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WILLOW CREEK HABITAT MONITORING

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Willow Creek Habitat Assessment and Monitoring Methods

The primary purpose of habitat assessment and monitoring using Citizen Scientists is to provide monitoring data for use in stream restoration activities. The Willow Creek catchment has been severely impacted most recently by wildfire, with the Whitewater-Baldy Wildfire in 2012 paramount. But prior to contemporary wildfire impacts, historical anthropogenic modification had already severely degraded stream conditions by activities for road and low water crossing construction and maintenance, livestock grazing, and vehicle use. The stream assessment and monitoring methodology detailed below is intended to implement a wadeable stream habitat assessment format to allow for data collection by citizen scientists under the supervision of technical experts. Those data are provided to resource managers for use in assessing post-wildfire recovery of Willow Creek and to monitor stream channel response to habitat restoration activities. Willow Creek holds a restored population of Gila trout.

Funding by the Western Native Trout Initiative's (WNTI) Small Grants Program was provided to the report authors to support ongoing efforts to use Citizen Scientists in the collection of valid data for use in stream restoration activities. Here we report on recent monitoring efforts using funds provided by WNTI, including updating field monitoring procedures and data management.

SMALL GRANT OBJECTIVES

Funding provided by the WNTI Small Grant will support activities for:

1. Utilize citizen scientists to collect habitat data
2. Provided technical expertise and guidance for training
3. Monitor stream habitat conditions
4. Data management
5. Information dissemination
6. Interagency cooperation
7. Monitor stream channel response to habitat improvements.

STUDY AREA (Fig. 1)

The Willow Creek drainage flows to the Middle Fork Gila River in the north central portion of the Gila Wilderness, New Mexico (Fig. 2). Willow Creek originates on the east side of the Mogollon Mountains and travels east to confluence with Gilita Creek before joining Snow Creek to become the Middle Fork Gila River. Topographical relief is considerable, resulting in large stream corridors in the bottoms of deeply eroded canyons, including Iron Creek, Willow Creek, and the upper West Fork Gila River.

METHODS

Stream habitat sampling methods were modified and updated to reflect needed changes to better describe stream channel dynamics relative to bank erosion. Principally, stream channel

