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Comparison of Electrofishing Fish Surveys and Angler Observation on Three Reaches of the Upper Rio Grande

by

Barry Weinstock

Committee
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A Professional Project Proposal Submitted in Partial Fulfillment of the Requirements
for the Degrees of
Master of Water Resources, Water Resources Program
and
Master Community and Regional Planning, School of Architecture and Planning
The University of New Mexico
Albuquerque, New Mexico
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Committee Approval

The Master of Water Resources and Master of Community and Regional Planning Professional Project Report of **Barry Weinstock,** entitled **Comparison of Electrofishing Fish Surveys and Angler Observation on Three Reaches of the Upper Rio Grande**, is approved by the committee:

______________________________ Chair	______________ Date
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Acknowledgements

I would like to thank my committee. Dr. Bruce Thomson and Dr. William Fleming for being so patient and encouraging for so long. Eric Frey Eric Frey, Sportfish Program Manager New Mexico Department of Game and Fish, for taking the time to help me with this.

The BLM Taos Field Office for their support with time, resources and data.

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Disclaimer

This report represents exploratory research that was conducted to satisfy the requirements of WR 598, Professional Project. The study included answers to questions asked of individual anonymous anglers. The results of this study are not intended for publication.

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Abstract

The purpose of fish population studies is to better understand the functional relations between life stages, abundances, and spatial distributions of fish populations in the upper Rio Grande and its tributaries. Taos Field Office, New Mexico, has managed an electrofishing fish population program since 2004 for seven reaches of the Rio Grande. Managers are interested in actual angler catches and satisfaction, and often use angler surveys to gather this data. This project compared two methods of gathering data about fish populations; electrofishing and angler questionnaires. Both have deficiencies in that they collect different types of data. The intent is to explore the utility of mixed method analysis for obtaining information regarding fish populations. Significantly larger sample sizes are necessary for the angler survey to be evaluated statistically. This study performed 39 surveys that provided 52 responses. Approximately 400 responses would be required for statistical significance. This project found that angler surveys can be used as a valuable supplement but not a replacement for, electrofishing data. In particular, angler surveys provide information on: 1. Historic knowledge of the resource. 2. As tools for identifying environmental conditions that affect the resource. 3. As tools for understanding stakeholder satisfaction. 4. Stakeholder engagement creates a sense of stewardship for the participant and opportunity for the manager to increase their understanding of the resource with angler's 'wisdom'. Combining the two methods has additional utility for fisheries study, even at the scale accomplished here. For example, the survey revealed what percent of anglers target trout in the Racecourse, and that those anglers experienced a decrease in the number and size of fish caught. With the assumption that anglers

enjoy catching more, and larger fish, survey results may be interpreted as a measure of satisfaction.

Between 2004 and 2014, electrofishing results showed that trout species in the Orilla Verde have declined in numbers, and size class has shown little change. Smallmouth bass have increased from 4% of an electrofishing catch to 45%. The Racecourse data show that Rainbow trout numbers have remained steady with an increase in size class. Brown trout stocking ceased in 2010, however, Brown trout data show that spawning is maintaining a population. Overall trout populations have declined. Smallmouth bass have increased from 3% of an electrofishing catch to 33%. The Middle Box comparison of trout population between 2005 and 2008 showed that trout numbers and sizes decreased.

There was concurrence between electrofishing and angler survey in identifying general trends about the Orilla Verde trout and bass population numbers and size of fish. The Racecourse results showed anglers in less strong agreement with electrofishing results. For the Middle Box, professional angler's observations concurred with electrofishing data, while less experienced angler's responses varied.

Introduction:

The upper Rio Grande in northern New Mexico is a rugged and beautiful river, dramatically cutting its way through an 800 foot gorge. The Bureau of Land Management (BLM) Taos Field office conducts a continuing electrofishing population survey program in several watersheds in this region. The purpose of these fish population studies is to better understand the functional relationships that that affect life stages, abundances, and spatial distributions of fish populations in the upper Rio Grande and its tributaries (Musich 2006). Fishery managers conduct these studies to collect data that can help make decisions to improve the health of fisheries as well as the enjoyment of recreationists. The ultimate objective for sport fish management is to provide a consistent, sustainable, high quality experience to the fishing public.

There are several field methods for estimating fish populations. They include electrofishing, snorkeling, netting, or simple shore observation. It is important to remember that without a complete removal, all surveys are merely indices of the populations. The effectiveness of electrofishing is influenced by a variety of biological, technical, logistical, and environmental factors. The catch is often selectively biased as to fish size and species composition (Sharber 1999). Some fish species respond differently to different methods. Northern Pike *(Esox Lucius),* for example have a high sensitivity to electricity which allows them to avoid electrofishing fields. Fish of different sizes also respond differently to different methods. Small fish, have such a small body area that the electrical field doesn't affect them (Sharber 1999). Also, different species live in different locations within the stream which affects their vulnerability to electrofishing. For example, Longnose Dace (*Rhinichthys cataractae)* rest on the bottom of rocky riffles and do not pop to the surface as easily as neutrally buoyant species so they are also difficult to catch with electrofishing. Larger fish are difficult to catch with seine netting because they escape while small fish are tough to catch with nets with large mesh sizes during electrofishing.

In addition to actual fish population data, managers are interested in angler catches and satisfaction, and often use angler surveys (i.e. creel surveys) to gather data. Creel surveys have drawbacks that are different than those for electrofishing. Participants may lie, forget, misidentify fish species, and creel surveys can require a large amount of staff time to collect data.

Both methods provide valuable information for characterizing the fishery's resource, but compared to the expense and time required to conduct angler surveys, electrofishing generally offers fishery managers the ability to determine population status more efficiently.

This paper compares the observations of anglers with electrofishing data collected over 10 years in the Middle Box (MB), the Orilla Verde (OV), and Racecourse (RC) reaches of the Upper Rio Grande.

This study is meant to enhance the understanding of population structures through an inductive research process. Electrofishing gives biologists a better estimate of fish population, diversity and dynamics than angler surveys, but gives little information about angler success and satisfaction. There are some sections of the Rio Grande, and some species in it that are better suited to different methods. Electrofishing can provide a good indication of what is in a certain reach at one time as well as a cross section of the entire fish community.

Conversely, fishermen often do not know what other types of fish are in a system, and can be unaware that they are fishing for a small fraction of the fish species present in that system. For example, in the OV reach the primary target fish is Brown Trout (*Salmo trutta)* however, based on electrofishing results, Brown trout comprises only 3% of the total fish biomass in the area. Consequently, angler surveys generally only provide data on sport fish species.

Over the years, I have had many conversations with fishermen about electrofishing data. There are a variety of directions that these conversations take. Sometimes, I relate new information derived from electrofishing data, and often I can support wisdom that they already have. Frequently, I relate to them something that they already know. More often, they disagree with this information. During one conversation, a fishing guide said, “you guys have no idea what’s in there”. Another angler said of the Rio Grande, “it is the most mysterious river I’ve ever fished”. These conversations made me question how alike biologist’s and angler’s perceptions of the Rio Grande fish populations are. There are many examples of angler surveys supplementing data from the sport fish perspective; and electrofishing can often be considered an alternate for angler surveys (Frey 2014).

Project goal

This project used a mixed methodology approach. It compared fish population data collected between 2004 and 2014 by the Bureau of Land Management (BLM), New Mexico Department of Game and Fish (NMDGF), and U.S. Forest Service (USFS) with data obtained from angler interviews. The goals of this project were to better understand the fish population of the Rio Grande and to determine relationships and correlations between electrofishing data and angler surveys.

This is an inductive (exploratory) study; therefore the intent is not to test a particular theory, but to explore the utility of mixed method data collection for fish population studies. As well as the goal of understanding fish populations in the Rio Grande, this project seeks to improve future population studies by relaying the utility and identifying the limitations of mixed methodology.

Mixed methodology

The term mixed methods research refers to using multiple methods to collect and analyze quantitative and qualitative data in the context of a single study (Driscoll et.al. 2007). Such designs have been used to augment traditional methods for assessing and monitoring physical environments (Mackay 2004). In this study, the quantitative data was extant as part of an ongoing program of data collection. The qualitative data has been collected non concurrently with the intention of exploring possible correlation.

Background:

Assessing fish populations allows managers to detect population trends and assess population status in order to support management decisions (Pope et at 2010). There are numerous methods for assessing fish populations. These include: observation from shore, observation from within the water, creel survey, passive and active netting, electrofishing, and complete chemical removal with subsequent sampling and enumeration. Each method has different advantages and disadvantages and is delivered at varying costs.

The BLM, New Mexico Department of Game and Fish (NMDGF), and United States Forest Service (USFS) initiated an electrofishing program in 2004 on the Rio Grande to standardize sampling methods in order to generate consistent and repeatable fish population data (Musich

2006). Data collection was planned in a 3 year rotating scheme through seven reaches of the Rio Grande between the CO-NM border and the Rio Embudo confluence. Each reach would be surveyed every three years.

