

**Survival of Rainbow Trout Fingerlings Stocked into the Special Regulation  
Zone of the Canyon Reservoir Tailrace**

by  
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## ABSTRACT

The Canyon Reservoir tailrace is a 22.2-km, hypolimnetic release tailrace trout fishery located below Canyon Reservoir on the Guadalupe River in Comal County, Texas. The section of the tailrace from 6.3 to 22.2 km has a 457-mm minimum length and one fish daily bag limit (rainbow and brown trout). Fingerling (62-130 mm) rainbow trout were stocked in the tailrace by the Texas Parks and Wildlife Department (TPWD) from 1996 to 2000. Rationale for these stockings was that fingerlings stocked in the tailrace special regulation zone would be protected from harvest and might grow to a quality size. If fingerling stockings were successful, a high quality catch-and-release fishery might develop, eliminating or decreasing the need to stock catchable size (203–304 mm) trout in this stretch of the tailrace. Catchable size trout stockings could then be concentrated at sites where harvest oriented fishing effort was high. In three of the five years stocked fingerlings oversummered, although almost all survival was in the first 6.3-km downstream from Canyon Dam. Beyond 6.3 km water temperature frequently exceeded recommended (< 21.1 C) and/or lethal levels (25 C), when flow from Canyon Reservoir was decreased during the summer months (May-October). Because of concerns with water temperature related mortality fingerling stockings were discontinued after 2000.

In May 2003, a water release contract between Guadalupe River Trout Unlimited (GRTU) and the Guadalupe River Blanco Authority (GBRA) was implemented with the specific objective of keeping water temperatures < 21.1 C in sections of the tailrace > 6.3 km downstream from the dam. Approximately ten thousand rainbow trout fingerlings (mean length = 135 mm) were tagged with blank micro wire tags and stocked in the special regulation zone during June 2005 to evaluate survival. Boat electrofishing surveys (2.42 hours effort/survey) were conducted from directly below Canyon Dam to approximately 17.2 km downstream once per month from August to November 2005 to collect tagged fingerlings. Backpack electrofishing was also conducted in August 2005.

No marked fingerlings were collected, although untagged rainbow trout were collected in all surveys. Similar to previous electrofishing surveys in the 1990's total catch rate decreased with successive collections. Water temperatures greater than recommended (21.1 C), but less than lethal (25 C) were recorded in the special regulation zone during the study period. Stress caused by elevated water temperature may have been a factor influencing mortality of stocked fingerlings and untagged trout. Based on results of this study the practice of stocking fingerlings for grow-out in the special regulation zone should be discontinued. Water temperature in 2005 and in previous years, from the outflow of Canyon Dam to 6.3-km downstream, almost always remains below 21.1 C. Stockings in this area may increase survival; however, trout in this area are not currently protected by a minimum length limit. Future studies focusing on increasing survival of stocked catchable size trout in the current special regulation zone should be explored.

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## INTRODUCTION

Tailrace trout fisheries are an important part of many state fisheries programs in the southern United States (Baker 1959, Fry and Hanson 1968, Axon 1975, Wiley and Dufek 1980). Hypolimnetic releases often keep water temperatures below optimal levels for endemic warmwater fish populations (Hickman and Hevel 1986, Ruane et al. 1986), making rainbow trout (*Oncorhynchus mykiss*) an acceptable replacement sport fish (Fry and Hanson 1968, Axon 1975, Hess 1980, Harper 1994). Tailrace trout fisheries can provide local economic benefits that greatly outweigh costs associated with stocking (Axon 1975, Forshage 1976, Weithman and Haas 1982, Choi et al. 1993, Harper 1994, Bradle et al. 2006) and provide diversified fishing opportunities.

Rainbow trout were first stocked in the Canyon Reservoir tailrace, a hypolimnetic reservoir release tailrace located in south-central Texas, in 1966 by the Texas Parks and Wildlife Department (TPWD) (White 1968). It is one of the most popular winter trout fisheries in Texas (TPWD, unpublished data) and catchable size (>203 mm) rainbow trout are stocked each winter (December - February) at public and Guadalupe River Trout Unlimited (GRTU) access sites. Harvest of the trout stocked at public access points with no minimum length limit can be high (83-91%) (Magnelia 2004).

Because of its location in south-central Texas, water temperatures in the tailrace during the summer (June through September) were thought to exceed lethal levels for rainbow trout. However, oversummer survival of trout (White 1968, Magnelia 2004) and acceptable growth (White 1968) sparked interest in developing a portion of the fishery into a put-grow-and-take section. On September 1, 1997 a 457-mm minimum length limit and one trout (rainbow and brown trout) daily bag limit was initiated in the section from 6.3 to 22.2 km downstream from the dam.

Trout harvested in this special regulation zone must be caught on an artificial lure, although anglers may fish with any bait type. Catchable size rainbow trout (N = 10,605) were stocked by TPWD and GRTU in this area from December 2004 to February 2005. In addition, TPWD stocked approximately 53,000 unmarked fingerlings (mean TL = 49 mm) in this area in March 2005 and 13,000 (mean TL = 76 mm) in April 2005.

