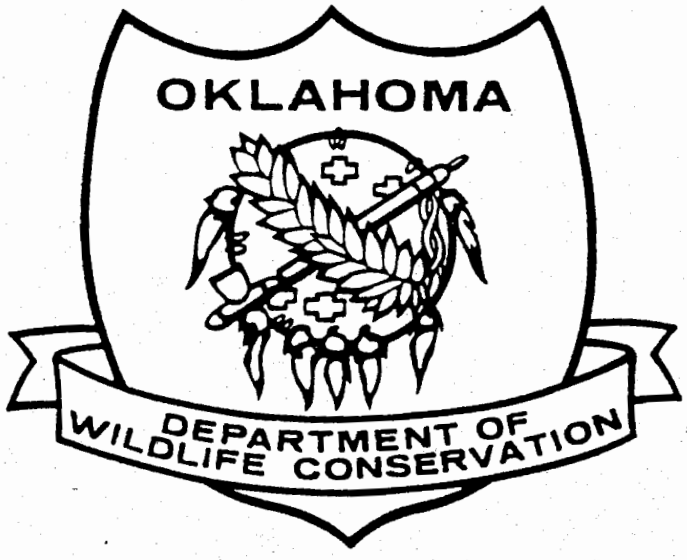
FINAL REPORT

RESEARCH AND SURVEYS



FEDERAL AID PROJECT NO. F-37-R

FISH RESEARCH AND SURVEYS FOR OKLAHOMA LAKES AND RESERVOIRS

JOB NO. 18

EVALUATION OF A YEAR-ROUND PUT-AND-TAKE RAINBOW TROUT FISHERY IN THE MOUNTAIN FORK RIVER

JANUARY 1, 1989 through FEBRUARY 28, 1994

FINAL REPORT

STATE: Oklahoma PROJECT NUMBER: F-37-R

PROJECT TITLE: Fish research and surveys for Oklahoma lakes and reservoirs.

STUDY TITLE: Evaluation of a year-round put-and-take rainbow trout fishery in the Mountain Fork River.

CONTRACT PERIOD: January 1, 1989 through February 28, 1994

OBJECTIVE NUMBER: 18 JOB NUMBER: 18

ABSTRACT

A year-round rainbow trout (Oncorhynchus mykiss) fishery was developed and maintained with bi-weekly stockings in the 12 miles of Mountain Fork River immediately below Broken Bow Dam. Sales of additional licenses in the three county surrounding area were more than sufficient to offset the cost of rainbow trout stocked. The five year harvest rate of 0.56 rainbow trout per hour compared favorably with harvest rates of other Oklahoma rainbow trout areas but the total angler pressure and rainbow trout harvest were less than those from other areas. The fishery achieved widespread acceptance and was a financial benefit to the local economy, however, additional publicity to increase exploitation of the rainbow trout would further enhance the program.

I. OBJECTIVE:

Evaluate the fishing pressure, catch rate, harvest rate and trout exploitation of a developing year-round put-and-take rainbow trout fishery in the Mountain Fork River below Broken Bow Dam downstream to the U. S. Highway 70 bridge.

II. BACKGROUND:

The construction and operation of Broken Bow Reservoir has had significant impact on the fishery resources of the Mountain Fork River below the dam. The Oklahoma Biological Survey (1972) reported that 48% of the 83 fish species historically recorded in this segment of the river had not been collected since impoundment. The most important environmental impact associated

with reservoir operation is alteration of stream flow involving shifts in frequency, duration and fluctuations due to hydropower generation. The water temperature regime in the river is also impacted by cold water releases from hydropower, thereby influencing egg development, spawning and other life history requirements of warmwater fishes. These impacts are most dramatic to the aquatic resources of the area between Broken Bow Dam and the downstream re-regulation dam, a distance of 8.7 miles. Sportfishing activity within this stretch of river and further downstream to the U. S. Highway 70 bridge (3.1 miles) is provided by access points within Beaver's Bend State Park, the re-regulation dam, Presbyterian Falls and a fee access area at the U. S. Highway 70 bridge.

In addition to a smallmouth bass fishery that existed in the river prior to impoundment, good populations of white bass (Morone chrysops), largemouth bass (Micropterus salmoides), spotted bass (M. punctulatus), channel catfish (Ictalurus punctatus) and flathead catfish (Pylodictus olivaris) were also present. Since impoundment, these fisheries have been significantly reduced and are either nonexistent or very limited.

Stocking rainbow trout on a put-and-take basis into rivers below reservoirs having coldwater release is a widely used fishery management tool. It provides a basis of re-establishing an acceptable fishery into streams which have had their quality warmwater fisheries restricted by coldwater releases.

Lake Taneycomo, Missouri was transformed from a warmwater to a coldwater lake in 1958 when Table Rock Dam resulted in a substantial decline in the warmwater fish populations in Lake Taneycomo. Subsequently, the Missouri Department of Conservation (MDC) stocked trout and successfully established a coldwater fishery (Fry and Hanson, 1968). The "river lake" has for many years been a popular recreational area and angler effort currently exceeds one million hours annually. The value of this trout fishery to the local economy is estimated to be nine to twelve million dollars annually (Weithman and Haas, 1980).

The Oklahoma Department of Wildlife Conservation's (ODWC) first put-and-take rainbow trout fishery was begun in 1965 in the Illinois River below Lake Tenkiller. This proved to be a very popular fishery providing 76,913 angler-hours annually with a return rate of 75% for stocked trout.

A winter put-and-take rainbow trout fishery in the upper Blue River experienced three times as many angler-hours fishing pressure during trout stocking season as during non-trout stocking months. The return rate of stocked rainbow trout in this area ranged from 48 to 93% (Mauck, 1982). The years of low percent return were years having high water flows.

ODWC's third and most recent successful rainbow trout stocking area is Lake Watonga, a 50 acre lake in Blaine County. It was established as a designated trout area in September, 1986. It is stocked biweekly with catchable size fish from November through March. A one year evaluation of the lake Watonga rainbow trout fishery showed a 1:18 cost:benefit ratio with license sales from vendors in the Watonga area alone more than offsetting the cost of the purchased rainbow trout (Gilliland, 1988).