The result of that effort is a large electrofishing dataset produced for the Rio Grande and selected tributaries. The quality of that data is enhanced by standardized collection methods completed by the same core group of people.

Many states, including New Mexico, use creel-survey methods for collecting catch and effort data for recreational anglers. As survey effort increases, so does the reliability of the information (Schlechte 2012). Creel surveys tend to be effective on lakes and ponds with restricted access points where the interviewer may sit and wait for anglers to be finished for the day. Creel surveys become less effective on larger bodies of water such as the Rio Grande, where there are many access points are increased that are widely dispersed.

Larger water bodies frequently require roving creel surveys. However because they contact anglers within the process of their fishing trip, they may not capture final results of the trip (Keefe et al. 2009). Roving creel surveys require more staff time and are therefore more expensive than access point creel surveys.

Many fisheries managers include electrofishing methods with creel surveys in order to understand fish population dynamics. Rather than a roving creel survey that would produce datasets for analysis, this project collected anecdotal observations of anglers that were considered experts on the Rio Grande fishery. Anglers were asked to relate observations about fish number and size for specific species in specific reaches, as well as their opinions about the possible causes of their observations.

Data collected through electrofishing is ultimately analyzed for trends, and the anecdotes of anglers can also be analyzed for trends. These trends reveal new information and identify areas to focus future research. This project seeks to answer whether or not observed trends from anglers concur with the trends detected from electrofishing data, and identify subjects for continuing study.

Description of reaches

Nomenclature for the reaches is most consistent with the whitewater recreation community's and is generally familiar to fishermen in the area. For the most part, the characteristics (substrate, flow, riparian vegetation, width-to-depth ratios, etc) of the river is consistent between the individual reaches. However, there are some transitional areas where fish population collection data might be skewed. For that reason, representative areas within the reaches were chosen for electrofishing.

The seven reaches of the Rio Grande that were included in the original BLM plan of study, beginning at the NM-CO border, are: Ute Mountain (UM), Upper Box (UB), Middle Box (MB), Lower Box (LB), Orilla Verde (OV), Racecourse (R), and Bosque (B). Of these, three are suitable for analysis: the Orilla Verde and Racecourse reaches, and the Middle Box. Figure 1.

Accepted Reaches

Middle Box

The Middle Box was accepted for analysis because numerous angler survey respondents related the same 2007 fish kill event in this reach. Reportedly, sedimentation, as a result of a mudslide in the Red River drainage, severely reduced trout population in this reach.

The Middle Box runs nine miles from the Red River confluence to the Rio Hondo confluence at the John Dunn Bridge. Gradient profile reveals an average drop of 20 ft per mile. Ownership is divided between Carson National Forest and BLM on the eastside of the river, approximately 70% Carson National Forest to 30% BLM. The west side is all BLM. There are a handful of access

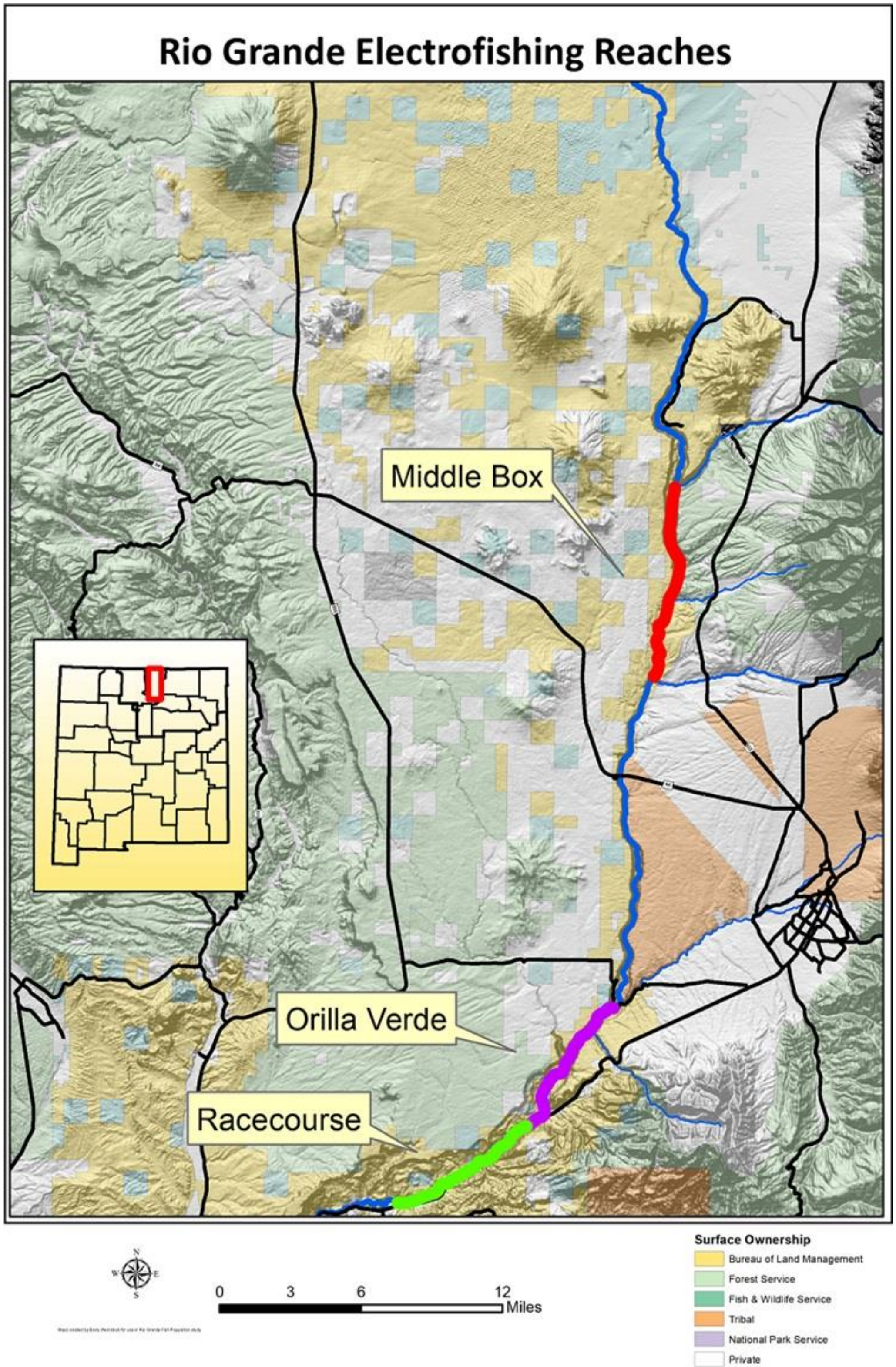


Figure 1. Map of northern New Mexico and accepted reaches.

points on the east side and one on the west. This reach of the river has a moderate gradient, with bottom substrate dominated by large boulders interspaced by fine sediment, large pond-like pools with short high gradient riffles, and riparian area dominated by willow (*Salix* spp.) and short sedges and grasses. Fishermen primarily walk down from the confluence with the Red River or up from the John Dunn Bridge, but some anglers access the river using steep unimproved trails in the Horsethief Mesa area and through Garapata and San Cristobal canyons.

Orilla Verde

The Orilla Verde goes from the Rio Pueblo to the Picuris escarpment. It drops 11 ft per mile over six miles, for an average drop of 11 ft per mile. The area was owned by the state until 1989 when it was given to the BLM in a trade. The first five miles are owned by the BLM, and renovation of campgrounds that were initially constructed in the 1960s has been intermittent throughout the past 10 years. These renovations include road reroutes, drainage channeling and erosion mitigation techniques.   New Mexico Highway 570 follows the river, and consequently small scale disturbance is common. This reach is the most assessable by anglers. The last mile of this reach is within the Village of Pilar, which rests on both sides of the river. Land use has not recently changed in Pilar and is dominated by small orchards and residential scale agriculture and gardening. NMDGF stocks several thousand catchable rainbow trout every year in the Orilla Verde section. This reach has as a low to moderate gradient, with bottom substrate dominated by cobbles and fine sediment, large pond-like pools with short low gradient riffles, with a terraced riparian area dominated by willow (*Salix* spp.), cottonwood (*Populus* spp.), salt cedar (*Tamarix* spp.), and short sedges and grasses.

Racecourse

The Racecourse elevation drops an average of 29 feet per mile and ends at the Taos and Rio Arriba County boundary. The east (south) side of the river is BLM while the west (north) is a patchwork of BLM and private. Although New Mexico State Highway 68 follows the river, disturbance of the banks is from anglers and rafters. Although access to the river is easy at multiple highway pullouts, many fishermen forego this section due to the rafting traffic present from the late spring to the early fall. NMDGF stocks several thousand catchable rainbow trout every year in the racecourse section. The reach has as moderate to high gradient, with bottom substrate dominated by large boulders interspaced by fine sediment, large pond-like pools with short high gradient riffles, and riparian area dominated by willow (*Salix* spp.), salt cedar (*Tamarix* spp.), and short sedges and grasses.