Rainbow trout fingerlings (mean size range = 62-130 mm) were first introduced by TPWD into this section of the tailrace in 1996 (Magnelia 2004). This practice continued annually through 2000. Justification for these stockings was that fingerlings stocked in this section would be protected from harvest and might grow to a quality size. If fingerling stockings were successful, a high quality catch-and-release fishery might develop, eliminating or decreasing the need to stock catchable size (>203 mm) trout in this stretch. Stockings of catchable size trout could then be concentrated at sites where anglers were primarily interested in harvest. From 1996 to 2000, stocked fingerlings oversummered in the Canyon Reservoir Tailrace during three years, although almost all survival was in the first 6.3-km of the tailrace (Magnelia 2004). Downstream of 6.3 km water temperature frequently exceeded recommended (< 21.1 C) and/or lethal levels (25 C), when flow from Canyon Reservoir was decreased during the summer months (Magnelia 2004). Growth of fingerlings was documented in four of the five years stocked (Magnelia 2004). However, because of concerns with water temperature induced mortality, fingerling stockings were discontinued.

Elevated water temperature has limited the scope of other tailrace trout fisheries until adequate reservoir releases were made for maintaining suitable downstream water temperature. Axon (1974) reported water temperature in the White River below Bull Shoals Reservoir,

Arkansas was a factor limiting that rainbow trout fishery, until the U.S. Army Corp of Engineers (USACE) agreed to provide adequate flows for keeping water temperatures below 21.1 C. Similarly, the Oklahoma Department of Wildlife Conservation made reservoir release recommendations for maintaining downstream water temperature at or below 21.1 C on the Mountain Fork River below Broken Bow Reservoir (Harper 1994). Although 25 C is considered an upper lethal temperature for rainbow trout (United States Fish and Wildlife Service (USFWS) 1984), 21.1 C can be considered a maximum threshold water temperature for maintaining tailrace trout fisheries. In May 2003, a water release contract between GRTU and the Guadalupe Blanco River Authority (GBRA) was implemented with the specific objective of keeping water temperature below 21.1 C from May through September in sections of the tailrace greater than 6.3 km downstream. The stocking of fingerlings as a management tool was reinitiated under this new water release operating policy in 2005.

In 2003, water temperatures were <21.1 C in much of the special regulation zone throughout the summer (TPWD, unpublished data). Despite protection under an 457 mm minimum length limit, water temperatures below the maximum threshold, and a stocking of 17,000 catchable size rainbow trout (mean TL = 302 mm) the preceding winter, the October 2003 total electrofishing CPUE in the special regulation zone was disappointing (8.0/hour, effort = 1.75 hours). This catch rate was only slightly better than fall 2001 (prior to the GRTU/GBRA water release agreement) (5.6/hour, effort = 1.25 hours) when water temperature 17.1 km downstream exceeded 21.1 C from June through August and 25 C in August (Magnelia 2004) and 11,724 catchable size rainbow trout were stocked in the special regulation zone. In comparison, fingerling rainbow trout stocked in the Canyon Reservoir tailrace from April through June (1996-2000) were

electrofished in October through December at a mean CPUE of 42/hour in years when survival occurred (Magnelia 2004), although almost all fingerling were collected within 6.3 km downstream of the dam where water temperature almost always remains below 21.1 C (Magnelia 2004). Other factors besides harvest and water temperature induced mortality may be limiting density of stocked catchable size trout in the tailrace's special regulation zone.

On the Clinch River below Norris Reservoir, Tennessee annual survival rates for rainbow and brown trout (*Salmo trutta*) stocked as fingerlings were much higher (26-52% annual survival) than rainbow trout stocked as catchables (2-6% annual survival) (Bettoli and Bohm 1997). Poor survival of rainbow trout stocked as catchables suggested that the quality of the fishery was due to fingerling stockings (Bettinger and Bettoli 2002). In the Clinch River, few rainbow trout stocked as catchables were harvested or survived long enough to contribute to the fishery as holdover trout (Bettinger and Bettoli 2002). The authors attributed low survival of rainbow trout stocked as catchables to rapid, long-range movements and high levels of activity, which were energetically inefficient and probably rendered them more vulnerable to predation. They suggested that stocking catchable size trout in the Clinch River might only be cost effective at popular access areas where fishing pressure was high. Perhaps the low electrofishing catch rate of stocked catchable size trout encountered on the Canyon Reservoir Tailrace in 2003 was due to similar factors. Striped bass (*Morone saxatilis*) were present in the tailrace in low densities (Terre and Magnelia 1996) and probably preyed on stocked trout. Specific objectives of this study were to evaluate survival and growth for tagged rainbow trout fingerlings stocked in the special regulation zone of the Canyon Reservoir tailrace.