In August and September, 1986, ODWC and U. S. Fish and Wildlife Service (FWS), with assistance from the U. S. Army Corps of Engineers (COE), conducted a preliminary study of the discharges below Broken Bow Dam. The purpose of this preliminary study was to determine appropriate releases to maintain adequate water temperature and dissolved oxygen to sustain a put-and-take rainbow trout fishery year-round. Data from this preliminary study provided the basis for initiating a feasibility study for developing a year-round put-and-take rainbow trout fishery below Broken Bow Dam. The Mountain Fork River and the developing fishery were evaluated to:

1. Collect water quality data during various water release regimes in order to determine the optimum water release requirements needed to maintain the fishery.

2. Monitor and evaluate angler use of the trout fishery by conducting a creel survey.

3. Assess the recreational and economic impacts associated with the trout fishery.

The FWS and ODWC conducted the water quality assessment portion. The Oklahoma Cooperative Fish and Wildlife Research Unit (OCFWRU) at Oklahoma State University (OSU) performed the assessment concerning the recreational and economic impact of the rainbow trout fishery. ODWC stocked rainbow trout and conducted a creel survey to assess angler use of the rainbow trout fishery.

Establishing a year-round put-and-take rainbow trout fishery in the Mountain Fork River below Broken Bow Dam downstream to the U. S. Highway 70 bridge could greatly enhance angler use of the area by providing an additional fishery. This new fishery would be unique to this locality

and could attract anglers from a wide area. Because much of the stream is within or very close to Beaver's Bend State Park (BBSP) the increased visitation will in turn greatly enhance the economic benefit to the park and surrounding areas.

On March 7, 1988, ODWC adopted a regulation establishing the Mountain Fork River and tributaries from Broken Bow Dam downstream to the U. S. Highway 70 bridge as a "Designated Trout Area" beginning January 1, 1989. This requires anyone fishing this area to posses a valid Oklahoma Fishing License and an Oklahoma Trout License.

III. PROCEDURES:

A. Stocking

From January, 1989 through February, 1994 catchable-size rainbow trout (8.5 inch minimum) were stocked biweekly (on Thursdays), except for adjustments to accommodate special holidays. Trout were purchased from and transported by Crystal Lake Fisheries (CLF), Ava, Missouri. Stockings of 3,850 rainbow trout every two weeks were made by CLF personnel assisted by ODWC employees. These stockings were normally made at 18 sites along the 12 mile length of stream beginning at the spillway and ending below the re-regulation dam (Figure 1). Only three of these sites were below BBSP.

B. Creel Survey

A 12 month random non-uniform probability (weekday/weekend) creel survey was conducted on the 12 mile length of river which was divided into three areas (Figure 2). BBSP employees conducted the survey in that portion of the river within BBSP boundaries (Area 1), ODWC employees conducted the survey on the two remaining areas; Area 2 (Eppler's Camp/Spillway) and Area 3 (Re-regulation Dam/downstream). There were 20 survey days (12 weekend and 8 weekday) each quarter (Spring = March-May, Summer = June-August, Fall = September-November, Winter = December-February) during the year for all three areas, making 240 total survey days. Each survey day consisted of pressure counts and angler interviews. In addition, three concurrent pressure counts were made by ODWC personnel each quarter by boat in the BBSP area at the same time BBSP personnel were making pressure counts from the bank. Pressure estimates were then adjusted in the BBSP area relative to differences in boat vs. bank counts. A bus-route survey was used in the lower areas to maximize efficiency of conducting a roving creel survey in a limited access river situation. Roving shoreline interviews and pressure counts were used in all other upstream areas.

Creel data were analyzed to determine fishing pressure (hours), number of rainbow trout harvested and harvest rate (number per hour), per season by area.

C. Tagging

On June 16, 1991, 2,195 rainbow trout were tagged with numbered reward tags in an effort to determine percent exploitation and movement. These tagged trout were stocked into each section of the stream at all the regular stocking sites. Tag numbers were recorded for each section to gather information on movement up or down the river and exploitation by area. Tags were valued at $1.00 and $10.00 and anglers were asked to indicate where the trout had been caught when the tags were redeemed at the Broken Bow, Oklahoma Wal-Mart Store. Tags could be redeemed any time from the stocking date through November 30, 1991. Money for the rewards was supplied by the Dallas and Ft. Worth, Texas Fly Fisheries Clubs, the Prairie Fly Fishers (Oklahoma City), Green Country Fly Fishers, Broken Bow Lake/Mountain Fork River Association and Wal-Mart Stores, Inc.

D. Mark and Recapture

Mark and recapture population estimates were conducted once during each of three seasons, Spring (March-May), Summer (June-August) and Fall (September-November) of 1992 to determine the extent of carryover from one stocking to the next. Because of the high consistency in the results, mark and recapture estimates were made only in the summer of 1993. The stream flow was too low during the winter season to conduct electrofishing. During these efforts all trout stocked into designated areas were marked by hole punching the caudal fin. The test areas were (Figure 2): A. River Bend. B. Swimming Beach Section. C. Power Outlet Section. D. Eppler's Camp. All areas are separated from each other by low water dams which greatly restrict movement from one area to another. Areas A, B and C were used during the spring season, however water flow in Area C was not conducive to electrofishing. Therefore Areas A, B and D were used during the summer and fall studies.

During each season trout were marked and stocked by 1100 hours and recapture procedures were begun at dark the same day. One electrofishing unit per each area was used for collecting trout during the recapture phase. Recapture data were analyzed to determine the percentage of marked trout collected.

E. Water Quality

Temperature, oxygen and discharge data were collected during various water release regimes to determine optimum water release requirements for maintaining the fishery.

Ryan (Model J) constant temperature recorders were installed at four sites along the 12 miles of river (Figure 2). Dissolved oxygen and temperature measurements were taken weekly with a Yellow Springs Instrument (YSI) Model 51 meter from June through November, 1992.

Water discharge at the spillway was estimated by the COE based upon calculations using reservoir level and the size of the gate opening. These flows were also gauged and verified below the spillway by COE and ODWC personnel.