Rejected reaches

The Orilla Verde and Racecourse reaches have data for 2004, 2006, 2007, 2009, 2011, and 2014. In contrast, the Ute Mountain reach and the and Lower Box reaches, have been electrofished two of the planned four years due to low water levels, budget and time constraints. Only two miles of electrofishing population surveys were completed on the Rio Grande in 2012 and 2013.

The Ute Mountain, Upper Box, Lower Box and Bosque reaches were rejected for this comparative study for a number of reasons. These include:

- Smaller desirable sport fish populations and therefore fewer fishermen available for angler survey (UM, B)
- Restricted access, due to private land or terrain (UM, UB, LB, B)
- Inadequate electrofishing or angler survey data available for comparison UM, UB, LB,B)

Fish Population Data Collection and Analysis Methods

Historic Methods

Various methods of collecting fish population data have been used throughout the years on the Rio Grande. Population survey efforts in 1963 and 1968 employed dynamite and gill nets. Drawbacks to these efforts include:

- Habitat destruction
- High mortality
- Instead of using a linear reach of the river, cross sections were surveyed

The 1968 survey report stated (Little 1968):

> "The water velocity prevented using a gill net to stop downstream movement of stunned or dead fish" "After the dynamite detonation, fish floating on the surface were picked up by boat […] Many fish were swept downstream".

The surveys are qualitatively valuable as a snapshot of a small area. We can derive a relative species abundance and length weight analysis from these surveys; including relative weight and biomass. However, the samples cannot be considered representative of the population because of missed stunned fish. The identification of the River carpsucker (*Carpiodes carpio*) presence in these early reports is significant, as it has not been found since.

The 1974 report references the reports from the 60's but it is the first documented mention of Northern pike (*Esox Lucius*) migrating downstream after introduction in southern Colorado (Conner 1974).

The 1978 and 1981 survey reports could not be located. The locations reported with the data are poorly defined and use conflicting nomenclature combined with confusing reference to access points. The datasheets record that backpack electrofishing was utilized along the banks as well as overnight nets set at two locations.

The 2003 survey approximated the locations and distances of the 1978 and 1981 surveys and were also accomplished with backpack shockers, with netters and shockers and no net containment.

There have not been creel surveys done on the Rio Grande in recent years, and little information exists of overall angler satisfaction on these reaches of the Rio Grande.

Current methods

The BLM, NMDGF and USFS initiated an electrofishing program in 2004 on the Rio Grande that would standardize fish population sampling methods in order to create consistent and repeatable samples (Musich 2006).

Standardized sampling is defined,

"…as sampling with identical gear during the same season (or set of environmental conditions) in the same manner over time or among fish populations. Standardization does not eliminate bias but holds the bias constant so that differences in fish populations can be attributed to relative changes in a population or relative differences among populations. Other benefits of standardized sampling include improved communications among fisheries professionals and production of large-scale data sets beneficial for current and future assessments" (Bonar and Hubert 2002).

Standardized data collection was planned in a 3 year rotating scheme through seven reaches of the Rio Grande between the CO-NM border and the Rio Embudo. Each reach would be electrofished every three years. There are some transitional areas between reaches where fish population collection data might be skewed. Because of transitional zones between habitats, the resource constraints of electrofishing all miles, and the intrinsic biases involved with continuous reach electrofishing, representative areas within the reaches were chosen.

The result of this combined and continuing electrofishing effort is a large dataset produced for the Rio Grande. The quality of that data is enhanced by standardized collection methods completed by the same core group of people.

A stated, there have not been creel surveys done on the Rio Grande in recent years, and few measurements exist of the overall angler satisfaction with these reaches of the Rio Grande.

Electrofishing

Fisheries managers historically attempt to understand the ecology and population dynamics of sport fish species (Francis et al. 2007). However, there is a trend toward holistic ecosystem management that has caused managers to devote more attention to nongame species (Cowx and Gerdeaux 2004). Electrofishing can inform fisheries managers about the entire fish community and population dynamics. There are biases in electrofishing, but by following the same sampling protocols, consistency between the amount of effort and catch rates can be achieved (Pope et al. 2010). The electrofishing method used for the Rio Grande (Single pass) doesn't define absolute populations – it is used to determine community structure, or variety of species. By implementing a carefully conducted electrofishing program over a long period of time electrofishing can provide large amounts of information about community structure and its temporal evolution.

For the data used in this study, the 2004 surveys were accomplished using a Smith-Root 5.0 GPP electro-fishing unit on a river raft. Half mile reaches were surveyed. Rafts were operated by crews of three people, one person to control (boat driver) the raft, and two people collected fish using 5/8 inch net size dip nets. All fish species were collected during the survey. Processing rafts followed behind the electrofishing raft. When the electrofishing raft holding tank reached capacity, fish were transferred to the processing crew. Every fish was counted, identified to species, measured to the nearest millimeter, weighed to the nearest gram, and released. Some surveys from 2005 through 2009 used two processing rafts, employing a "leap-frog" approach to avoid down time, but there were no improvements in survey productivity or efficiency, and surveys after 2009 typically used one processing raft and one electrofishing boat.

The 2004 studies surveyed five reaches. Reach length was between 360 and 620 meters. The 2005 surveys used the same raft as the 2004, but sought to accomplish longer reaches. In 2005, six miles of the Middle Box were fished consecutively. Data for consecutively fished miles may possibly be affected by recapture.

All surveys from 2006 until 2014 used the same Smith-Root 2.5 GPP mounted on a newly acquired BLM cataraft'. Although the GPP size changed, the target electric output was accomplished in the same frequency and amperage ranges as the Smith-root 5.0. The crews numbered the same. 5/8 inch net size was the same. There are slight differences between the rafts, and catch efficiency may have increased slightly with the different rafts. The 2006 and 2007 surveys were done in one mile reaches and the 2008 through 2014 were mostly 2 mile reaches. A complete list of the Rio Grande electrofishing history was compiled for this study and is in the appendix.

Electrofishing data analysis

Fish population data was collected between 2004 and 2014 on the reaches described above. I participated in all electrofishing surveys since 2005.

Goals of the analysis included:

- Data was in raw form and required compilation (available in appendix) and collaboration with other surveyors to identify and clarify causes of inconsistencies and flaws in the data in order to detect and correct them. Examples include mileage nomenclature and errors in individual surveys which may have affected data.
- Analyze seven reaches for sport fish population data. Brown Trout *Salmo Trutta*, Northern Pike *Esox lucius*, Smallmouth Bass *Micropterus dolomieu*, and Rainbow Trout *Onchorynchus mykiss* were analyzed for: Percent of total catch, Catch per Unit Effort (CPUE), Percent of total catch Biomass, Wr (relative weight), and, mean length, and size class (length frequency). Non game fish were analyzed for their percent of total catch and percent of total catch biomass.
    - Percent catch – percent of each species of the total catch
    - CPUE – Catch per-unit effort expressed as number of fish captured per hour of effort
    - Percent biomass – percent of total live weight of catch

  - Wr -- Relative weight is the ratio of the actual weight of a fish to what a rapidly growing healthy fish of the same length should weigh. The relative weight is a measure of condition calculated using standard equations per species. Fish not of sufficient size for this analysis are removed from the data for this parameter.
  - Mean length – average length of each species
  - Size class –length frequency displaying percentage of fish by size for each species
- Compare results for reaches to determine trends within and between reaches.
- Of the **seven** original reaches, **Three** (Middle Box, Orilla Verde and The Racecourse) were chosen for this project because the datasets were large enough to analyze for trends and for comparison to angler survey.
  - Orilla Verde and Racecourse reaches will be analyzed because both have good data from both electrofishing and for angler survey
  - Middle Box will be analyzes for trout in response to a specific fish kill event reported by anglers to have happened 2007. This section was electrofished two years prior to the event, and again the year after the event

Limitations of electrofishing

It is accepted that there is bias introduced by the electrofishing method. For example, electrofishing in some habitats is technically difficult, or there is little chance of finding sites which represent an entire habitat type (Valtonen et.al. 2002).

There are logistic constraints before the boat launches; including river stage, weather, and personnel and resource availability. One of the most challenging habitats to electrofish is a narrow high gradient river like the Rio Grande. There is a balance between sufficient flow to maneuver a heavily loaded raft and excessive flows which increase water turbidity making it difficult to spot stunned fish.

Consistency between electrofishing surveys requires many variables to align. As an example, the first survey of the Middle and Lower Box sections were accomplished in 2005 by helicoptering the boat and equipment into the 800 foot deep gorge. The next year, the BLM purchased a raft that could be disassembled and transported by pack horse into the gorge and reassembled at the river. The middle and lower box were surveyed again in 2008. Water levels in the Middle and Lower box have either not been high enough to survey, or the window of opportunity has been so questionably short that crews for the surveys cannot be scheduled.