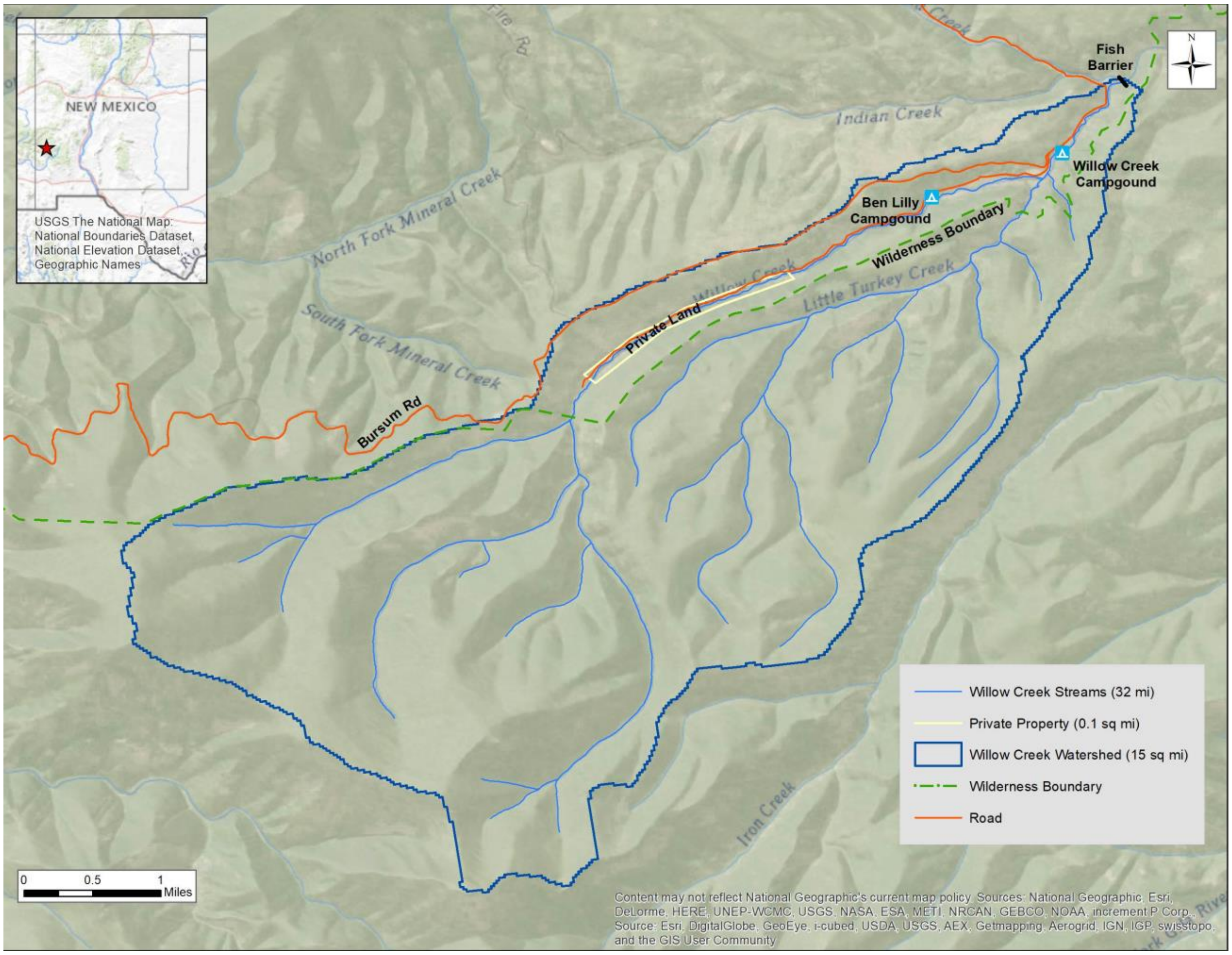

Figure 1. Map of Willow Creek Watershed in study area

measurements were expanded to included conditions at bankfull elevation and also at top of bank for assessing erosion.

Stream Habitat Characterization

Stream habitat characterization data for Willow Creek have been recorded during post-spring runoff and post-summer monsoon season since April 2017. We used a standard sampling protocol for wadeable streams. The protocol is modified to simplify field procedures for volunteer citizen scientists to ensure accuracy and utility of data collected. A training session is provided to volunteers to ensure all participants understand the methodology and are consistent in measurement techniques and assignment of habitat types and streambank status. Continual supervision by professional field biologists during field monitoring is maintained.

Five permanent monitoring reaches have been established on Willow Creek. Specific reaches were determined from review of USGS topographical maps, field reconnaissance, communication with agency biologists on resource management priorities, and review of land use impacts, recent wildfire history, and location of privately owned lands. Minimum length reach is 30X average bankfull width for that reach. The reaches are:

1. Willow Creek beginning 100m upstream of the fish migration barrier and ending at Willow Creek Campground,
2. Willow Creek from trail crossing at NMGF cabin upstream to spring-fed meadow at USFS development,
3. Willow Creek immediately downstream of private property development,
4. Willow Creek upstream of private property boundary ending at confluence with South Fork Willow Creek,
5. Little Turkey Creek upstream of Willow Creek confluence beginning at Trail (Fig. 1).

Monitoring of stream channel conditions in Willow are conducted immediately after spring runoff (late April to mid-May) and in autumn (variable but normally Oct-Nov). Stream habitat characteristics are measured for reaches with a minimum length 30X bank-full width. Meso-habitat characterization in Willow Creek recognizes two types, pools and riffles. Meso-habitat descriptions are:

Pool – Variable water velocity but usually still to moderate water; smooth/glassy surface; usually deeper than other parts of the channel. Substrates most often are of smaller particle sizes, although large cobble, boulders and bedrock may be present. Often associated with instream and shoreline presence of boulders and large woody debris.