IV. FINDINGS:

A. Stocking

During the five year period, 1989 through 1992, the Mt. Fork River was stocked annually with approximately 100,000 rainbow trout averaging 0.3 pound each. Cost of the trout was $0.69 each, $69,000.00 annually and $345,000.00 for the five year period. Each biweekly stocking consisted of 3,850 rainbow trout, 8.5 inch minimum length. Occasionally several larger individuals (1 to 2 pounds) were stocked and during each year a few brooders in the 3 to 6 pound size range were also stocked.

Income from total license sales increased during the first four years but declined slightly in 1993 (Table 1). Although total income was less in 1993 than the previous year, it was higher than the first three years.

Sale of trout licenses decreased by 11.2% in 1993 but were second only to those sold in 1992. Annual resident fishing license sales decreased by 9.3% in 1993 and were less than any of the previous years except the first year. Sale of annual non-resident fishing licenses decreased by 24% to its third lowest amount during the five year period. Non-resident 10 day fishing license was the only type showing an increase in 1993. These sales increased by 23% to their second highest level. Non-resident 3 day fishing license sale decreased by 9% but were second highest for the five year period.

B. Creel Survey

Creel survey data provided estimates of daylight fishing pressure and harvest by season (Table 2). During 1989 and 1990 total angling pressure was very similar (approximately 68,000 hours). In 1991, the third year, a substantial increase in pressure occurred (35%) to a total of 92,246 hours. A further increase occurred in 1992 to 107,000 angler hours. This was the highest pressure recorded and was followed by a 28.5% decrease in 1993 to 76,499 hours.

Seasonal analysis revealed the highest angling pressure occurred during the summer in 4 of 5 years (Table 2). The exception was 1990 when the highest pressure occurred in the spring. The five year mean pressure for the summer season was 28,500 hours followed closely by the spring average of 24,500 hours. The fall pressure (15,800 hours) was similar to the winter pressure of 13,700 hours and both were considerably less than spring and summer.

Analysis of creel data by Area showed the greatest fishing pressure was in Area 1 four of the five years (Table 3). The notable exception was 1989 when the highest pressure was recorded in Area 3 followed by Area 2 and lastly, Area 1.

The rainbow trout harvest rate was 0.6 trout per hour in 1989 and increased to 0.8 in 1990 (Table 2). In 1991 harvest rate decreased to 0.4, the lowest rate recorded. This was followed by a slight increase in 1992 to 0.5 which was the same rate recorded in 1993 with a five mean harvest rate of 0.6.

By area the highest harvest rates occurred in Area 2 three of the five years and in Area 1 the other two years (Table 3). The highest mean harvest rate for all areas (0.79) occurred in 1990 and the lowest (0.42) in 1991. The second highest harvest rate (0.59) was in 1989. The remaining two years (1992 and 1993) had harvest rates of 0.5 each (Table 3).

Seasonally the highest harvest rates consistently occurred during the winter (Table 2). Harvest rates were generally similar during the spring and fall and were slightly higher than during the summer. However, in 1992 the lowest harvest rate (0.3) occurred during the spring and in 1993 it was during the fall (0.3).

Total harvest was nearly 40,000 in 1989 and increased to 54,236 in 1990 (Table 2). However, in 1991, harvest decreased to 38,618 rainbow trout but was followed by an increase in 1992 to 50,366 rainbow trout. In 1993, harvest decreased to its lowest level (34,500 rainbow trout).

The greatest harvest also occurred in Area 1 during four of five years (Table 3). Again the exception was 1989 when the greatest harvest was recorded in Area 2 with harvest in Areas 1 and 3 being similar.

C. Tagging

During the six month redemption period of the 1991 tagging study, 1,078 of the 2,195 tags were returned indicating a 49% exploitation of the tagged trout. The Beaver Creek Area had the highest exploitation (78%), BBSP had 46%,

from BBSP to the reregulation dam had 15% and below the reregulation dam was the lowest (4%). Almost 75% of all the tagged fish caught were caught during the first three weeks after tagging. Also, 71% of the tagged rainbow trout remaining in the area stocked, while 15% moved downstream, 8% moved upstream and the remaining 6% were not reported. Total redemption cost for tags over the six month study was $1,376.00.

D. Mark and Recapture

Marked individuals constituted a large percentage of the trout sampled in each of the three seasons in 1992 (Table 4). Of the rainbow trout collected, marked individuals accounted for 91% in the spring, 87% in the fall, 66% in the summer and 84% for the three seasons combined. Data from the summer 1993 was similar with marked individuals accounting for 88% of the rainbow trout collected.

E. Water Quality

Spillway water releases of 140 cfs were requested during 1989 based upon preliminary data collected in 1988. Hydropower releases of 3,000 cfs, 5 hours per day, 3 days per week were requested from the COE and Southwest Power Administration (SWPA). However, actual hydropower releases were much more sporadic than the requests and on June 23, 1991 a trout kill was reported in the section below the reregulation dam. This followed 16 days of air temperatures in the mid to upper 90's° F. and only nine hours of hydropower releases during these 16 days. On June 28, 1991, ODWC, COE and SWPA arrived at an agreement for hydropower releases to be made 3 days per week for 5 hours per day. This proved to be insufficient to maintain downstream water temperatures 70° F. or below and on July 13, 1991, a 6 day per week, 3 hours per day minimum schedule was begun. This maintained acceptable downstream water temperatures for the remainder of the summer (Harper, 1990). Following these experiences, ODWC devised a spillway release and generation schedule based upon ambient air temperatures (Table 5). This schedule was used in 1992 and 1993 with some adjustments based upon temperature data from the constant monitors. Satisfactory water temperatures were maintained (Table 6), although, hydropower releases were greater than requested much of the time.

Releases from the spillway sluice gates were sufficient to maintain satisfactory water temperatures in that stretch of stream in BBSP above the power outlet (Figure 1). However this gate is approximately 30 feet below the normal pool elevation of 599 feet msl in Broken Bow Reservoir and temperature of water from this gate is influenced by the pool elevation. This can be critical, as was the case

September 26, 1993 when the lake level was 11 feet below normal and the temperature of water from the spillway was 72° F., near the upper limit desired for trout. The shorter daytime hours and cool nighttime temperatures (48 to 69° F.) at this time actually created cooler water temperatures (70° F.) at the downstream sites in BBSP. Cooler air temperatures and a 2 feet increase in the lake elevation the following week resulted in decreased water temperatures from the spillway release.