Standard electrofishing procedures target sport fish species, and population assessments of sport fish are often influenced by a desire to provide recreation or harvest for anglers. Conversely population assessments of nongame fish typically aim at maintaining or enhancing the distribution and abundance of nongame species. (Pope et al. 2010). Electrofishing has limited efficiency for censusing small fish.

In the Rio Grande, many of the natives are caught more effectively using techniques for catching small bodied fish. Seine netting is typically used to catch small bodied and fingerling fishes but is unachievable in most reaches of the Rio Grande due to steep bank drop-offs and boulders in the water.

Survey standardization can improve results. Standardized sampling is defined as sampling with identical gear during the same season (or environmental conditions) in the same manner over time or among fish populations. Although the BLM program has been consistent with its methods since 2006, there are still challenges. On one reach in 2008, the anode and cathode were accidently switched – causing fish to be drawn to the rear of the boat, where the netters were not present.

Additionally, electrofishing results are dependent on numerous variables. These include:

- Stream conditions vary from year to year
- Water quality parameters vary from year to year
    - pH and water temperature affects fish liveliness, habitat utilization
- Spawning occurs at different times in the year for each species and fish may be occupying different habitat
- Electrical conductivity varies and affects the output of the electrofishing unit and catch probability
- Level of effort changes throughout the day, seasonally, and between participants
- The probability of capture of fish by electrofishing is related to fish length, habitat complexity, stream size, water depth, water conductivity, species being sampled, and fish density

Angler Survey

The survey

Large programs are capable of spending time and money and have access to mailing lists of anglers to get random samples from large populations. For example, In 1989, the Montana Legislature approved funding for an "Enhanced Survey of Angling Pressure". The funding was such that the surveys were to be conducted every other year (McFarland2010). In 2009 the Montana Department of Fish, Wildlife and Parks mailed 89,423 surveys. In 2011, 89,697 surveys were sent out.

In order to compare angler observations with electrofishing data collected between 2003 and 2014, angler data was required. The angler survey is part of an analysis that will use the observations of fishermen to better understand the fish population of the Rio Grande. This survey was designed to be associated to abundance and size class data from electrofishing and was intended to identify trends over the 10 year period.

The survey (angler survey available in appendix) was created and administered to anglers specifically asking them to reflect on and relate observed trends over the period between 2004 and 2014 for specific reaches of the Rio Grande. The reaches were selected to match reaches in which quality electrofishing data was available.

This angler survey was designed to employ both convenience and snowball sampling. These methods were chosen because the survey questions focus on specific reaches of the Rio Grande, potential participants are rare, and because of funding and time limitations. Focused angler surveys assume a number of characteristics about the survey participants, discussed below.

Convenience sampling is used in exploratory research where the researcher is interested in getting an inexpensive approximation of the truth. As the name implies, the sample is selected because they are convenient. This nonprobabilistic method is often used during preliminary research efforts to get a gross estimate of the results, without incurring the cost or time required to select a random sample. (Peakman 2012)

Snowball sampling is a nonprobabilistic method used when the desired sample characteristic is rare and is used when it is difficult or cost prohibitive to locate sufficient number of respondents to provide meaningful results. Snowball sampling relies on referrals from initial subjects to generate additional subjects. While this technique can dramatically lower search costs, it comes at the expense of introducing bias because the technique itself reduces the likelihood that the sample will represent a cross section from the population. (Peakman 2012)

The survey described in this report was exploratory, and because participants in the survey are considered to have expert knowledge of the reaches of the Rio Grande under consideration, they constitute a small population for the study. Some of the chosen participants have been fishing the Rio Grande for more than 50 years, and have accumulated thousands of fishing days under a variety of river conditions. Their expertise is justified by the definition of a performative expert, "[one who has] the capacity to perform a skill well, according to the rules and virtues of a practice" (Weinstein 1993).

Approximately half of the participants were approached though e-mail and telephone as a result of referrals from prior participants. The other half was a roving survey. Roving surveys approach anglers while they are fishing. There were few respondents (<10%) who have been fishing the Rio Grande for less than 10 years. Expert anglers were surveyed in order to reduce bias due to learning curve, but the experiences of all anglers is important.

This survey is meant to discover the opinions and impressions of anglers, and the quality of their fishing experience. The survey focused on the number of fish of each species, and size of those fish. The questions were designed to correlate with the type of population structure data collected by electrofishing. The open ended questions were intended to provide an opportunity for anglers to relate a little wisdom. The survey was one page with an explanation, directions and example, a blank data table, and 4 open ended questions (Appendix page 2). The survey was short to minimize survey effort and limit the time required for anglers to participate in the survey (Pollock 1994).

The survey was administered in February 2014, using convenience and snowball methods. Thirty-nine surveys were completed. Some surveys were completed in person, while some were done over the telephone, and three were completed by the respondent and returned to the researcher. Each respondent was asked to complete a row of the survey for each method used for fishing used and for each species targeted. Surveys were analyzed by reach for:

- Type of fishing method used –Fly, Spin, Bait
- Target species
- Observed changes in number of fish by species
- Observed changes in size trend by species

Additional observations by anglers were categorized and tallied.

Goals of Survey analysis:

- Survey anglers by reach and species for: Method used for fishing, Target species, observed size and frequency trends
- Compare survey results with electrofishing data analyzed for trends by reach.
    - Angler observations size class and number of fish with electrofishing data
    - Compare angler target species w/ abundance by reach – e.g. Some anglers are fishing for bass in a section that data shows has no bass
- Compare trends in temperatures, hydrograph, compared with angler impressions

- Discuss advantages and disadvantages by species in relation to abiotic conditions
- Look at size classes before and after 2007 in mid box and box because of “Red river kill”
- Identify unique events from Angler surveys
- Other angler anecdotes
- Lack of statistical potential

Statistical Potential

Statistical analysis, at this sample size, is incompatible across methods. First level analysis (such as standard deviation) is justified for electrofishing data but not for the angler survey. At a 95% confidence level, the standard deviation of angler observation responses exceeded the amplitude of the observations. This means that the differences noted in the analysis would not be able to be differentiated (Hanson 2014). In other words, for the responses for trout in the Orilla Verde, 56% of respondents said “increase”. The margin of error calculated for this was 60 and therefore would include all values from -4% to 116%. There were not enough participants. An online calculator from Creative Survey Solutions (CRS 2014) calculated that 377 people would need to respond to bring confidence down to 5% of responses.

Angler Survey Advantages

This qualitative angler survey is focused on a small group of resource users – those who fish the Rio Grande in specific reaches. Therefore it was less expensive to produce than a large quantitative survey, and the data relates to specific reaches. A third benefit is the fact that anglers enjoy talking about their experiences and the resource and they appreciate the opportunity to participate in its management.

Limitations of Angler Survey

Although angler supplied data is considered a useful source of population data, and has been used for population abundance and age determination (Santucci 1991), there are some fundamental issues with qualitative research methods. These methods collect information about what the selected group of participants feels or thinks. You can't necessarily use this data to make assumptions beyond the specific group of participants (Peakman 2012).

Furthermore, qualitative methods, at the scale completed in this survey, conveniently allows for the collection of statistical data. However this is only a disadvantage if your research question also requires statistical data (Peakman 2012).

As well as the intrinsic limitations of small surveys that rely on participation, impressions and recall for accuracy, participants in the survey may lie, forget, or simply misidentify fish species. Additionally, both fish and angler behavior changes as fish become larger. Because larger fish become more piscivorous - prey on other fish- (Hanson 2014) they may be less likely to strike what a particular angler has to offer.

Results

Electrofishing Orilla Verde

The Orilla Verde reach was electrofished in 2004, 2006, 2007, 2009, and 2011. The 2004 and 2006 surveys were completed in September, the 2007 and 2011 were completed in June, and the 2009 was done in late May.

Brown Trout

From 2004 to 2011, Wr (relative weight, or plumpness) increased from 89.1 to 93.8 for a 5% increase. By 2014 Wr increased to 104.3 for an overall increase of 17%. Percent of catch ranged from 7% in 2004 to 19.5% in 2007, 5.5% in 2011, and 11% in 2014 -- a 57% overall increase. Between 2004 and 2014, Percent biomass increased from 5.5% to 9% (63%). CPUE decreased from 121.9 to 15.7 between 2004 and 2011 (-88%), then increased to 34% by 2014, for an overall decrease of 71%. Mean length increased 3%. While the condition and percent biomass of Brown trout has increased and indicates plumper, healthier fish, the CPUE has decreased.

Smallmouth bass

Wr decreased from 99.1 to 86.4 (-13%) from 2004 to 2009. Between 2009 and 2011 Wr increased from 86.4 to 109.8, then decreased to 98 by 2014 for virtually no change in ten years. Percent of catch in 2004 was 4%, it increased to 19.3% by 2006 and varied slightly until 2009, after which it increased to 35.5% (162%) by 2011. By 2014 percent catch increased to 45%, for a total increase of 1025% between 2004 and 2014. Biomass increased from 2.5% to 16% (540%) and CPUE increased from 63 to 137.2 (117%). Mean length of the Smallmouth bass decreased 24% between 2004 and 2011, then increased again for a small (2%) overall decrease.