Riffle – Riffle habitats are the most common type observed in Willow Creek. Water velocity is moderate to fast, surface is usually broken, substrate is typically cobble and boulder and frequently rises above water surface; smaller substrate of moderate to large-sized gravel may also occur. Gradient in riffles is typically higher than in other habitat types.

Habitat Measurements

General Reach Characterization - At all five of the permanent monitoring reaches, data are collected for determining the relative surface area (m^2) of pool and riffle habitats and for residual pool depth for all pools encountered in the reach. Two volunteers measure the length of each reach along the thalweg and mark meso-habitats at the lower and upper ends with surveyor pin flags. The proportion of pool and riffle habitats is determined for each individual reach (pool: riffle). Residual pool depth is determined by measuring the difference between the deepest portion of the pool and the pool tail depth. Pool tail depth is measured at the downstream limit of the pool where depth shallows, current velocity increases, and habitat transition to riffle begins.

Detailed Reach Characterization - A single reach was selected for more detailed data collection to further describe stream channel conditions. Reach number two, Willow Creek between the NMDGF Cabin and the spring-fed meadow at USFS development, was selected based upon the absence of man-caused disturbances for road and campground maintenance and construction within that reach. While the stream channel in this reach is indirectly affected by such disturbances upstream, the channel is generally located away from the road travelling up the valley and is not directly impacted by any campground location up- or downstream. The location of this reach then allows for data collection where natural stream processes are predominant and changes in stream channel conditions can be more easily related to restoration activities.

Meso-habitat Characterization

Starting at the lower end of each meso-habitat (habitat unit) encountered measurements are recorded for maximum length and three widths along transects located in the lower, middle, and upper portions of the habitat, roughly located at 25, 50, and 75 % of the habitat length. In the thalweg along these transects measurements are recorded for current velocity (m/s), depth (m), and substrate size (mm). An additional six randomly located points are measured within the meso-habitat to provide additional detail to meso-habitat variability. Current velocity is determined by use of an electronic flow meter attached to a graduated stadia rod. The stadia rod is also used to measure depth and mark the location of substrate particle measure. Substrate size is determined by a 'blind' grab of a single piece of substrate at the base of the stadia rod and measured along the intermediate axis.

For habitat units, subunits may be designated if encountered within the primary meso-habitat sampled. For example, if the first habitat sampled is a riffle, but contains two small pocket pools created by a boulder or rootwad, the riffle habitat is designated as No. 1 and the pocket pools as 1a and 1b. If the sixth habitat unit sampled is predominantly a pool, but contains a small riffle running along one stream bank, the designations are No. 6 and 6a. In both cases, width and length measurements are recorded separately for each unit and sub-unit. For individual pocket pools within a larger riffle, single measurements are made for length, width, depth, current velocity and substrate.

Calculating the total surface area of the habitat unit is determined by:

$$A = L \cdot \bar{x}\, W$$

Where:

A = surface area (m^2)

L = Length (m)

$\bar{x}\, W$ = mean width (m)

To avoid over-estimating habitat surface area of a habitat unit when a sub-unit is contained within the unit, surface area of the sub-unit is subtracted from the overall area of the unit.

Bank-full Cross Section

During May 2020, a single bank-full cross section was established and measured for stream channel profile. The cross section was established in the lower portion of reach number two on the inside bend of a channel meander and stable bank to the north and a steep, eroding bank to the south. A metal survey stake was placed at bank-full height on the stable left bank to locate the permanent cross section. On the opposite bank a survey stake is placed at bankfull level at the time of cross section measurement and removed once complete. The procedure for cross section measurement is as follows:

1. Stretch the tape tight between the two stakes placed at left and right bankfull with zero on the left bank (downstream view). Level the tape with placement of a line level at bankfull elevation.