V. ANALYSIS:

A. Stocking

Stocking of rainbow trout into the Mountain Fork River went smoothly during each of the five years and appeared to provide a good number of trout for the anglers. Of the 18 stocking sites used, 12 were within BBSP, 3 were on Beaver Creek just above BBSP and 3 were in the downstream sections. This resulted in approximately 80% of the rainbow trout being stocked into the upper 5.5 miles of the 12 mile trout stream. During the five year study period an average of 82% of the angling pressure was expended in these areas. Therefore the stocking distribution approximated the angler distribution.

In 1989, it was estimated the cost of rainbow trout exceeded the revenue of license sales within the surrounding three county area generated from the trout fishery by $24,078.00 (Harper, 1990). In 1990, the deficit was decreased to $1,329.00 (Harper, 1991). In 1991 and 1993, income from license sales generated by the trout fishery exceeded cost of trout by approximately $20,000.00 and in 1992 by approximately $40,000.00. Essentially since the second year of the project cost of trout has been more than offset by increased license sales in the immediate 3 county area.

Additional economic information concerning the impact of the rainbow trout fishery to the local area was reported in a study conducted by Oklahoma State University (OSU), Choi, et.al. (1993). It was estimated that in 1990 anglers spent an estimated $792,000.00 while participating in the rainbow trout fishery. Of this, 73 to 84% was spent within a 25 mile radius of the fishery. Benefit/Cost ratio was estimated to be 16:1. The local economy also benefited by over $600,000.00 in increased revenue income.

B. Creel survey

Angling pressure in 1989 and 1990 was similar, followed by substantial increases in 1991 and 1992. However, in 1993 a 28% decrease in pressure was recorded. At this time license sales showed only an 11% decrease raising the

question whether the 28% was real or partially due to survey error. The decrease in pressure was all recorded in Area 1 (BBSP), an area in which several different new creel clerks were used during 1993. It requires time for a new creel clerk to become comrortable conducting surveys and these inexperienced clerks are more prone to making errors than are experienced personnel.

In Areas 2 and 3 a slight increase of 6% was recorded. In these areas one creel clerk was used throughout the five year study.

Fishing pressure in the Mountain Fork River trout stream during the first five years was relatively light compared to other trout areas. Average pressure during the five years of 6,875 hours per mile of stream was considerably less than the 30,332 hours per mile for the Blue River trout stream (Mauck, 1980). Two factors contributing to this are: 1. During the six year evaluation period Blue River was only one of two rainbow trout fisheries in Oklahoma whereas, now the Mountain Fork River is one of six rainbow trout fisheries. 2. Mountain Fork River is approximately 1.5 hours travel time farther from the major metropolitan areas of Oklahoma City and Dallas, Fort Worth, Texas than Blue River.

The five year average harvest rate of 0.56 trout per hour compares favorably to the harvest rates of 0.6 trout per hour at Watonga (Gilliland, 1988), 0.66 trout per hour at Blue River (Mauck, 1980) and 0.61 trout per hour at the Illinois River (Hicks, 1968).

The 44% return of trout harvested from Mountain Fork River was lower than the 87% from Watonga (Gilliland, 1988), 64% for Blue River (Mauck, 1980) and 63% for Illinois River (Hicks, 1968).

One factor contributing to this lower total harvest is of course the lower pressure. The 300 acre lake formed by the reregulation dam offers a large haven for the rainbow trout and is little fished. Also, during periods of hydropower releases, two thirds of the stream is essentially not fishable due to the large river flows. This occurs often during the spring and summer, the two most heavily fished seasons.

As the Mountain Fork River rainbow trout fishery becomes more widely known and accepted, pressure is expected to increase and as this happens total harvest will also increase.

Creel data indicated that most fishing pressure occurred in Area 1 (BBSP), the area which is most accessible and because it is a state park naturally draws more visitors. The two downstream areas showed an increasing trend in

popularity and these areas have much more potential in providing opportunities for fly fishermen. As the entire fishery grows in popularity these areas should experience increased pressure.

The spring and summer seasons had the heaviest angling pressure. This is not unusual since these two seasons are the most utilized by Oklahoma anglers seeking all fish species. Many family vacations are also taken during this time and conversely many outdoor enthusiast are more interested in hunting during the fall and winter. The winter season consistently provided the highest harvest rates, possibly because of heavier rainbow trout feeding activity during the colder months. Winter anglers may also have been the more determined and experienced rainbow trout anglers.

C. Tagging

The 1991 tagging results suggested an exploitation rate of 49% which closely agrees with the percent harvest estimated by the creel survey. Nearly 75% of tagged fish were caught within three weeks of their stocking.

The Beaver Creek area had the highest exploitation of any area (78%) reflecting it's apparent accessibility to anglers. This stream is narrow enough for anglers to walk along both banks for much of it's length. Conversely the lowest return was from the lower portion of the designated trout stream, an area where much less fishing pressure was recorded. Access is not readily available in this part of the stream because it is very broad (approximately 100 yards) and not easily fished from the bank.

D. Mark and Recapture

The mark and recapture data revealed a high percent (84%) of the rainbow trout collected during electrofishing surveys were marked. This suggested the residual population becomes very low between stocking dates. However, creel data indicate only 50% of the rainbow trout stocked were harvested by anglers. This raised the question about the disposition of those rainbow trout not harvested by anglers.

Movement from one area to another is limited by the presence of low water dams separating the areas and no large flows of water occurred through the areas during the study which would have had a flushing effect. Therefore, it appears migration of rainbow trout from the area would have been minimal.

Undoubtedly, some predation on the stocked trout by an existing population of largemouth bass, spotted bass, gar and walleye did occur. However, it is improbable this

could account for all the discrepancy between the harvest estimate and the low residual population indicated by the mark and recapture data.

Natural mortality of the stocked trout could also contribute to some loss of trout. However, no mortalities of more than two or three trout have been observed or reported; therefore, loss attributed to this factor appears minimal.