Northern Pike

The sample sizes were small with an average of 6.6, a low of 0 (2007), and high of 11. Wr increased 2%. Percent catch increased from 2% to 4% between 2004 and 2011, and was 1% in 2014. Percent biomass increase from 17% to 20% (18%) in by 2011, and decreased to 5% in 2014. CPUE decreased from 23 to 1.8 (-92%) and Mean length decreased 14%.

Rainbow trout

There were no Rainbow trout caught in 2004. Wr had a steady decrease of from 109 to 86.3 (-21%) by 2011 and increased again to 105 by 2014, for an overall decrease of 4%. Percent catch increased from 0 in 2004 to 11% in 2009 then decreased to 1% in 2011 and 2014. Biomass increased until from 0% in 2004 to 5.5% in 2007, then dropped to .5% by 2011, and increased to 2% in 2014. CPUE increased from 3.5 to 31.1 between 2006 and 2009, decreased to 1.9 by 2011, and increased again to 4.4 by 2014, for an overall gain of 25%. Mean length, after a dip between 2006 and 2011 had an overall increase of 16% by 2014. Percent catch was up in 2009 from 2007, Percent biomass was down— perhaps reflected by decreased condition number Although the sample size is low for such an analysis, it should be noted that Rainbow trout is the only species to show a significant correlation between flow and CPUE. Brown trout and Smallmouth bass displayed correlations of -.51 and -.46 respectively, while Rainbow trout had a .86 correlation. (Figure 2, Page 27)

Both trout species had a decrease in Wr, Percent catch, Percent biomass and CPUE between 2007 and 2009, and most parameters decreased.

Orilla Verde Percent change by Parameter from 2004 to 2014						
	Wr	% Catch	% Biomass	CPUE	Mean Length	Size class change
Brown Trout	17	57	63	-71	3	1
Smallmouth Bass	1	1025	540	117	-3	1
Northern Pike	2	-50	-70	-92	-14	*
Rainbow Trout	-4	0	185	26	14	0

Table 1 *Northern pike sample size very small

Size class analysis (Table2) shows the dominant size class for Brown trout increased by one size class from 2004 to 2011. Smallmouth Bass decreased 5 size classes. Rainbow trout Increased 1 size class.

Orilla Verde Dominant Size Class by Species and Year						
	2004	2006	2007	2009	2011	2014
Brown Trout	200-219	260-279	180-199	200-219	220-259*	220-239
Smallmouth Bass	160-179	220-239	220-239	220-239	80-99	180-199
Northern Pike	720-899*	200-220	0	489-499	360-379	680-759
Rainbow Trout	280-299	180-199 320-339	260-279	260-279	320-339	280-299 320-339

Table 2 *size classes joined for same number of fish present in class

Racecourse Electrofishing

The Racecourse reach was electrofished in 2004, 2006, 2007, 2009, 2011, and 2014. The 2004 and 2006 surveys were completed in September, the 2007, 2011, and 2014 were completed in June, and the 2009 was done in late May.

Brown Trout

Wr decreased from 101 to 86.3 (26%) from 2004 to 2009 then increased to 103.79 (53%) by 2014. Percent catch decreased from 24% to 8% (-66%) from 2004 to 2006 then increased to 19.5 (144%) in 2009. Percent of catch decreased again in 2011 to 9% (-55%), and increased from 9% to 18% by 2014. Percent biomass decreased from 12% to 2.5% from 2004 to 2009 then increases to 10% in both 2011 and 2014. CPUE followed this erratic trend with a decrease from 212.2 to 32.3 between 2004 and 2011 (-91%), and an increase to 121.27 (275%) in 2014. Mean length increased 6.6%. Condition and length went up and other parameters went down.

Smallmouth Bass

Wr decreased from 99.5 to 93 (-7%) from 2004 to 2007, then increased 15% by 2014 for an overall increase of 7%. Percent catch went from 3% to 33% between 2004 and 2011 then decreased to 30% in 2014. Percent biomass decreased from 5% to 2% from 2004 to 2009, then increased to 10% by 2011 and 33% in 2014. CPUE decreased from 56.2 to 30.6 (-46%) from 2004 to 2009 then increased to 221.1 by 2014, an increase of 295%. Mean length decreased 30%. All numbers increased except mean length.

Rainbow trout

Wr increased from 89 to 95.32 (6.7%). Percent of catch increased from 0 to 9.5% by 2009 then decreased to 3% in 2014. Biomass increased from 0% in 2004 to 5.5% in 2007, then dropped to 3% by 2014. CPUE increased from 9 to 26.2 between 2006 and 2009 and decreased to 6 by 2011. CPUE increased to 21.4 by 2014. Mean length increased from 224mm in 2004 to 356mm in 2014. Most of this increase was between 2011 and 2014 (274mm to 356mm).

Although the sample size is low for such an analysis, it should be noted that Rainbow trout is the only species to show a significant correlation between flow and CPUE. Brown trout and Smallmouth bass displayed correlations of -.4 and -.08 respectively, while Rainbow trout had a .81 correlation.

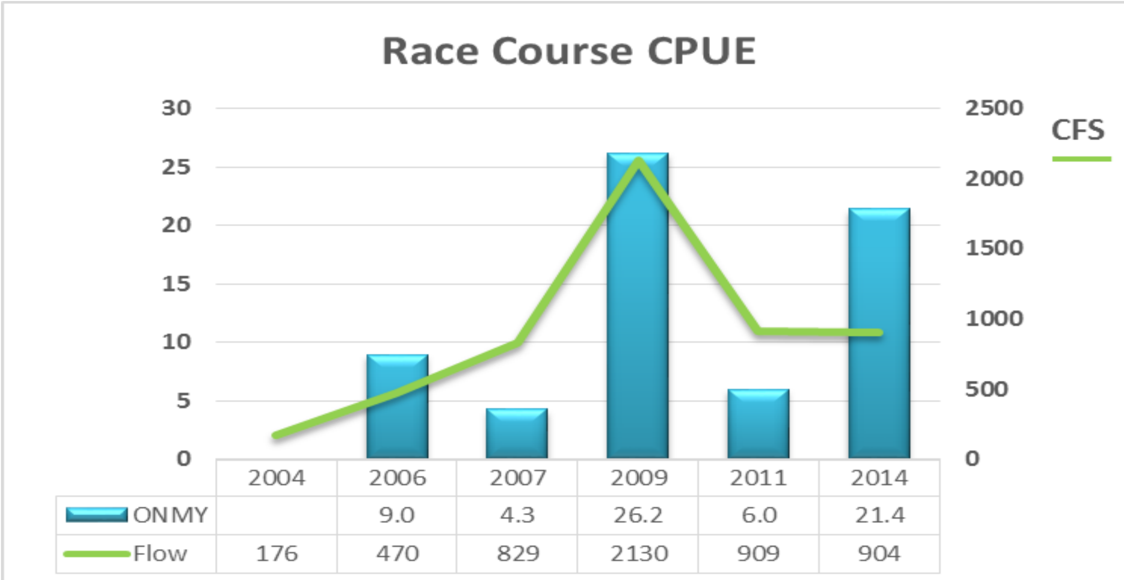


Figure 2 compares Catch per Unit Effort with river flow for survey years. ONMY is an abbreviation for Rainbow trout.

Racecourse Percent change by Parameter from 2004 to 2011

	Wr	% Catch	% Biomass	CPUE	Mean Length	Size class change
Brown Trout	33	-63	-50	-91.5	15	-5
Smallmouth Bass	15	1233	180	38	-19	-6
Northern Pike	17	-33	50	-64	46	10
Rainbow Trout	-21	0	-24	-46	11	2

Table 3.

Size class analysis (Table 4) shows the dominant size class for Brown trout increased by one size class from 2004 to 2011, then decreased by 6 by 2014. Smallmouth Bass decreased 5 size classes from 2004 to 2011, then decreased by another class by 2014. Rainbow trout increased 2 size classes from 2004 to 2011, then increased 8 by 2014.

Racecourse Dominant Size Class by Species and year						
	2004	2006	2007	2009	2011	
Brown Trout	220-239	240-259 280-299	220-219	180-199	240-259	120-139
Smallmouth Bass	180-199	180-199	120-139	180-199	80-99	40-79*
Rainbow Trout	260-279	200-219	260-279	240-279 300-319	300-319	460-479

Table 4.

Fish stocking

When money is available, NMDGF monitors angler activity over time, such as fishing pressure and take (Table 5). The last survey was completed in 2004. Angler use and harvest data for the Rio Grande upstream of Pilar, NM (NMDGF angler use database).