2. Using a stadia rod, the surveyor takes the first reading at the left stake. Record (LBKF) in the comments section of the field sheet for left bankfull.
3. The surveyor proceeds across the stream holding the stadia rod perpendicular to the tape recording the measurement where the stadia rod intercepts the tape (rod height) at a minimum of 20 points (Harrelson et al. 1994), including all major changes in bed elevation and key features such as the left edge of water (LEW), the thalweg (THL), right edge of water (REW) and right bankfull (RBKF). Note these key features across from their associated recorded data point in the comments section of the data sheet. This information provides the bankfull cross sectional area, bankfull width, bankfull max depth, bankfull mean depth and the bankfull width/depth ratio.
4. To measure the maximum depth of the flood-prone area at the cross section, multiply the bankfull max depth by two. Holding the stadia rod in the spot in the stream at max depth, use a second tape and stretch it tight and level at the height of two times the bankfull max depth. Measure the distance across the tape where it meets the ground. If the tape does not make contact with the ground on one or both sides, indicate such on the data sheet. From these measurements are calculated the flood-prone area, the flood-prone width and the flood-prone width/depth ratio.

<u>Pebble Count</u>
To determine substrate particle size distribution within reach number two, we use a modified representative reach pebble count procedure. One observer walks in a zig-zag transect pattern in an upstream direction picking up and measuring substrate particles at 100 random points between bank-full elevations on both sides of the stream channel. Our procedure does not quantitatively assess proportion of meso-habitat types to guide location of points where substrate particles were measured, relying instead upon randomly measuring the 100 points throughout the sample reach.

Substrate size measurements are plotted by size class distribution and frequency. Stream classification may then be determined (Rosgen 1996), as well as analyses for dominant substrate size, streambed features, and reach sediment characteristics.

<u>Stream Channel Sinuosity</u>
Sinuosity is determined on site by direct measurement along the thalweg and straight line measurement of the reach. Sinuosity is calculated by dividing the thalweg length by the straightline length. A straight channel = 1 and a sinuous channel > 1.

<u>Width/Depth Ratio</u>
The width/depth ratio (W/D) is measured at the permanent cross section in Reach Number two. W/D is a ratio of the bank-full surface width to the mean depth of the bank-full channel. W/D allow for evaluation of channel stability and how various discharges occurring within the channel move sediment, thereby affecting fish habitat

Qualitative Fishery Habitat Assessment

To assess habitat complexity of each meso-habitat unit relative to aquatic habitat complexity we qualitatively assess and score shoreline conditions and habitat characteristics at each meso-habitat unit as follows:

1. bank condition: stable (vegetated or otherwise stable) or unstable (active erosion) and scored as stable = 1 and unstable = 0.
2. Presence of certain habitat attributes are each assigned a value of 1 for undercut bank, large woody debris, overhanging vegetation, boulder, and eddy pool. A higher tally of these characteristics demonstrates more complexity and, presumably, better fish habitat.

The total number of bank stability determinations and habitat attributes is summed to generate a score for habitat unit. Scores are summed separately for each habitat type (pool, riffle) and for all habitat units combined at the sample site

Observer Comments for Habitat Quality

This provides for individual volunteer assessment of stream habitat quality. This is companion to the qualitative fishery habitat assessment, using the same attributes, and allows a comparison of habitat assessments by technical experts and by volunteers. Each volunteer is provided a data sheet designed to allow for individual assessments through not only identifying presence/absence of habitat attributes, but individual perceptions of what constitute quality stream habitat. Providing volunteers with the opportunity to provide individual assessments of stream habitat quality broadens and engages volunteer contributions to community involvement and understanding of stream channel restoration and management needs.