Another factor contributing to the loss of trout could have been night angler harvest which is not evaluated in the present creel survey. During the mark and recapture surveys several night anglers were observed. This could certainly have accounted for some additional harvest during the warmer months but would not be significant in the colder months.

In summary, it is possible that the creel harvest estimate of 50% is conservative. Natural predation, harvest by night anglers and natural mortality also account for loss of unknown numbers of rainbow trout in the study areas. In the portion of stream below the power outlet, some rainbow trout probably were flushed from and/or migrate downstream during periods of prolonged high flow releases. The extent of this is unknown and some of these were undoubtedly caught by anglers utilizing lower portions below the designated trout area.

E. Water Quality

Dissolved oxygen content in the Mountain Fork River is 7.5 ppm or greater throughout the year and are not a limiting factor in establishing a year-round rainbow trout fishery.

Releases from the spillway sluice gate were sufficient to maintain satisfactory water temperatures above the power outlet when made according to the recommended schedule. However, these temperatures should be continually monitored and during periods of abnormally high air temperature additional releases may required.

Another major factor affecting water temperatures in this upper stretch of stream is the water level in Broken Bow Reservoir. As mentioned earlier, when the lake level was 11 feet below normal in 1992, the temperature of water being released was near the upper limit desired for trout. Had these lower lake levels developed earlier in the summer, conditions within the upper stretch of stream would have been critical. Efforts should therefore be made to alleviate this problem.

Releases from the power outlet in 1992 and 1993 were generally greater than the recommended water releases

and did maintain satisfactory water temperatures in the downstream stretch during the summer. However, because hydropower releases have not been made according to the "outlined recommendations" it is unknown if these volumes have been sufficient to maintain satisfactory temperatures during periods of extreme high air temperature.

VII. RECOMMENDATIONS:

A. Permanent water releases must be secured. In order to expand and build this fishery to it's maximum potential an adequate, reliable, permanent water allocation must be acquired from COE and SWPA.

B. Have the COE retrofit the spillway sluice gate with a draft tube to draw water from lower in the lake or hold the water level in Broken Bow Reservoir 2 feet higher than normal in late May. Colder water obtained from deeper lake levels would provide more desirable water temperatures during extremely hot summers and would afford an insurance zone against low lake levels like those of 1993.

C. Downstream water temperatures should continue to be monitored weekly so additional releases can be requested if needed.

D. Advertise/publicize the fishery to attract additional anglers. The Mountain Fork trout stream has developed into a premier rainbow trout stream but people must be made aware of its offerings. A high visibility advertising campaign should be initiated. BBSP has much to be gained from the stream and indeed has realized much already as does local businesses. Therefore, a cooperative effort involving ODWC, BBSP, Broken Bow Chamber of Commerce (BBCC) and other local businesses should be developed to provide adequate publicity. As more people realize how much the stream has to offer more will come and more improvements can be made.

E. Establish a trophy trout area. Initiate trophy size and creel limits on brown trout (Salmo trutta) and consider same on rainbow trout in the stretch of stream between the low water dam at the lower end of BBSP and the reregulation dam, approximately 4 miles downstream. This will provide an additional incentive for anglers to fish the Mountain Fork.

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Table 1. Fishing license sales in McCurtain, Pushmataha and LeFlore Counties, Oklahoma, 1989 - 1993.

LICENSE TYPE	1989 *NUMBER SOLD/$	1990 *NUMBER SOLD/$ (CHANGE %)	1991 *NUMBER SOLD/$ (CHANGE %)	1992 *NUMBER SOLD/$ (CHANGE %)	1993 *NUMBER SOLD/$ (CHANGE %)
TROUT	5,432/$38,666.00	6,925/$46,743.75 + 27.5%	7,914/$53,419.50 + 14.3%	9,456/$63,828.00 + 19.5%	8,394/$56,659.50 - 11.2 %
RESIDENT ANNUAL FISHING	4,968/$45,954.00	5,700/$52,725.00 + 14.7%	6,239/$57,710.75 + 9.5%	6,179/$57,155.75 - 0.9%	5,604/$51,837.00 - 9.3%
NON-RESIDENT ANNUAL FISHING	923/$20,767.50	1,036/$23,310.00 + 12.2%	1,267/$28,507.50 + 22.3%	1,489/$33,502.50 + 17.5%	1,131/$25,447.50 - 24.0%
NON-RESIDENT 10 DAY FISHING	562/$ 7,868.00	734/$10,276.00 + 30.6%	614/$ 8,596.00 - 16.3%	546/$ 7,644.00 - 11.1%	673/$ 9,422.00 + 23.3%
NON-RESIDENT 3 DAY FISHSING	3,616/$23,504.00	4,171/$27,111.50 + 15.3%	4,899/$31,843.50 + 17.5%	6,297/$40,930.50 + 28.5%	5,721/$37,186.50 - 9.1%
TOTALS	$134,760.00	$160,167.00 + 18.9%	$180,077.25 + 12.4%	$203,060.75 + 12.8%	$180,552.50 - 11.1%

Table 2. Estimated seasonal angler hours, trout harvest and trout harvest rate for the Mountain Fork River trout fishery, 1989 - 1993.

ASON	JAN.1,1989-NOV.30,1989 ANGLER HOURS (NO.)	TROUT HARVEST (NO.)	TROUT HARVEST RATE (NO./ HR.)	DEC.1,1989-NOV.30,1990 ANGLER HOURS (NO.)	TROUT HARVEST (NO.)	TROUT HARVEST RATE (NO./ HR.)	DEC.1,1990-NOV.30,1991 ANGLER HOURS (NO.)	TROUT HARVEST (NO.)	TROUT HARVEST RATE (NO./ HR.)	DEC.1,1991-NOV.30,1992 ANGLER HOURS (NO.)	TROUT HARVEST (NO.)	TROUT HARVEST RATE (NO./ HR.)	DEC.1,1992-NOV.30,1993 ANGLER HOURS (NO.)	TROUT HARVEST (NO.)	TROUT HARVEST RATE (NO./ HR.)
NTER: C. - B.	11,493 *	10,146 *	0.9	16,181	23,890	1.5	13,312	10,332	0.8	14,214	12,680	0.9	13,145	9,318	0.7
RING: R. - Y	18,606	13,353	0.7	21,569	13,589	0.6	29,893	12,147	0.4	35,258	12,132	0.3	17,424	7,600	0.4
MMER: NE - GUST	26,472	9,536	0.4	18,209	9,056	0.5	32,155	9,026	0.3	35,758	14,443	0.4	29,684	11,219	0.4
LL: PT. - V.	11,520	6,905	0.6	12,686	7,701	0.6	16,688	7,113	0.4	21,771	11,111	0.5	16,246	6,364	0.3
TAL	68,091 **	39,940 **	0.6	68,645	54,236	0.8	92,248	38,618	0.4	107,001	50,366	0.5	76,499	34,501	0.5

Two months (January and February, 1989).
Eleven months (January through November, 1989).