Fishing Pressure			
	Average Number of Fishermen Annually 97-2004	Number of days fished Average	Average Number of fish harvested
Rio Grande Gorge Above Pilar	13,902	36,786	19,103

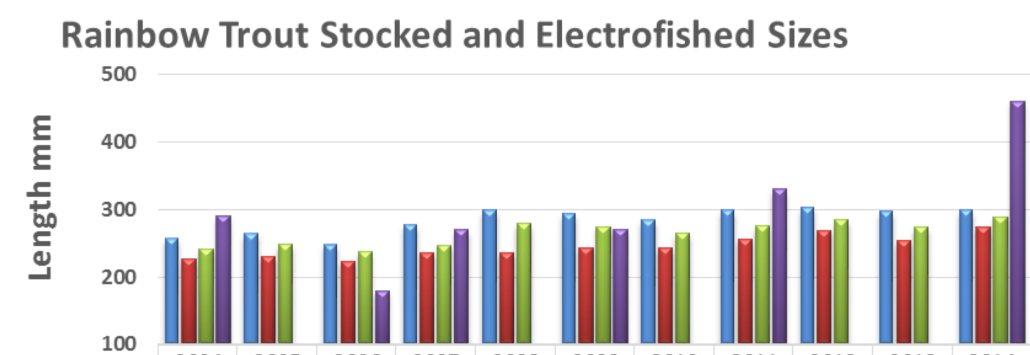
Table 5.

To satisfy anglers, NMDGF stocks thousands of fish in the Orilla Verde and the racecourse annually. Most of the Rainbow trout caught in the Orilla Verde and the Racecourse reaches are believed to have been stocked. The Brown trout that were stocked in 2004 were 20mm long. Stocking of Brown trout was terminated in 2008 due to inconsistent quality of fish from suppliers. Rainbow trout have replaced Brown trout as the primary stocked fish. Genetically normal Rainbows were stocked until 2010, when the agency began stocking triploid fish. Triploid rainbows are incapable of reproducing, and therefore do not threaten the native

Cutthroat trout’s genetic purity through hybridization. Data from NMDGF was analyzed with the following results:

Between 2004 and 2007, the average stocking length was 241.88mm, with the smallest at 226mm and the largest at 264mm. Between December 2007 and May 2014, the average stocking length was 276.45mm, with the smallest at 226mm and the largest at 299mm.

2006 stands out because the dominant size class was smaller than any fish stocked in three year prior. 2014 is significant for its dominant size class being far above stocked sizes. In many salmonids, sterility also means that fish will live longer (Seeb 1993).



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Maximum stocked mm	256	264	248	276	299	294	284	299	302	297	299
Minimum stoked mm	226	231	223	236	236	243	243	256	269	254	274
Average stocked mm	240.6	248.2	237.3	246.4	279.4	274.7	264.9	275.8	284.9	274.0	289.5
Dominant size class	290		180	270		270		330			460

Figure 3. Maximum, Minimum, and Average stocked refers to NMDGF stocking data. Dominant size class refers to electrofishing data.

Middle Box

The Middle box analysis is in response to conversations with anglers. Six of the respondents related a fish kill event in 2007. The Middle box was electrofished in 2005 and then again in 2008. This gives us a nice baseline and a dataset from after the event to analyze for changes.

Wr increased for Brown trout (1.4%) and Northern pike (5.4%), and decreased slightly for Rainbow trout. Percent of catch decreased for all trout species, from 31.3% to 24.5% for Brown Trout, and from 9.6% to 4.3% for Rainbow. Catch per unit effort decreased 87.5 to 35.5 (59.4%) for Brown trout and from 26.4 to 6.4 (75%) for Rainbow trout. Pike were unchanged at 3%. The large non game species showed minimal change. Common carp *Cyprinus carpio* increased 7% and White sucker *Catostomus commersoni* increased 4.2%. The Rio Grande Chub *Gila pandora* increased from 1.8% of the catch to 9.5% (427.78%).

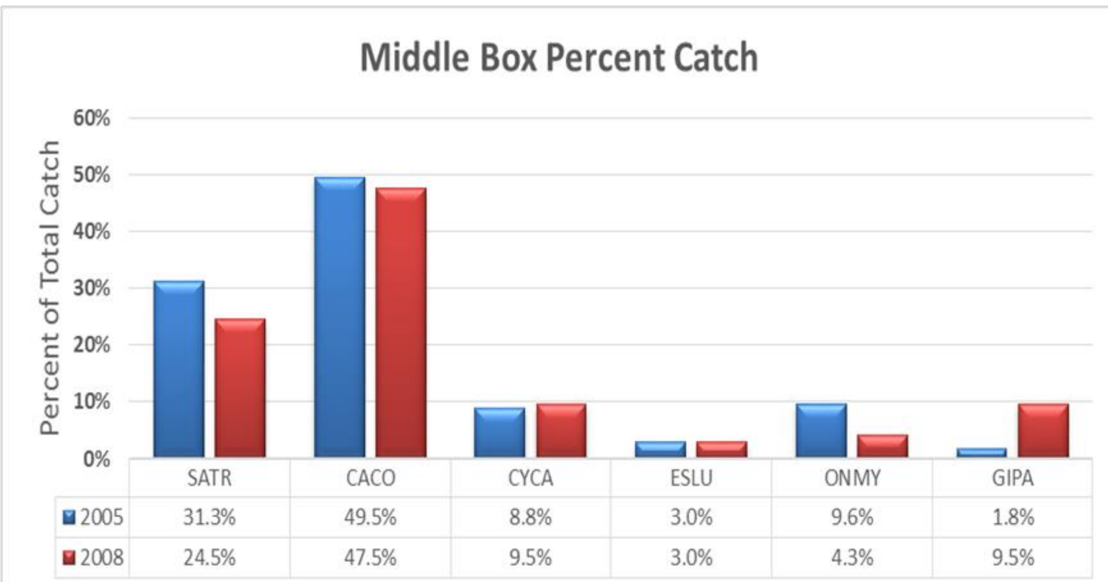


Figure 4. Percent Catch of all species in Middle Box. Each fishes name is abbreviated in this chart with the first two letters of its scientific name. Brown Trout Salmo trutta SATR, Rainbow Trout Oncorhynchus mykiss ONMY, Common Carp Cyprinus carpio CYCA, Rio Grande Chub Gila pandora GIPA,White Sucker Catostomus commersoni CACO, Northern Pike Esox Lucius ESLU

Percent Biomass nearly halved for Brown trout (11.5% to 6.5%), Northern pike (11% to 6.5%), and Rainbow trout (4.4% to 2%). Percent biomass decreased slightly for White sucker and increased slightly for Commmon carp. Of 26 size classes Brown Trout had 17 size classes represented in 2005, with the dominant being 220-239. In 2008 there were 16 size Classes with the dominant being 140-179 (two consecutive classes combined).

Of 26 size classes Rainbow trout had 12 size classes represented in 2005, with the dominant being 220-239. In 2008 there were 12 size classes with the dominant being 60-79, with a large gaps between classes.

Hydrograph

River stage was high each year of Middle Box survey. In 2005, the flow was 2751 cubic feet per second (cfs) and in 2008 it was 2042 cfs. The Orilla Verde and Racecourse reaches had relatively consistent flows across surveys.

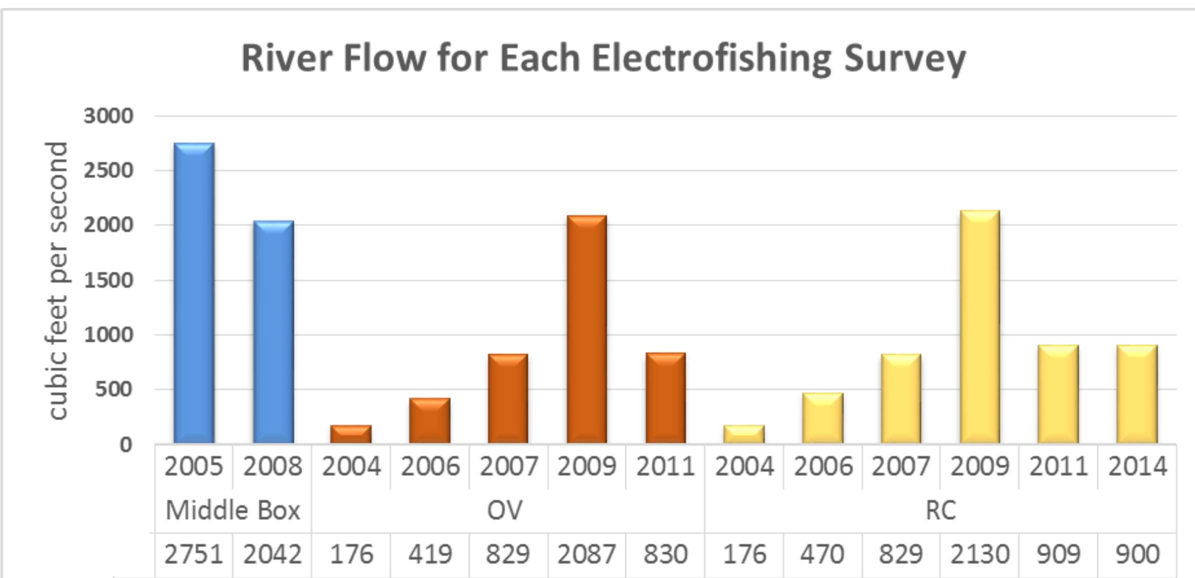


Figure 5

Water Temperature

There are a number of causes for changing fish populations. In the case of the smallmouth bass, temperatures and sudden changes in temperature, and flow differences may affect their life cycle and habitat choice (Emig 1996).