Stream Discharge (Q)

Discharge at time of habitat sampling is measured in three locations within the study area: 1) downstream terminus at fish migration barrier, 2) Little Turkey Creek immediately above Willow Creek Confluence, 3) in Reach Number 2 at the established cross section. Discharge is calculated as:

$$Q = W \cdot D \cdot V$$

where:

W = channel width (m)

D = channel depth (m)

V = current velocity (m/s)

The specific site for discharge measurement is located where the channel is uniform and absent of obstructions that impede flow. A tag line or tape is anchored on both sides of the stream bank, width determined, and divided into ten cells. Point measurements for depth and velocity are taken at 10 equidistant points using an electronic flow meter and graduated stadia rod. All point measurements are located in the center of the cell. The starting point is the middle of the first cell at the stream channel edge and each subsequent measurement is located in the center of each cell, ending in the center of the last cell at opposite stream channel edge. For each cell the cross-sectional area (a_n) and current velocity (V_n) are measured. The discharge is calculated for each cell using the formula:

$$Q_n = a_n V_n$$

where:

Q_n = discharge for subsection n,

a_n = area of subsection n,

V_n = mean velocity for subsection n.

The total for all discharge measurements is the total discharge measurement calculated in cubic meters per second (m^3/s):

$$Q = aV$$

where:

Q = total discharge

aV = sum of all discharges

Photo Point Monitoring

Fixed photo points are established at each sample reach at the lower and upper ends and select locations within the reach to document visual changes over time for stream channel conditions, including changes in streamside vegetation, erosion of banks, pool formation, and presence/absence of instream cover. e.g. large woody debris, undercut banks, etc.

RESULTS

Stream channel conditions were monitored during 13-17 May 2020 and 30 April thru 1 May 2021. A single fall sample was just completed, 7-12 November 2021 and these data will be analyzed in the continuing monitoring program. Volunteers representing Trout Unlimited and retired agency biologists provided adequate support for data collection activities. Due to health concerns over potential virus impacts, field personnel were restricted during May 2020 efforts to retired agency biologists and sampling during autumn 2020 was not completed due to continuing virus concerns. The award was amended to extend the project period with submission of final report and final invoice to WNTI/WAFWA by November 15, 2021

The five long-term monitoring sites were surveyed during post spring runoff in 2020 and 2021. All other field efforts included considerable volunteer support, including 8 Trout Unlimited members during spring 2021 monitoring efforts. Our recent efforts in November 2021 included 4 members and 3 staff from Trout Unlimited.

Discharge was low for all three sampling periods, ranging 0.029-0.084 m3/s (1.04-2.95 ft3/s). Spring runoff for both 2020 and 2021 were negligible and resulted in minimal stream channel disturbance. Pool habitats were more frequently encountered than during previous monitoring efforts prior to 2020 (Fig. 1). Substrate sizes were small and pools were relatively shallow, an indication of low runoff conditions. Greatest pool abundance was observed during November 2021 sampling and is likely attributable to late summer rainstorms that displaced smaller substrates from pool habitats during short flow spikes. During late March thru early April 2021 we were able to directly observe change in stream stage during snow melt and runoff. The change in stage from spring snowmelt resulted in an increase in stage of approximately 2 cm (1 inch). While pools were most frequently encountered during November 2021, residual pool depths (maximum pool depth minus pool tail depth) were greatest in Spring 2020 sampling.