## METHODS

### Study Areas

#### **Canyon Reservoir**

Canyon Reservoir, a 3,335-ha flood control reservoir located in Comal County, Texas, was created in 1964 when the Guadalupe River was impounded. It is classified as an oligo-mesotrophic, hard water, deep storage, bottom draining reservoir (Hannan et al. 1979). Thermal stratification is normally present from May through November with anoxic conditions existing in the hypolimnion from July through November (Hannan and Young 1974).

#### **Canyon Reservoir Tailrace**

The Canyon Reservoir tailrace is a section of the Guadalupe River extending 22.2 km below the stilling basin of Canyon Reservoir. The lower boundary was set because it was assumed this would be the furthest distance downstream where oversummer survival of stocked trout might occur. A bridge at this point also provided a landmark for enforcement of fishing regulations. The tailrace was regulated under the statewide 5 trout daily bag limit (rainbow and brown trout) in any combination) and no minimum length limit regulation until September 1, 1997, at which time a 457-mm minimum length and one trout (rainbow and brown trout) daily bag limits were initiated in the stretch from 6.3 to 22.2 km below the dam. Trout harvested in this area must be caught on an artificial lure, although anglers may fish with any bait type.

Water from Canyon Reservoir is discharged from a fixed depth of 41 m below the surface, at a conservation pool elevation of 277 m msl. In 1989, a 6-megawatt hydropower plant constructed at the stilling basin by the GBRA became operational. Under the Federal Regulatory Energy Commission (FERC) hydropower permit, minimum outflow into the tailrace during non-drought periods was 2.5 m<sup>3</sup>/sec, but under drought conditions outflow may be reduced to reservoir inflow.

When the reservoir was in the flood pool the United States Army Corp of Engineers (USACE) dictated reservoir releases. Outflow rate when the reservoir was below conservation pool level was determined by inflow into the reservoir and downstream water rights (GBRA, personal communication).

A minimum dissolved oxygen level of 6 mg/l was also required as part of the FERC permit. This level of dissolved oxygen meets minimum standards for tailrace trout fisheries (Weithman and Haas 1984). Meeting requirements of the FERC permit was mandatory only when the reservoir was below conservation pool and water releases were regulated by GBRA.

Lethal hydrogen sulfide levels ( $> 0.025$  mg/L for trout, Environmental Protection Agency (EPA) 1976) are often present at the outflow from Canyon Dam from July through October (TPWD, unpublished data). In September 1997 when hydrogen sulfide was measured in downstream areas it was non-detectable 1.6-km downstream (TPWD, unpublished data). Water temperature at the discharge during this period was high compared to other years (Magnelia 2004), which probably decreased the length of the plume as aqueous solubility of hydrogen sulfide gas decreases with increasing temperature (Morel and Herring 1993). How this plume changes in response to flow and water temperature, and affects the distribution, mortality or movement of trout in the tailrace is unknown.

Beginning in January 2003 Canyon Reservoir releases when the reservoir was below conservation pool from May through September were set according to a contractual agreement between GRTU and GBRA. However, this agreement was only in effect if Canyon Reservoir reached conservation pool elevation for any length of time prior to that day during the period between January 1 and September 30 of that year. Minimum reservoir releases were; May 1-15 ( $3.96 \text{ m}^3/\text{sec}$ ),

May 16-31 (4.81 m<sup>3</sup>/sec), June 1-14 (5.95 m<sup>3</sup>/sec), June 15-30 (6.80 m<sup>3</sup>/sec), July 1-31 (5.66 m<sup>3</sup>/sec), August 1-31 (5.66 m<sup>3</sup>/sec), September 1-30 (5.66 m<sup>3</sup>/sec). These releases were recommended to maintain water temperatures below 21.1 C in sections of the tailrace greater than 6.3 km from the outflow.

### **Water Temperature and Flow**

ONSET<sup>TM</sup> water temperature loggers were deployed at 1.0, 6.3, 11.7, 17.1 and 22.2 km downstream of Canyon Dam (Figure 1). Water temperature was recorded every 30 minutes. Water temperature loggers were deployed attached to the inside of a 305-mm length of 76-mm diameter plastic pipe with 8-10, 18-mm holes. Each end of the pipe was closed using 76-mm plastic end-cap grates. A 1.8-kg lead weight was attached to the lower end of the pipe to anchor it. Pipe and logger were chained and locked to suitable anchor points in an area of good flow.

Release rate (m<sup>3</sup>/s) at Canyon Dam was provided by the USACE. Release rate was reported once per hour.