For example, Smallmouth bass typically spawn in water 57 to 64 degrees, but as low as 52. Smallmouth bass typically move into spawning areas when water temperatures range from 4.4 to 15.6 °C, and spawning commences when temperatures range from 14.4 to 21 °C. A drop in temperature may cause nesting to stop (Emig 1966).

Taos BLM fisheries program began deploying Onset hobo thermographs in 2005. These dataloggers record temperatures in Celsius hourly. There are three dataloggers in the Rio Grande. One is at the New Mexico Colorado state line. Another is about 20 miles downstream at Chiflo Mountain. The third is at the John Dunn Bridge, the end of the Middle Box and the beginning of the Lower Box. Various factors have resulted in gaps in the datasets. Theft, siltation, and low water resulting in exposure compromise the temperature data.

The methods for downloading the data have been differed over the years from large tablet computers in the field to retrieving then redeploying dataloggers. The current method involves a wireless shuttle that transfers the data on and then resets the device.

The three dataloggers show slightly different results. A trendline on the data for the State line datalogger displays a rise in temperature of approximately 2^{o} C between 2006 and 2009. This thermograph freezes regularly because the water is shallow and slow moving and the datalogger is near the bank. The Chiflo site shows large periods of unchanging temperatures when the datalogger was buried in sediment. It shows extreme trend of temperature increase

(+7^{o} C) between 2005 and 2009. The datalogger at the John Bunn Bridge (Figure 6), shows virtually no increase in river water temperature between 2005 and 2011. (All thermograph data available in appendix.)

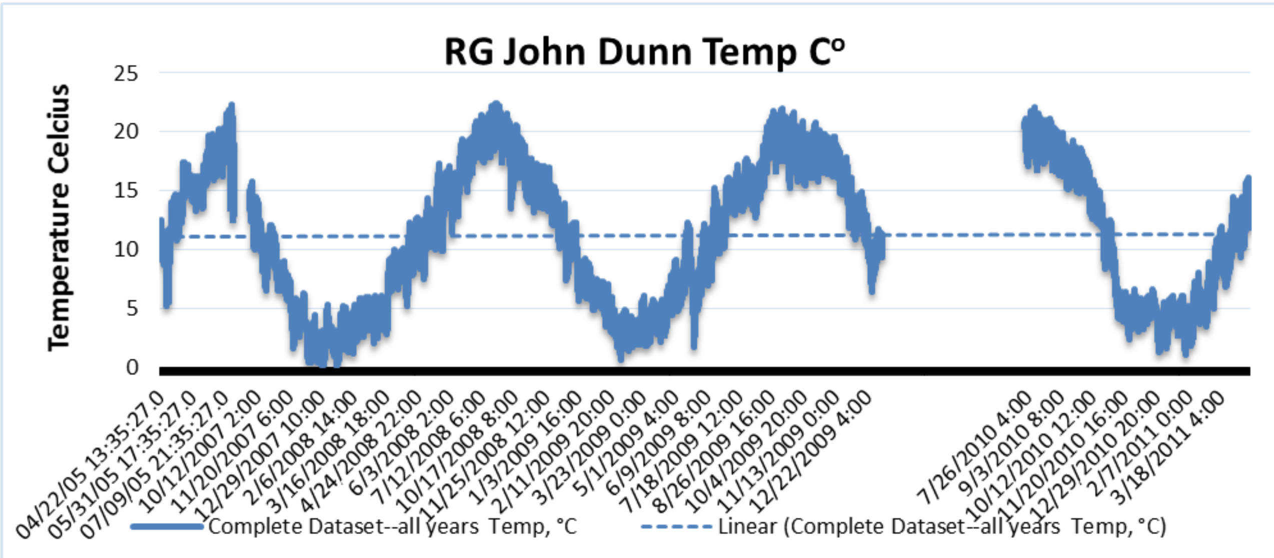


Figure 6. Data from Taos Field Office BLM Fisheries Program

Angler Survey results

Respondent characteristics

The Orilla Verde had the most angler survey responses of the reaches with 25 responses. The most experienced angler (Figure 7) on the Orilla Verde section had fished for 42 years, and the least experienced was 4 years. The average number of years was 14.2 and the median was 10. The average number of days fished was 17.8, and the lowest average number of days fished for the Orilla Verde was three for Northern pike, three for Smallmouth bass, and five for trout.

The Racecourse had 15 angler survey responses. The most experienced angler on the Racecourse section had fished for 50+ years ("when you get that old, you don't remember the specifics"), and the least experienced was 4 years. The average number of years was 17.2 and the median was 14. The average number of days fished on the Racecourse was 14, and the lowest number of days was five for Northern pike, five for Smallmouth bass, and five for trout.

The Middle Box had 12 responses. The most experienced angler (Figure 7) on the Middle Box section had fished for 42 years, and the least experienced was 5 years. The average number of years was 19.8 and the median was 20. The average number of days fished was 17.3.

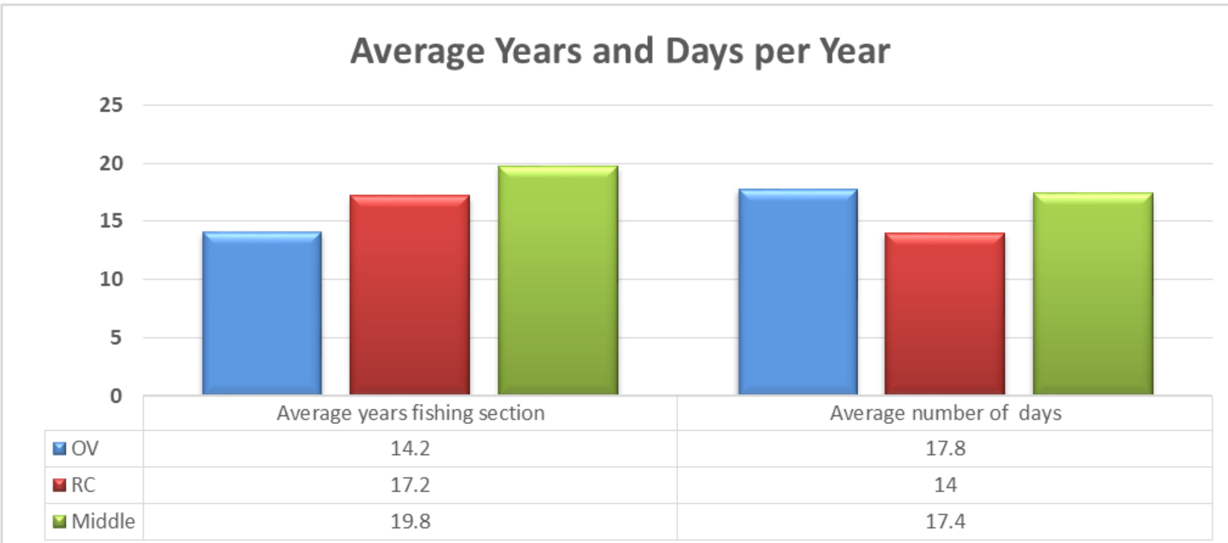


Figure 7. Average number of years fishing each reach and days per year per reach from angler survey.

Species Targeted

One of the interesting things learned through conversation is that some people in northern New Mexico discontinued the use of the term pesca when describing fish (Joyce). They replaced pesca with the word trout, or, 'Truchas'. As a result, there were many respondents who identified both brown and rainbow trout simply as 'trout'. There were others who defined rainbow as the trout in the survey, and said additionally, "I also like to catch browns". For this reason, all trout were grouped together for this analysis (Figure 8).

Of the four Smallmouth bass specific responses for the Orilla Verde reach, the average years targeting bass was 5.75. There were 14 responses that targeted trout in this reach and the average number of years was 16. The average number of days (18.25) that Smallmouth bass are being targeted by these anglers is equivalent to the days spent targeting trout (18.7), and exceeds the days spent targeting Northern pike (14.4). The average number of years of the five anglers targeting Northern pike was 17.4.

Of the three Smallmouth bass specific responses for the Racecourse reach, the average years targeting bass was 7.6. There were 11 responses that targeted trout in this reach and the average number of years was 21. The average number of days (6.3) that Smallmouth bass have been being targeted by these anglers is less than the days spent targeting trout (18.7), and exceeds the days spent targeting Northern pike (5). One angler targeting Northern pike in this reach for four years.