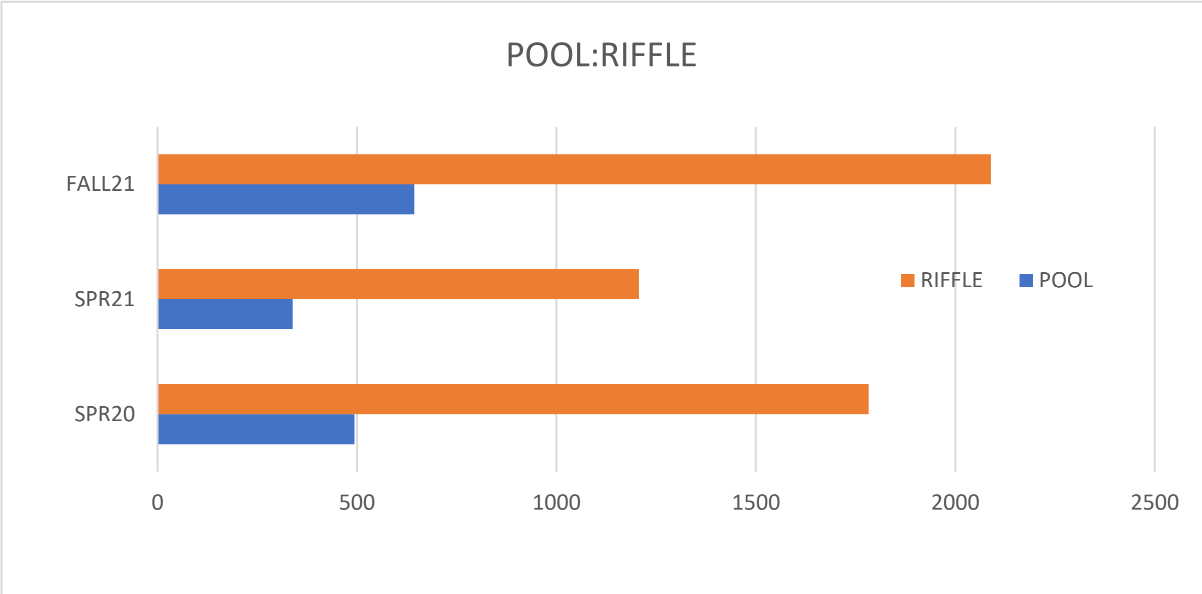

Figure 1. Pool:riffle in Willow Creek monitoring sites. X axis is m^2.

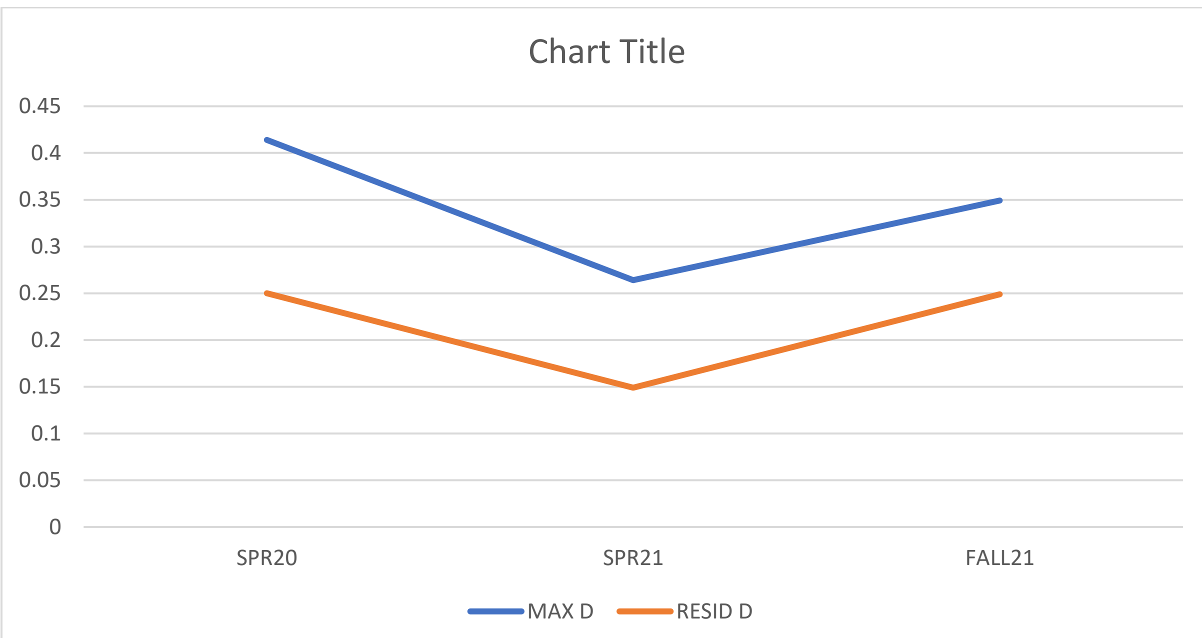

Figure 2. Maximum and residual pool depths for Willow Creek. Y axis is meters.