Table 3. Creel summary by season and area for the Mountain Fork River designated trout stream during 1989 - 1993.

A NUMBER EASON	1989 PRESSURE (HRS.)	1989 TROUT HARVEST (NO.)	1989 TROUT HARVEST RATE (NO./HR.)	1990 PRESSURE (HRS.)	1990 TROUT HARVEST (NO.)	1990 TROUT HARVEST RATE (NO./HR.)	1991 PRESSURE (HRS.)	1991 TROUT HARVEST (NO.)	1991 TROUT HARVEST RATE (NO./HR.)	1992 PRESSURE (HRS.)	1992 TROUT HARVEST (NO.)	1992 TROUT HARVEST RATE (NO./HR.)	1993 PRESSURE (HRS.)	1993 TROUT HARVEST (NO.)	1993 TROUT HARVEST RATE (NO./HR.)
A NO. 1 AVERS BEND STATE PARK):															
ER	5,363	5,630	1.00	12,261	20,614	1.70	8,862	6,913	0.80	8,596	6,129	0.70	9,093	6,791	0.70
NG	3,867	2,614	0.68	15,625	10,755	0.70	17,296	7,651	0.40	28,629	9,627	0.30	11,518	5,595	0.50
ER	2,377	2,377	0.70	5,630	4,767	0.80	16,977	6,037	0.30	23,907	11,052	0.50	16,517	6,046	0.40
ER	6,204	2,373	0.48	6,575	4,168	0.60	12,431	5,328	0.40	16,135	8,216	0.50	7,515	4,230	0.60
T A L	18,811	12,373	0.67	40,299	40,324	1.00	55,618	24,729	0.45	77,067	35,024	0.50	44,643	22,662	0.50
A NO. 2 LERS AND SPILLWAY)															
ER	5,206	4,132	0.80	3,486	2,842	0.80	3,906	3,055	0.80	4,955	5,623	1.10	3,482	2,395	0.70
NG	5,105	2,512	0.50	4,526	2,712	0.60	9,210	3,777	0.40	3,668	2,474	0.70	3,526	1,315	0.40
ER	5,770	4,449	0.80	6,879	3,700	0.50	8,631	3,571	0.40	6,841	3,141	0.50	6,985	2,788	0.40
ER	4,385	3,847	0.98	4,823	3,324	0.80	3,557	1,671	0.50	4,855	2,691	0.50	6,371	2,030	0.30
T A L	20,466	14,940	0.73	18,914	12,870	0.67	25,302	12,074	0.48	20,419	13,929	0.70	20,364	8,528	0.40
A NO. 3 EGULATION, DOWNSTREAM)															
ER	924	575	0.80	434	434	1.00	746	364	0.50	663	928	1.40	570	132	0.20
NG	9,634	8,427	0.90	1,218	122	0.10	3,385	719	0.20	3,161	31	0.01	2,380	690	0.30
ER	17,325	2,710	0.16	5,692	569	0.10	6,567	618	0.10	5,010	250	0.05	6,102	2,385	0.40
ER	931	685	0.78	2,088	209	0.10	650	114	0.20	681	204	0.30	2,360	104	0.10
T A L	28,814	12,397	0.43	9,432	1,334	0.14	11,328	1,815	0.16	9,515	1,413	0.15	11,492	3,311	0.30
AL FOR AREAS	68,891	38,948	0.59	68,645	54,236	0.79	92,248	38,618	0.42	107,001	50,366	0.50	76,499	34,501	0.50

Table 4. Results of mark and recapture comparisons of the relative abundance of stocked vs. carryover rainbow trout in the Mountain Fork River, 1992 and 1993.

DATE	SECTION	EFFORT IN HOURS	C/f (NO./HR.)	NUMBER OF RAINBOW TROUT COLLECTED			
				MARKED	UNMARKED	TOTAL	PERCENT MARKED
1992:							
SPRING							
(04/16/92)	A	1.40	60.7	79	6	85	92.9
	B	1.90	31.8	54	7	61	88.5
	C	1.50	4.0	6	0	6	100.0
TOTAL:				139	13	152	91.4
SUMMER							
(07/16/92)	A	0.50	88.0	31	13	44	70.5
	B	0.78	44.7	21	14	35	60.0
	D	0.75	50.7	25	13	38	65.8
TOTAL:				77	40	117	65.8
FALL							
(10/22/92)	A	1.20	116.8	125	21	146	85.6
	B	1.50	57.3	78	8	86	90.7
	D	2.00	54.5	94	15	109	86.2
TOTAL:				297	44	341	87.1
1992 TOTAL:				513	97	610	84.1
1993:							
SUMMER							
(06/10/93)	A	1.00	164.0	150	14	164	91.5
	B	1.00	72.0	57	15	72	79.2
1993 TOTAL:				207	29	236	87.7

Table 5. Recommended water releases from Broken Bow Dam.

Spillway Releases:

15 May to 31 May..... 80 cfs
1 June to 15 October.....140 cfs
16 October to 31 October.....Decrease
16 October to 31 October.....Decrease
flows in steps to 14 cfs.

Power Generation:

Step I. When maximum ambient air temperatures reach 85° F. on two consecutive days, a three day per week hydropower generation schedule is requested. The schedule should include Monday and Friday with the third day at SWPA discretion based on demand. Power generation requested is 1/2 unit, 3 hour minimum.

