to Cochran Creek
Transect 5 - Smallmouth Bass
WUA per 1000 ft
60,000
50,000
40,000
30,000
20,000
10,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE
ADULT

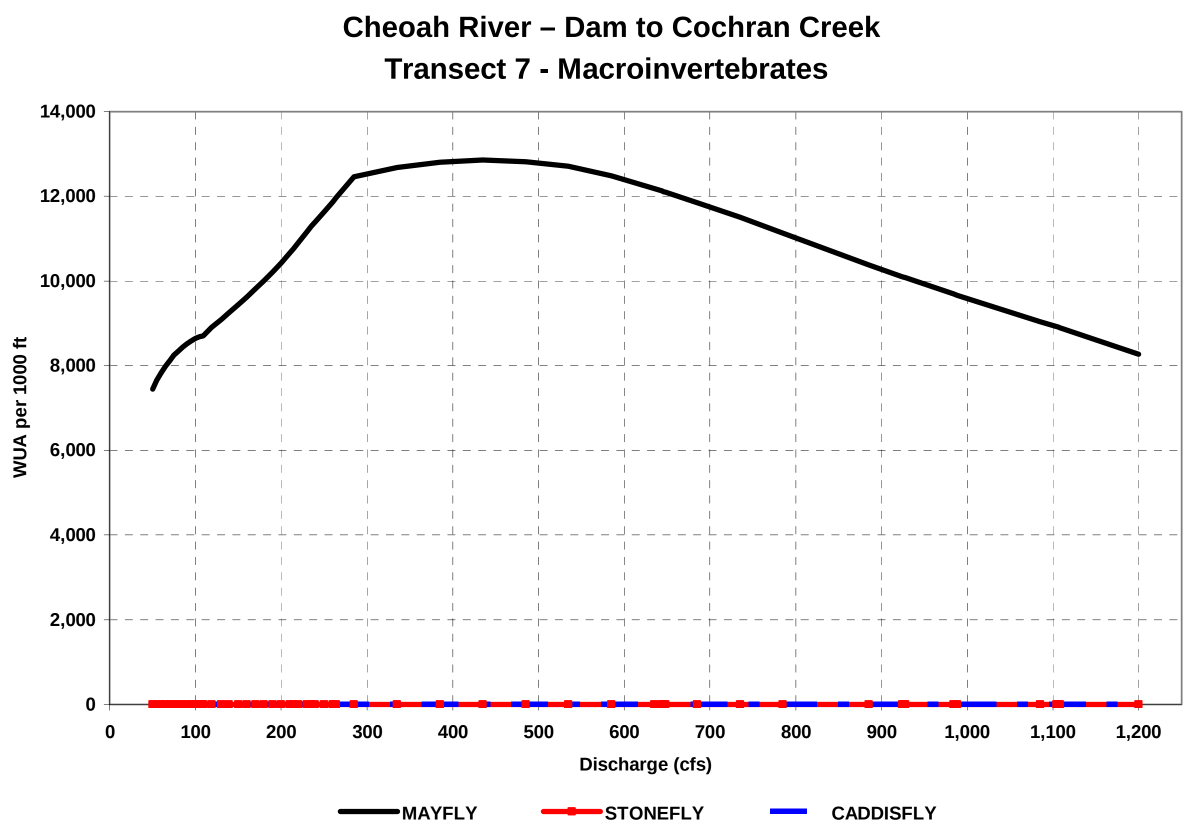

Cheoah River – Dam to Cochran Creek
Transect 7 - Smallmouth Bass
WUA per 1000 ft
60,000
50,000
40,000
30,000
20,000
10,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE
ADULT