### **Fingerling Tagging and Stocking**

On June 20, 2005 rainbow trout fingerlings purchased from Crystal Lake Fisheries Inc. Ava, Missouri were transported by truck to the A.E. Wood State Fish Hatchery in San Marcos, TX. Upon arrival, fingerlings were placed in chilled water (18 C) circular flow through holding tanks and a subsample (N=200) was measured (mean length = 135 mm, STD = 9 mm). On June 21 and 22 fingerlings were removed from the tanks with a dip net (20-30 per net), anaesthetized with a buffered 15 mg/L tricaine solution and tagged (N = 10,697) with Northwest Marine Technology blank wire micro-tags. Tags were injected into the snout area using a Northwest Marine Technology rainbow trout head mold and automatic tag injector. Dissolved oxygen in the tricaine solution was monitored throughout the tagging process and a new solution was made when dissolved oxygen fell below 6

mg/l. Presence of tags immediately after tagging was verified using a Northwest Marine Technology Tunnel Detector Quality Control Device. After being tagged, individuals were immediately placed in a recovery tank. When tagging operations ceased for the day fingerlings ( $N = 300$ ) were checked for tags using a Northwest Marine Technology Handheld Wand Detector. At the end of each tagging day tagged fish were loaded into a 2.7 kL fish hauling unit and transported approximately 30-40 minutes to stocking sites on the Canyon Reservoir tailrace (Figure 1). Appropriate water quality was maintained as fingerlings were transported. All stocking sites were located  $> 6.3$  km downstream from the outflow in the special regulation zone of the Canyon Reservoir tailrace (Figure 1). Over a two day period 10,597 tagged fingerlings were stocked at 9 sites (approximately 1,100 to 1,200/site). Where practical fingerlings were stocked directly off the bank at the access site. At remote locations fingerlings were boat stocked. Boat stocked fingerlings were netted from the hauling unit into 95 L round containers approximately half full of river water. Compressed oxygen was bubbled into each container in the boat using a commercial grade oxygen diffuser en route to the stocking site. Upon reaching the stocking location fingerlings were poured directly from the container.

To verify 30 day tag retention, tagged fingerlings ( $N = 106$ ) were held for 32 days in a chilled ( $< 21.1$  C) water circular tank at the A.E. Wood State Fish Hatchery. If wire micro tags are shed, they do so by 30 days post-stocking (Northwest Marine Technology, personal communication). At the end of the 32 day period these fingerlings were checked for tags using a Northwest Marine Technology Handheld Wand Detector. Fish held at the hatchery were monitored daily by fish hatchery personnel and fed a maintenance diet. Surface water temperature, dissolved oxygen and pH were checked on 23 of the 32 days. Individuals which died before the end of the 32 day period were removed from the tank and frozen.

### **Recapture of Tagged Fingerlings**

From August to November 2005 electrofishing surveys were conducted once per month to collect marked fingerlings. Twenty-nine fixed sites (5 minutes electrofishing effort/site, total effort = 2.42 hours) were boat electrofished on each survey using a Smith Root™ model GPP 15 pulsator (Figure 1). High voltage and low amperage (approximately 4-6 amps) 15 hz pulsed direct current (DC) was used. Pulsed DC electrofishing has been found to cause spinal injuries (Sharber and Carothers 1988, Reynolds and Kolz 1988, Holmes et al. 1990, Taube 1992) and mortality (Taube 1992) in rainbow trout. Electrofishing-induced mortality of marked fingerling could bias estimates of survival, growth (Gatz et al. 1986, Dalby et al. 1996, Ainslie et al 1998) and body condition (Thompson et al. 1997). However, using direct current with pulse rates of 30 or less (low pulse DC) are thought to reduce the overall injury rate (Sharber et al. 1994). A pulse rate of 7.5 pulses per second (pps) direct current (DC) has been found to decrease electrofishing induced mortality when compared to continuous DC and other pulse DC frequencies (Henry 2002), however when that pulse rate was used in this study it was ineffective at stunning trout. Pulsator settings were held constant between collections. Additional electrofishing pulse frequencies (30-60 pps) were used at each site in the last (November) survey after it was first electrofished with 15 pps. This was done to verify that the pulse rate was not a factor in the non-collection of tagged fingerling. Electrofishing sites were located from directly below the Canyon Dam hydropower plant to approximately 17.2 km downstream (Figure 1). No sites were electrofished further downstream than 17.2 km because there was no suitable access for launching a boat. Sites inaccessible to boat electrofishing in the first 17.2 km were sampled in the August 2005 survey using a Smith Root™ model 12-A POW backpack electrofisher (Total effort = 1.2 hour) (Figure 1). Backpack electrofishing was discontinued after this

survey as no tagged fingerlings were collected (i.e. no more effective than boat electrofishing).

Backpack pulse settings were the same as those used in the boat electrofisher. Captured trout were placed in an aerated livewell (boat electrofishing) or placed in a bucket with river water (backpack electrofishing), checked for tags using the handheld wand detector, measured (TL, mm), weighed (gm) and released. Water temperature and dissolved oxygen were recorded at each station.

## RESULTS AND DISCUSSION

### **Water Temperature and Flow**

Water temperature exceeded 21.1C at all water temperature stations except at the station closest to the dam (1-km) (Figure 2). Reservoir outflow remained at or above values set in the GRTU/GBRA flow agreement until October 1 and then remained above 3.13 m<sup>3</sup>/s throughout the remainder of the study period (Figure 2). These flows maintained water temperature very near 21.1 C as far as 6.3-km, but were not adequate for maintaining temperatures less than 21.1 C in areas further downstream (Figure 2).