Step 2. When maximum ambient air temperatures reach 90° F. on two consecutive days, a four day per week hydropower generation schedule is requested. The schedule should include Monday, Wednesday, Friday and one weekend day at 1/2 unit, 3 hour minimum.

Step 3. When maximum ambient air temperatures reach 93° F. on two consecutive days, a six day per week hydropower generation schedule is requested. The schedule should include all weekdays and a weekend day of choice by SWPA. Power generation requested is 1/2 unit, 3 hour minimum.

Step 4. When maximum ambient air temperatures reach 96° F. on two consecutive days, the power generation duration should increase to a 5 hour minimum.

Step 5. When the weekly mean ambient air temperatures decrease to below 96° F., hydropower generation can be decreased to a 3 hour duration.

Step 6. When the weekly mean ambient air temperatures decrease to below 93° F., hydropower generation can be decreased to a four day per week schedule; Monday, Wednesday, Friday and one weekend day at 1/2 unit, 3 hour minimum.

Step 7. After the third week in September when two consecutive fall weekly recording periods indicate mean daytime air temperatures at or below 85° F. and mean nighttime air temperatures at or below 55° F., the weekend generation schedule should be discontinued. The revised schedule would then include Monday and Friday with day three scheduled by SWPA based on hydropower demand. Hydropower generation requested is 1/2 unit, 3 hour minimum.

TABLE 6. Mountain Fork River trout stream average weekly temperature and flow data for June 7-Aug. 15, 1993.

	MONTH	JUNE	JUNE	JUNE	JUNE/ JULY	JULY	JULY	JULY	JULY/ AUG.
	DAY	7-13	14-20	21-27	28-4	5-11	12-18	19-25	26-1
Park Pool	Min. Air (F)	66.0	65.0	64.0	67.0	65.0	69.0	66.0	64.0
	Max. Air (F)	90.0	92.0	91.0	93.0	95.0	100.0	103.0	105.0
	Min. Water (F)	63.1	62.8	60.8	64.0	65.3	65.1	65.8	66.0
	Max. Water (F)	66.9	69.6	66.6	68.2	68.9	68.2	68.4	69.8
Eppler's	Min. Air (F)	66.0	65.0	64.0	67.0	65.0	69.0	66.0	64.0
	Max. Air (F)	90.0	92.0	91.0	93.0	95.0	100.0	103.0	105.0
	Min. Water (F)	59.9	55.8	56.0	56.7	56.0	57.4	57.2	57.2
	Max. Water (F)	66.7	68.5	66.2	69.1	71.4	72.5	70.0	68.7
	Daily Gen. (CFS)	2288.0	2620.0	2899.0	2743.0	2597.0	3003.0	2463.0	3009.0
	No. of Days Gen.	2.0	6.0	6.0	6.0	4.0	6.0	7.0	6.0
	Total Hrs. Gen.	13.0	31.0	32.0	33.0	18.0	31.0	45.0	53.0
Presbyterian Falls	Min. Air (F)	66.0	65.0	64.0	67.0	65.0	69.0	66.0	64.0
	Max. Air (F)	90.0	92.0	91.0	93.0	95.0	100.0	103.0	105.0
	Min. Water (F)	61.2	61.0	60.4	60.8	62.8	62.4	62.6	62.4
	Max. Water (F)	66.2	74.1	66.0	70.0	73.2	71.2	69.8	66.6
	Daily Gen. (CFS)	2288.0	2620.0	2899.0	2743.0	2597.0	3003.0	2463.0	3009.0
	No. of Days Gen.	2.0	6.0	6.0	6.0	4.0	6.0	7.0	6.0
	Total Hrs. Gen.	13.0	31.0	32.0	33.0	18.0	31.0	45.0	53.0
Hwy. 70	Min. Air (F)	66.0	65.0	64.0	67.0	65.0	69.0	66.0	64.0
	Max. Air (F)	90.0	92.0	91.0	93.0	95.0	100.0	103.0	105.0
	Min. Water (F)	64.0	62.6	62.6	63.5	68.4	64.2	65.8	64.2
	Max. Water (F)	70.7	72.3	68.9	72.0	75.4	73.4	73.4	69.8
	Daily Gen. (CFS)	2288.0	2620.0	2899.0	2743.0	2597.0	3003.0	2463.0	3009.0
	No. of Days Gen.	2.0	6.0	6.0	6.0	4.0	6.0	7.0	6.0
	Total Hrs. Gen.	13.0	31.0	32.0	33.0	18.0	31.0	45.0	53.0

Spillway releases were 140 CFS.

Temperatures and generation readings are average for 7 days.

TABLE 6. Mountain Fork River trout stream average weekly temperature and flow data for Aug. 2-Oct. 3, 1993.