INTEGRATION OF WNTI SUPPORT TO WILLOW CREEK CONSERVATION EFFORTS

Spring Volunteer Stream Habitat Survey at Willow Creek, was held the weekend of April 30 – May 2, 2021. Included USFS, TU volunteers from multiple chapters and TU-NM Staff, and we hosted Daniel Ritz a journalist and digital media professional and a volunteer for Idaho Trout Unlimited, who was pursuing the WNTI Western Native Trout Challenge Master Caster level (catching 20 species across all 12 states) in 2021 and documenting the different fish with a series of articles, blogs and social media posts. This was a productive interaction that provided additional national exposure for Gila trout and the awareness of fire and habitat impacts.

Autumn Volunteer Stream Habitat Survey at Willow Creek, was held the week of November 7-12, 2021. Featured training on use of the Bank Erosion Hazard Index method was provided by NCD Director Allen Haden, in addition to TU Chapter participants work group included USFS and NMED Staff, and TU-NM Staff and TU-NM Council members

River Stewardship Program Proposal
We submitted a grant proposal for the River Stewardship Program titled "Post-Wildfire Restoration of Little Turkey Creek, Willow Creek Watershed, Southwestern New Mexico" that is based on the work we have been conducting with agency partners in the Willow Creek watershed since 2017 studying the post fire impacts that the 2012 Whitewater-Baldy Complex Fire on the watershed and its tributary, Little Turkey Creek. Willow Creek and its headwaters are designated by NMED as a high quality coldwater stream but currently does not meet standards for total recoverable aluminum and temperature according to the 2020 - 2022 State of New Mexico Clean Water Act 303(d)/305(b) integrated list. The goal of the proposed project is to reduce stream instability and improve water quality and aquatic habitats to support Gila trout for species conservation and recreational angling. The restoration strategy for Little Turkey Creek is to reconnect the stream and floodplain through aggradation of the current stream channel. We will be working with Natural Channel Design, Inc., a civil engineering consulting firm with experience in river and conservation engineering, and a long history of designing project that can be built with minimal tools using native materials, a critical concern for the proposed work in designated Wilderness. With the leadership of Jim Brooks, providing the equipment and pack stock to facilitate mobilizing a project of this magnitude in the wilderness and the prior experience in the watershed and our combined expertise, we have a uniquely strong team to implement the project in this proposal. At this time (Nov-15-2021) we are expecting the final decision on funding to be announced in the very near future, and this project will be a critical component of pending large-scale habitat restoration projects within the watershed.

USFS Group Innovation Award "Thinking Outside the Box"
The Southwest Regional Fish Program Leader at US Forest Service, Yvette Paroz, presented our Willow Creek Volunteer Habitat Monitoring project team leaders with the USFS Group Innovation Award "Thinking Outside the Box". Specific recognition was presented to Jim Brooks (USFWS retired), Jeff Arterburn (GRG-TU) and Chris Canavan (NMED retired) who have developed, adapted and refined the methodology, and volunteers from the Mesilla Valley Fly Fishers who have participated were also recognized with accompanying awards.

Information and Data Sharing
Data files were provided to U.S. Forest Service and State of New Mexico, Environment Department for use in completion of a watershed based survey of the Willow Creek Watershed. In addition, we met with contracting and agency personnel on numerous occasions for coordination of monitoring activities. Private landowners along Willow Creek are critical to successful restoration of stream habitats and information sharing with individual landowners was conducted on several occasions during monitoring surveys.

ACKNOWLEDGEMENTS

The WNTI provided funding support for Willow Creek monitoring. Numerous helpful discussions and meetings were held with U.S. Forest Service personnel, the land management agency responsible for Willow Creek restoration activities. Allen Haden and other personnel of Natural Channel Design were helpful in discussions to review monitoring protocols and adjust as appropriate. New Mexico Environment Department personnel provided support and expert guidance on habitat data needs.