### **Tag Retention**

Of the fingerlings tagged 97.7% (293 of 300 checked) had retained tags when they were placed in the hatchery hauling unit. Of the fingerlings held at the hatchery, after 32 days all (N=106) had retained tags, but 52% had perished. Between days 26 and 32 hatchery staff collected 55 dead fingerlings. Mortality may have been the result of stress caused by a temperature spike on day 9 when an afternoon surface water temperature of 32.3 C was recorded. Temperature below the surface must have been cooler, as this temperature far exceeded the lethal level of 25 C. This was a short term event as surface water temperature 24-hours before was 18.9 C (Day 8) and had

cooled to 19.6 C by the afternoon of day 10. Tag retention at 30-days for similarly micro tagged rainbow trout fingerlings (mean TL range = 148-155 mm) stocked in the Clinch River, Tennessee was 86 to 89% (Bettoli and Bohm 1997).

### **Recapture of Tagged Fingerlings**

No tagged fingerlings were recovered using either boat or backpack electrofishing. The inability to collect marked fingerlings is puzzling since they should have been large enough to be sampled with boat electrofishing gear. On the Clinch River tailrace trout fishery in Tennessee both rainbow and brown trout recruited to boat electrofishing gear at 100 mm although 60 pps electrofishing was used in all surveys (Bettoli and Bohm 1997). Fingerlings stocked in this study (mean length = 135 mm) exceeded that length. Water temperatures during the study period exceeding 21.1 C were recorded at the two temperature monitoring sites in the special regulation area (Figure 2). Although water temperature at these sites never reached lethal temperature (25 C), stress from tagging and stocking, and additional stress from water temperatures above 21.1 C may have induced mortality. Specific mortality rates (percent per day) of juvenile rainbow trout (mean length = 30.2 mm) acclimated at 16 C and exposed to water temperature fluctuating 3.8 C around a daily mean of 21 C ranged from 11.5 to 21.5 percent over a ten day period (Hokanson et al. 1977). Mean water temperature on the two stocking days at the 11.7-km temperature monitoring station was 19.4 C. Mean water temperature from the day of stocking (June 21, 2006) through September at the temperature monitoring station 11.7-km downstream (approximate middle of the special regulation zone) of the Canyon Dam outflow was 20.8 C (SD = 1.3 C). Forty-eight percent of the fingerlings held at the A.E. Wood Fish Hatchery were alive at 30 days post stocking. Except for the temperature spike previously mentioned water temperature in the

tank remained below 21.3 C.

### **Capture of Untagged Trout**

Untagged trout were collected in all surveys (Figure 3) and indications are that mortality substantially reduced their numbers during the study period. These were larger individuals (mean length = 387.5 mm, STD = 53.1 mm) than stocked tagged fingerlings, with 14% exceeding the 457 mm minimum length limit. Total electrofishing catch rate of untagged trout decreased with each electrofishing survey (Table 1) decreasing to only 1.6/hour in November 2005. Similarly, total electrofishing catch rate decreased between June and October electrofishing surveys in 1993 and 1994 (Magnelia 2004). Mortality from water temperature above 21.1 C, harvest or predation may have singularly or in combination been responsible for this decrease. A July through September 1994 creel survey documented no harvest or catch of trout, although anglers seeking trout were interviewed (Magnelia 2004). Striped bass have been implicated as potential predators of stocked trout on tailrace trout fisheries (Bettoli 2000). Large (mean length = 742 mm) striped bass were collected on three of the four electrofishing surveys, but catch rate was extremely low (CPUE = 1.7/hour, Effort = 9.7 hours, N = 16, ). One striped bass was collected with a 457 mm rainbow trout in its esophagus. However, almost all striped bass (81%) were found at electrofishing sites 15 and 16 (Figure 1), directly below a low water dam, and 50% (N = 4) of the striped bass collected in the October and November surveys were recaptures (marked with a fin clip) from previous surveys. This indicated the population was concentrated in one area and population density was extremely low.

## CONCLUSIONS

The stocking of fingerlings for grow-out in the special regulation zone of the Canyon Reservoir tailrace should be discontinued. While larger untagged trout were collected throughout the study it appears conditions were not suitable for sustaining fingerlings in this area. Decreased electrofishing catch of unmarked trout through time during this study was similar to preceding studies (Magnelia 2004) indicating mortality or harvest is decreasing population density by October/November. Specific factors causing mortality are unknown, but may be related to ongoing stress caused by water temperatures above 21.1 C. A paucity of invertebrate food items in the Tailrace (Halloran and Arsuffi 2000) may also be responsible for mortality. While the GBRA/GRTU agreement was put in place to provide water temperature less than 21.1 C, water temperatures in 2005 still exceeded this level in the special regulation zone. Previous experiences with fingerlings stocked in the Canyon Reservoir Tailrace (1996, 1999 and 2000) met with some success, however these fish were collected within 6.3 km of the outflow where water temperature generally remains below 21.1 C when outflow and stratification in the reservoir are adequate (Magnelia 2004). Fingerlings stocked in this area would not be protected by harvest restrictions and would likely be harvested if caught. Results of a creel survey conducted in 1993/94 indicated most (82.8%) of the catchable size trout stocked at a site directly below Canyon Dam were harvested almost immediately (Magnelia 2004). Future studies should concentrate on determining factors responsible for mortality of stocked catchable size trout in the special regulation zone. If no other factor except water temperature can be identified, angler opinion information should be gathered regarding movement of the upstream boundary of the special regulation zone closer to Canyon Dam where water temperature almost always remains below 21.1 C. Survival in this area,

with adequate harvest protection, might be higher.