	MONTH	AUG.	AUG.	AUG.	AUG.	AUG./ SEPT.	SEPT.	SEPT.	SEPT.	SEPT./ OCT.
	DAY	2-8	9-15	16-22	23-29	30-5	6-12	13-19	20-26	27-3
	Min. Air (F)	64.0	71.0	70.0	68.0	52.0	58.0	46.0	48.0	38.0
Park Pool	Max. Air (F)	102.0	100.0	106.0	99.0	99.0	93.0	90.0	95.0	90.0
	Min. Water (F)	63.0	63.1	67.6	68.0	66.7	65.1	63.1	67.6	65.5
	Max. Water (F)	68.9	69.6	69.6	69.6	68.9	68.0	69.8	72.9	69.8
	Min. Air (F)	64.0	71.0	70.0	68.0	52.0	58.0	46.0	48.0	38.0
	Max. Air (F)	102.0	100.0	106.0	99.0	99.0	93.0	90.0	95.0	90.0
	Min. Water (F)	58.1	59.5	60.3	60.3	59.2	59.5	59.4	63.0	60.6
Eppler's	Max. Water (F)	68.0	70.0	70.0	70.9	70.0	67.3	67.6	69.8	66.4
	Daily Gen. (CFS)	2471.0	3009.0	3306.0	2710.0	2168.0	2760.0	2802.0	3669.0	3933.0
	No. of Days Gen.	6.0	6.0	6.0	5.0	6.0	5.0	6.0	7.0	5.0
	Total Hrs. Gen.	28.0	36.0	38.0	19.0	31.0	20.0	19.0	32.0	35.0
	Min. Air (F)	64.0	71.0	70.0	68.0	52.0	58.0	46.0	48.0	38.0
	Max. Air (F)	102.0	100.0	106.0	99.0	99.0	93.0	90.0	95.0	90.0
	Min. Water (F)	63.7	63.5	65.5	66.0	65.5	64.4	64.4	66.7	63.7
Presbyterian	Max. Water (F)	68.4	69.8	71.4	72.9	72.1	68.5	69.3	69.8	68.5
Falls	Daily Gen. (CFS)	2471.0	3009.0	3306.0	2710.0	2168.0	2760.0	2802.0	3669.0	3933.0
	No. of Days Gen.	6.0	6.0	6.0	5.0	6.0	5.0	6.0	7.0	5.0
	Total Hrs. Gen.	28.0	36.0	38.0	19.0	31.0	20.0	19.0	32.0	35.0
	Min. Air (F)	64.0	71.0	70.0	68.0	52.0	58.0	46.0	48.0	38.0
	Max. Air (F)	102.0	100.0	106.0	99.0	99.0	93.0	90.0	95.0	90.0
	Min. Water (F)	65.5	67.1	67.5	69.4	72.0	66.2	64.4	68.0	64.4
Hwy. 70	Max. Water (F)	69.8	73.2	73.8	75.2	73.8	71.1	71.6	71.7	70.7
	Daily Gen. (CFS)	2471.0	3009.0	3306.0	2710.0	2168.0	2760.0	2802.0	3669.0	3933.0
	No. of Days Gen.	6.0	6.0	6.0	5.0	6.0	5.0	6.0	7.0	5.0
	Total Hrs. Gen.	28.0	36.0	38.0	19.0	31.0	20.0	19.0	32.0	35.0

Spillway releases were 140 CFS.

Figure 1. Mountain Fork River trout stream showing trout stocking sites and creel areas (1, 2 and 3).

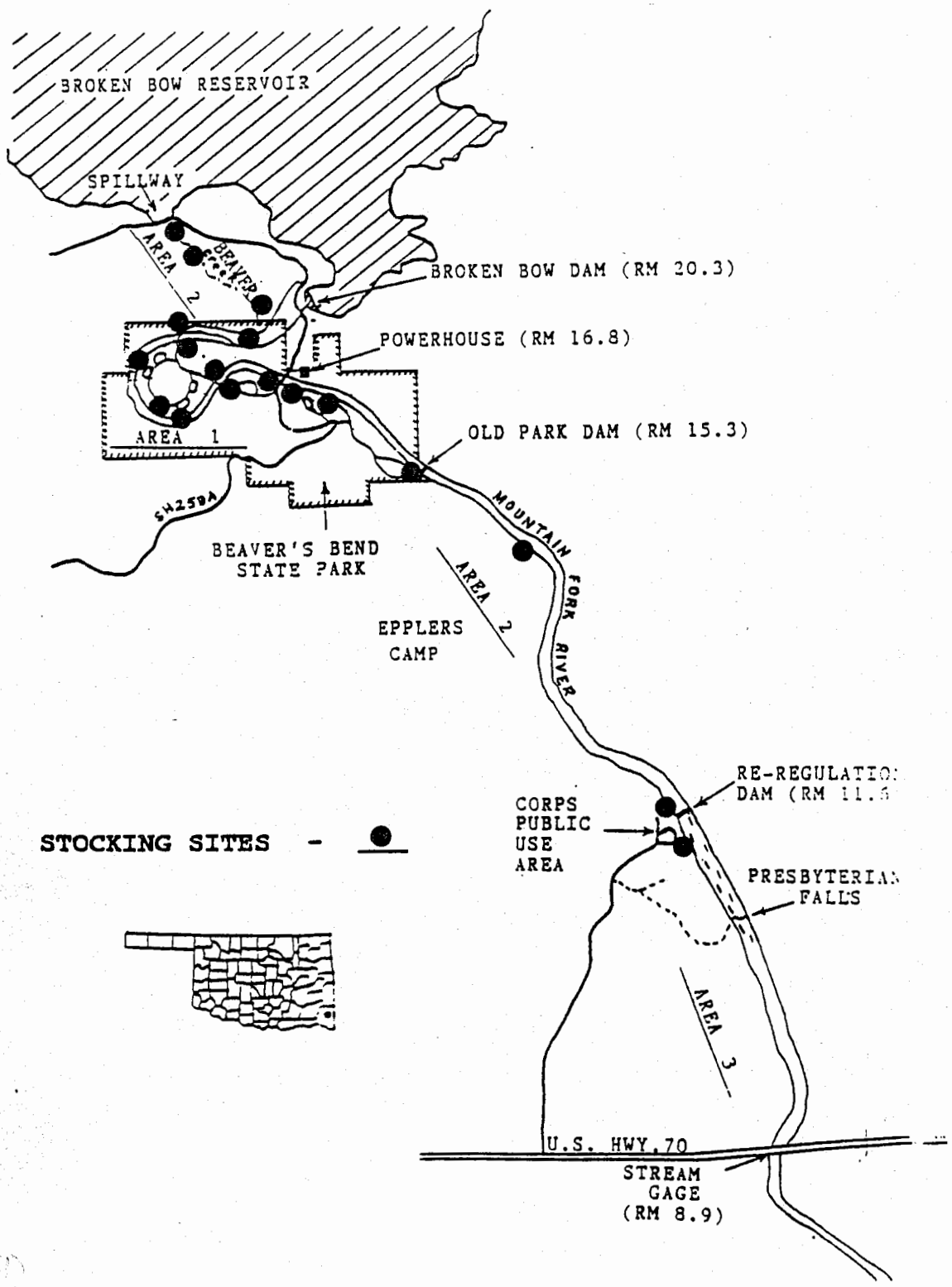

Figure 2. Mountain Fork River trout stream showing temperat
recording and stream gauging sites.