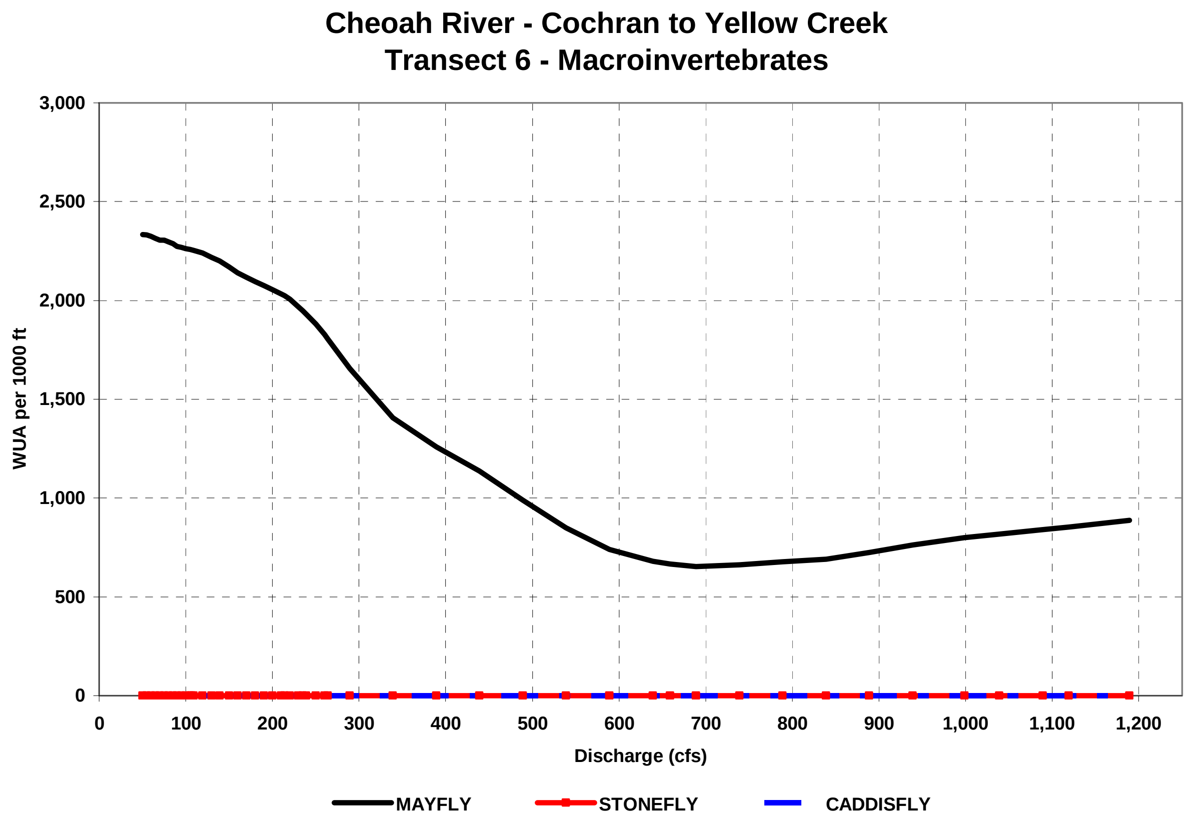

Cheoah River - Cochran to Yellow Creek
Transect 6 - Smallmouth Bass
WUA per 1000 ft
10,000
8,000
6,000
4,000
2,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE
ADULT

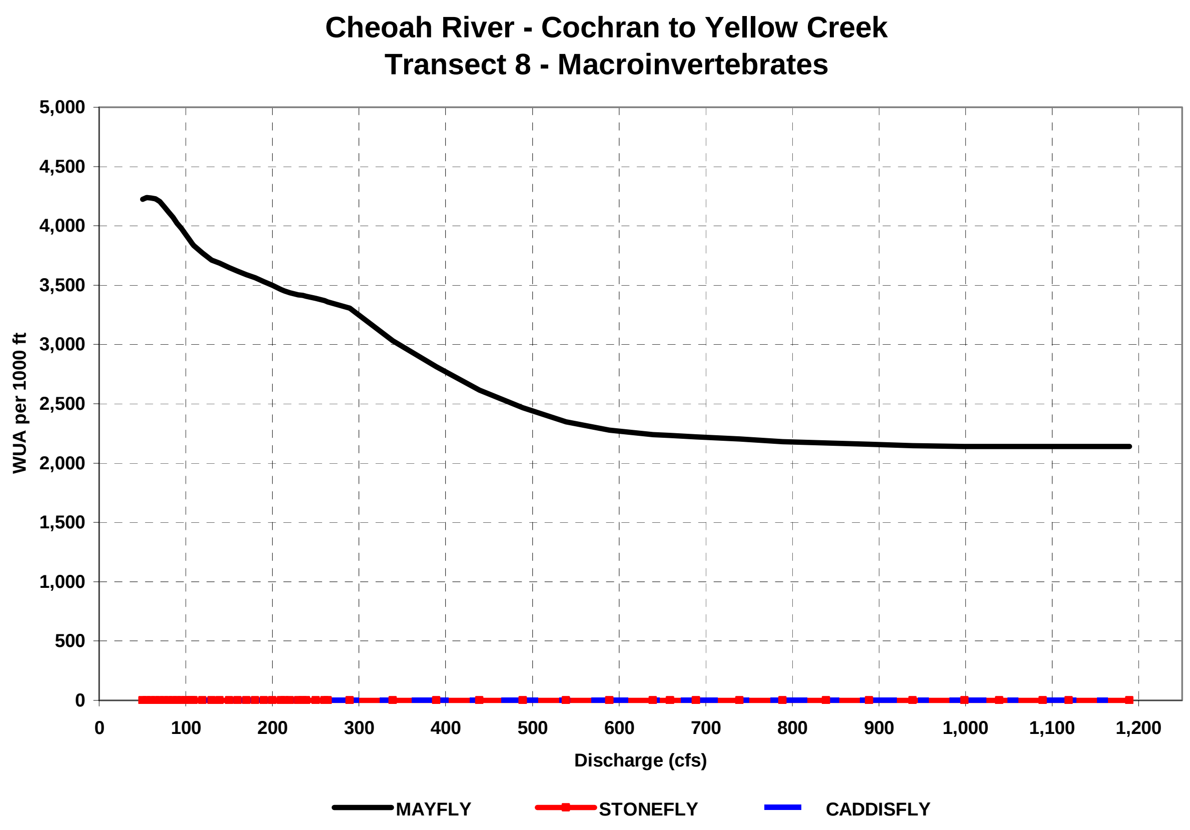

Cheoah River - Cochran to Yellow Creek
Transect 8 - Smallmouth Bass
WUA per 1000 ft
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE
ADULT