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Table 1. Sample dates, total boat electrofishing effort (hours), electrofishing site<sup>a</sup>, number of trout caught-per-site and total catch rate (fish/hour) for rainbow trout, Canyon Reservoir tailrace, August to November 2005.

Date	Site <sup>a</sup>																													Fish/hour	
	Effort (hrs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		29
8/4/05	2.42	0	0	0	2	0	6	1	2	1	3	0	0	7	4	1	0	13	1	0	0	0	1	0	0	0	1	3	4	0	20.6
9/8/05	2.42	0	0	0	2	0	1	0	2	1	2	0	0	0	2	0	1	4	1	0	0	0	1	0	3	1	0	0	4	0	10.3
10/17/05	2.42	0	0	0	0	0	0	0	0	1	3	1	1	0	0	0	3	3	1	0	0	0	0	0	2	0	0	0	0	0	6.2
11/17/05	2.42	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1.6
Total	9.68	0	0	0	5	0	7	1	4	3	8	1	2	7	6	1	4	22	3	0	0	0	2	0	5	1	1	3	8	0	9.7

<sup>a</sup> Electrofishing sites are identified in Figure 1. Sites were numbered sequentially starting closest to Canyon Dam and moving downstream. Sites 7 through 29 were located in the Special Regulation Zone.

Figure 1. Location of water temperature monitoring, electrofishing and tagged fingerlings stocking sites, June to November 2005, Canyon Reservoir tailrace, Comal County, Texas. Because backpack electrofishing sites were in close proximity to each other the number of stations is noted. Boat electrofishing sites were numbered sequentially in descending order starting at Canyon Reservoir Dam. Map is to scale.

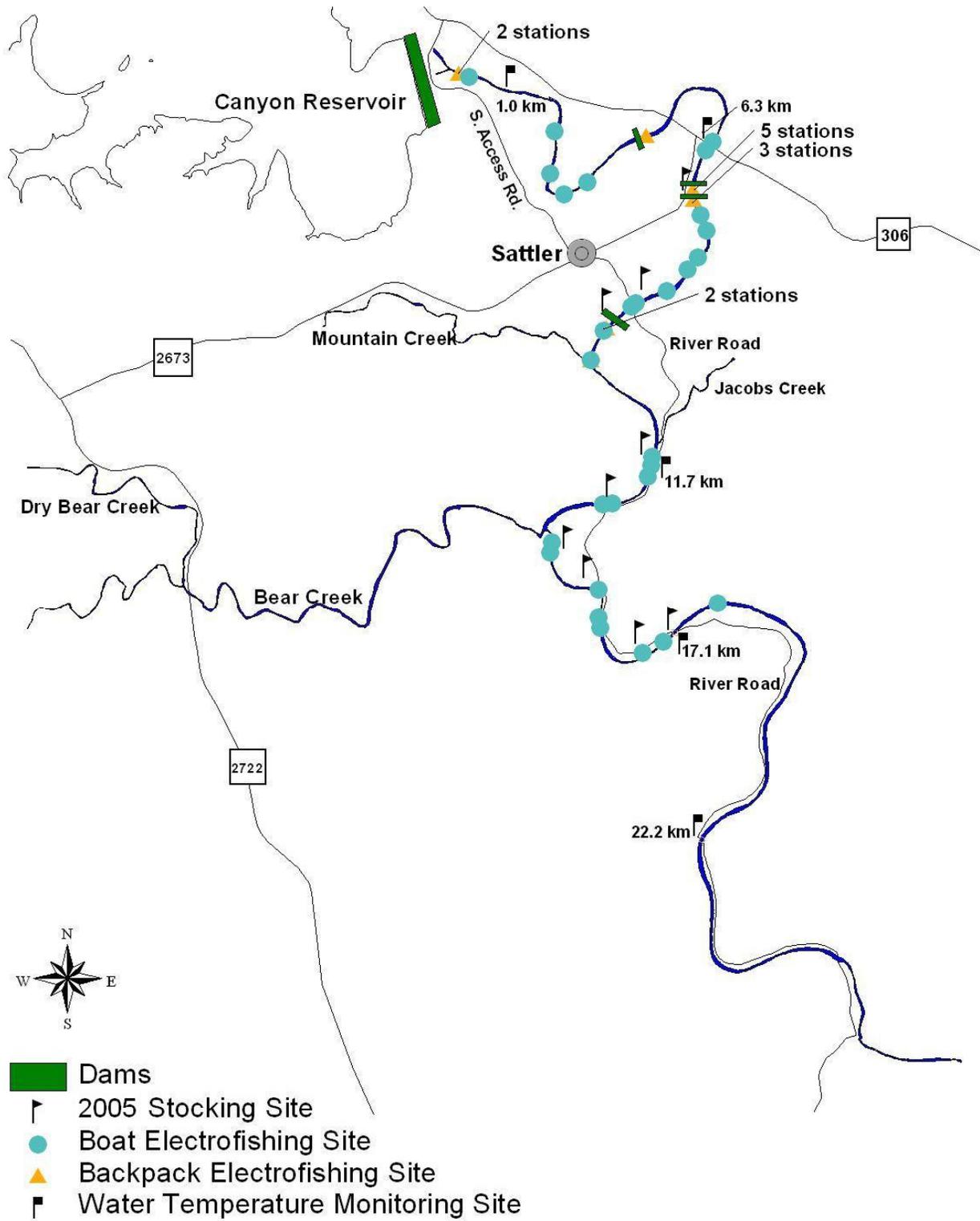


Figure 2. Water temperature 1.0 km, , 6.3 km, 11.7 km, 17.1 km and 22.2 km downstream from the outflow of Canyon Reservoir, Texas, June through November 2005. Flow rate was recorded by the USACE at Canyon Dam. Horizontal line represents 21.1 C, the maximum recommended for tailrace trout fisheries (Axon 1975, Harper 1994).

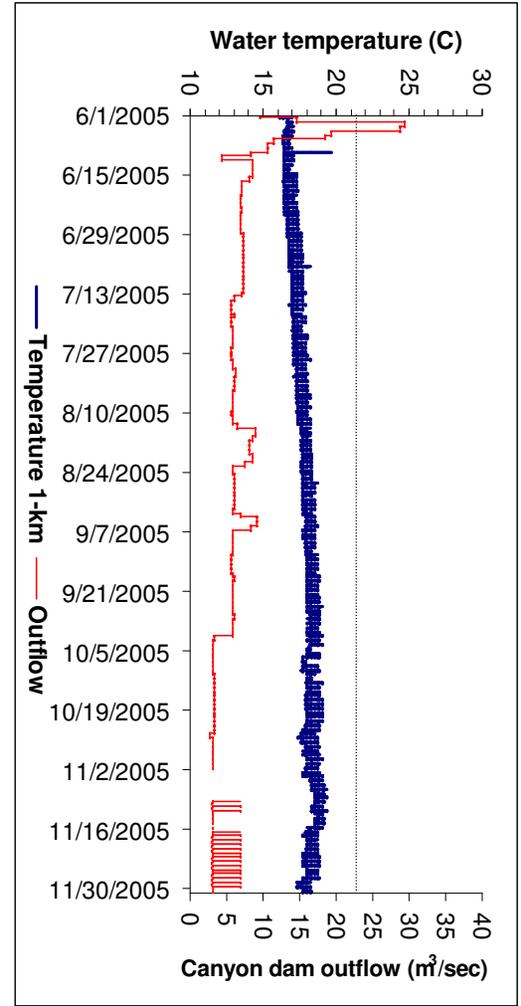
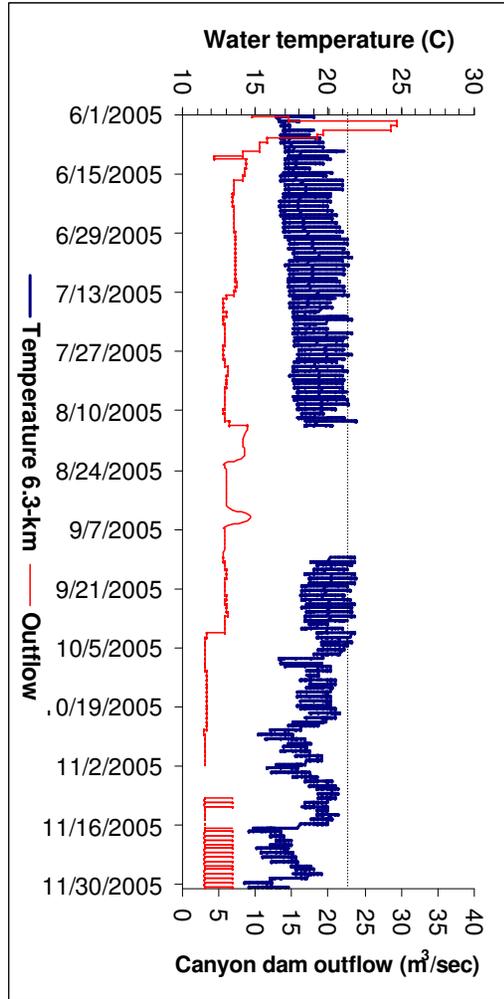
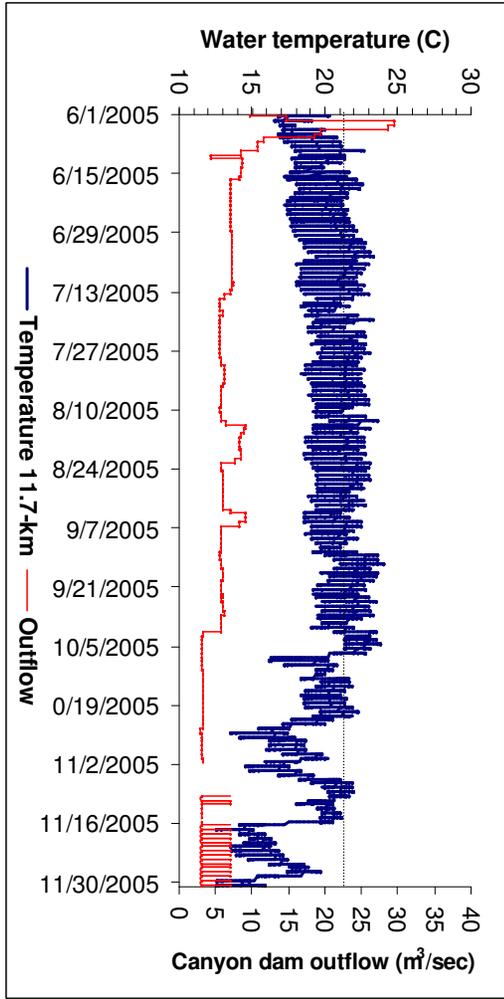