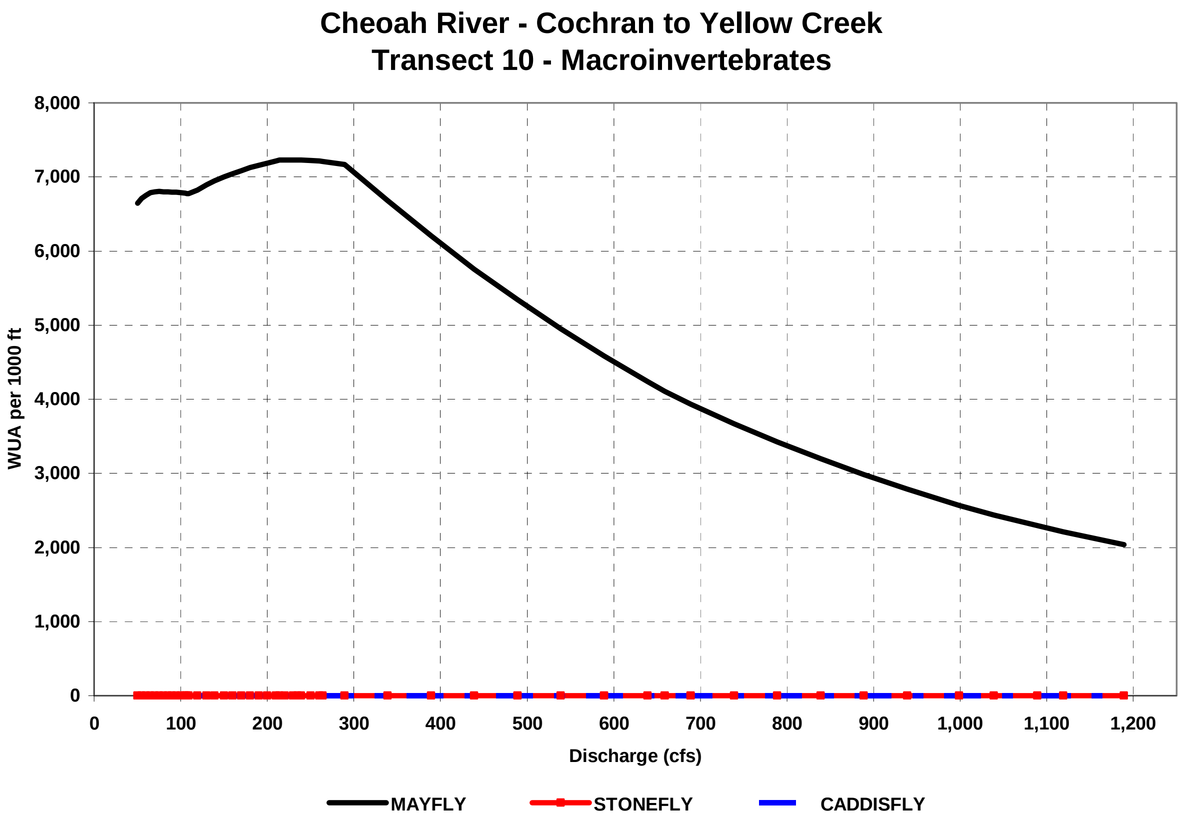

Cheoah River - Cochran to Yellow Creek
Transect 10 - Smallmouth Bass
WUA per 1000 ft
50,000
40,000
30,000
20,000
10,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
SPAWNING
FRY
JUVENILE
ADULT


Cheoah River – Dam to Cochran Creek
Transect 5 - Macroinvertebrates
WUA per 1000 ft
10,000
8,000
6,000
4,000
2,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
MAYFLY
STONEFLY
CADDISFLY


Cheoah River – Dam to Cochran Creek
Transect 7 - Macroinvertebrates
WUA per 1000 ft
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
MAYFLY
STONEFLY
CADDISFLY


Cheoah River - Cochran to Yellow Creek
Transect 6 - Macroinvertebrates
WUA per 1000 ft
3,000
2,500
2,000
1,500
1,000
500
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
MAYFLY
STONEFLY
CADDISFLY


Cheoah River - Cochran to Yellow Creek
Transect 8 - Macroinvertebrates
WUA per 1000 ft
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
MAYFLY
STONEFLY
CADDISFLY


Cheoah River - Cochran to Yellow Creek
Transect 10 - Macroinvertebrates
WUA per 1000 ft
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Discharge (cfs)
MAYFLY
STONEFLY
CADDISFLY

Document Content(s)

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