Figure 2. Continued

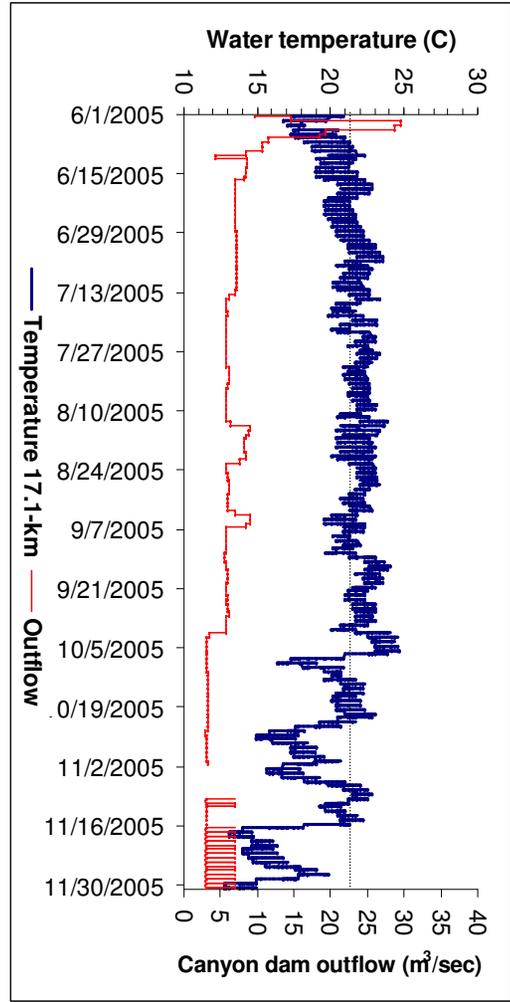
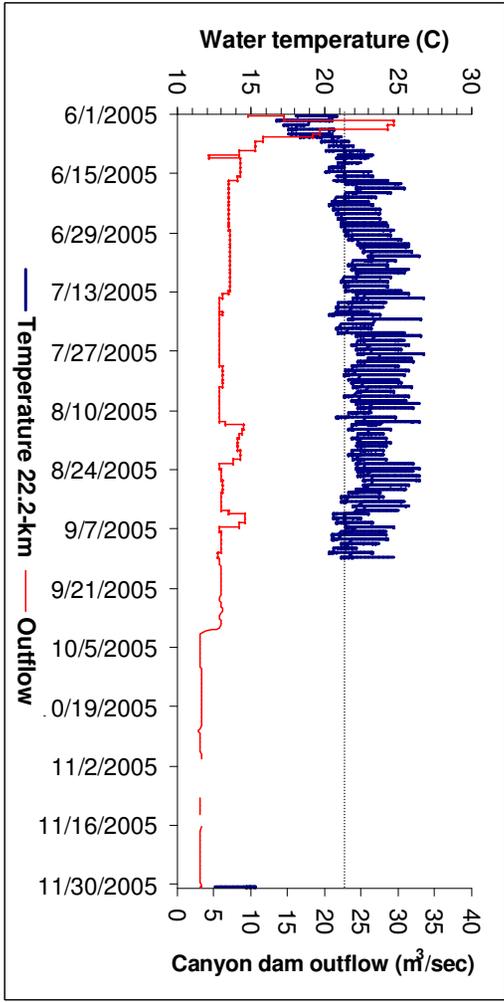


Figure 3. Length (mm groups) frequency histogram and catch rates (CPUE) for all rainbow trout collected boat electrofishing on the Canyon Reservoir Tailrace, August to November 2005.