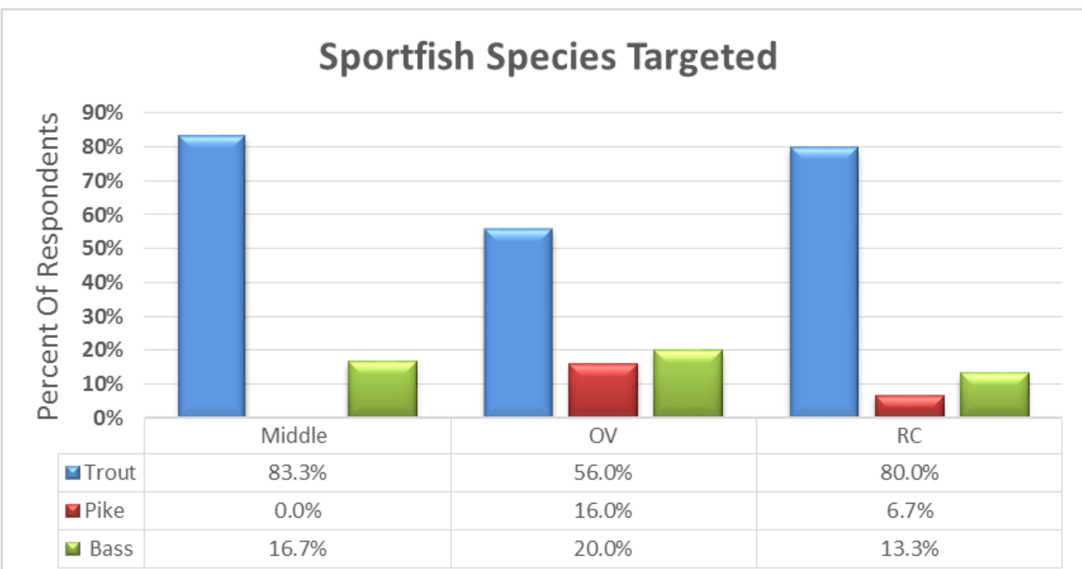


Figure 8. Sportfish species targeted by species and reach. Data from angler survey.

Fishing method

In the Orilla Verde, 75% of the anglers in this section fly fish and 25% spin fish.

In the Racecourse, 60% of the anglers in this section fly fish and 40% spin fish.

The Middle Box had 75% fly fishing and 25% spin casting.

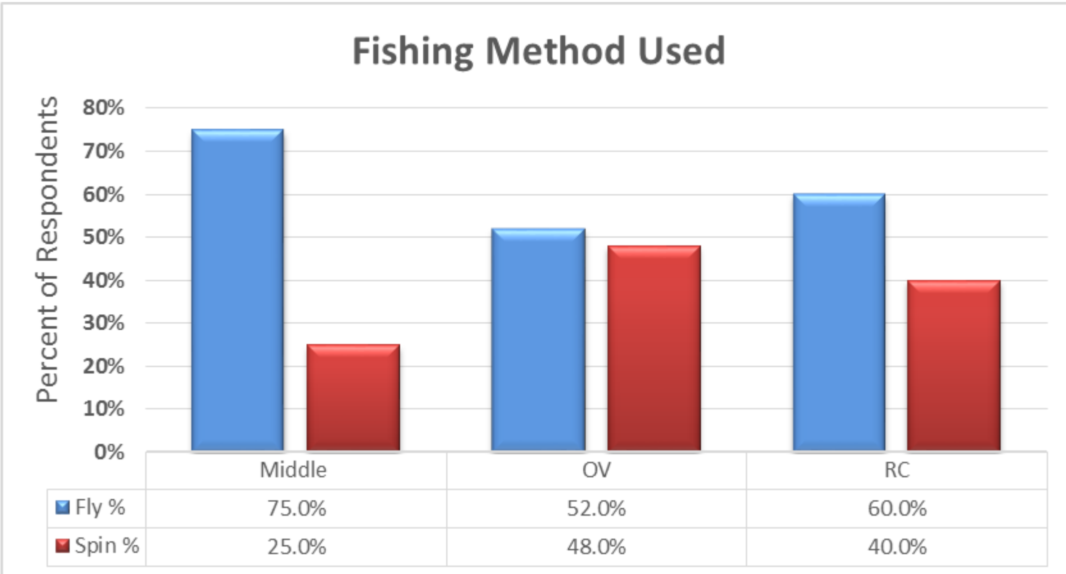


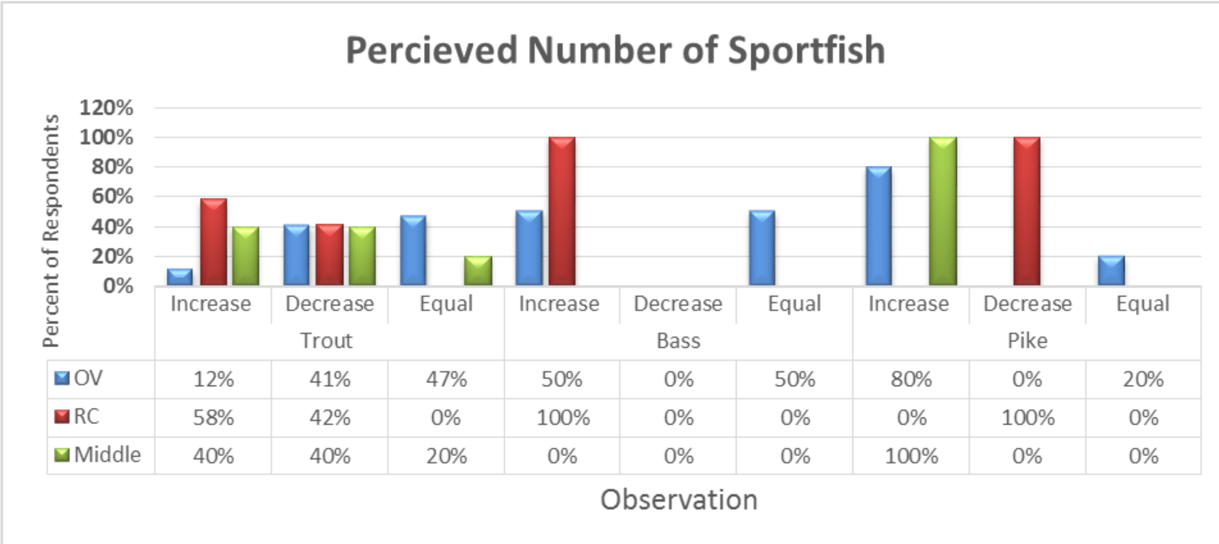
Figure 9. Sportfish fishing method used by reach. Data from angler survey.

Number of fish observation results

In the angler survey, no specification for size to remain 'equal' was suggested. Nonetheless, numerous (Figure 10) respondents said 'same", or 'equal' to the questions of number and size of fish.

In the Orilla Verde reach, 12% of respondents observed the number of trout increase, 41% observed decrease and 47% said equal. 88% perceived trout in the Orilla Verde to be equal or decreasing in numbers. The numbers of Smallmouth bass were perceived by 50% to increase, 0% to decrease, and 50% to remain equal. 100% of respondents perceived Smallmouth bass to be equal or to increase in numbers. Though small sample sizes, Northern pike in the in the Orilla Verde were perceived to increase by 80% of respondents and remain equal by 20%, with no perception of decrease.

In the Racecourse, 58% of respondents observed the number of trout increase, 42% observed decrease and 0% said equal. Smallmouth bass were perceived by 100% to increase. Though also a small sample size, Northern pike in the in the Racecourse were perceived to decrease by 100% of respondents (maybe that's why nobody fishes for pike there).



	Trout			Bass			Pike		
	Increase	Decrease	Equal	Increase	Decrease	Equal	Increase	Decrease	Equal
OV	12%	41%	47%	50%	0%	50%	80%	0%	20%
RC	58%	42%	0%	100%	0%	0%	0%	100%	0%
Middle	40%	40%	20%	0%	0%	0%	100%	0%	0%

Figure 10. Angler response to perceived number of sportfish by species and Reach. OV stands for Orilla Verde, and RC stands for Racecourse.

Size of fish observed results

Orilla Verde

In the Orilla Verde reach, 13% of respondents observed the size of trout increase, 19% observed decrease and 69% said equal. 88% perceived trout in the Orilla Verde to be equal or decreasing in size. Smallmouth bass size was perceived by 50% to increase, 0% to decrease, and 50% to remain equal. 100% of respondents perceived Smallmouth bass to be equal or to increase in size. Though small sample sizes, Northern pike size in the in the Orilla Verde was perceived to increase by 20% of respondents and remain equal by 80%, with no perception of decrease.

Racecourse

In the Racecourse reach, 17% of respondents observed the size of trout increase, 25% observed decrease and 58% said equal. 83% perceived trout in the Racecourse to be equal or decreasing in size. Smallmouth bass were perceived by 33% to increase, and 67% to remain equal. 100%

of respondents perceived Smallmouth bass to be equal or increased in size. Though also a small sample size, Northern pike in the in the Racecourse were perceived to increase by 100% of respondents.

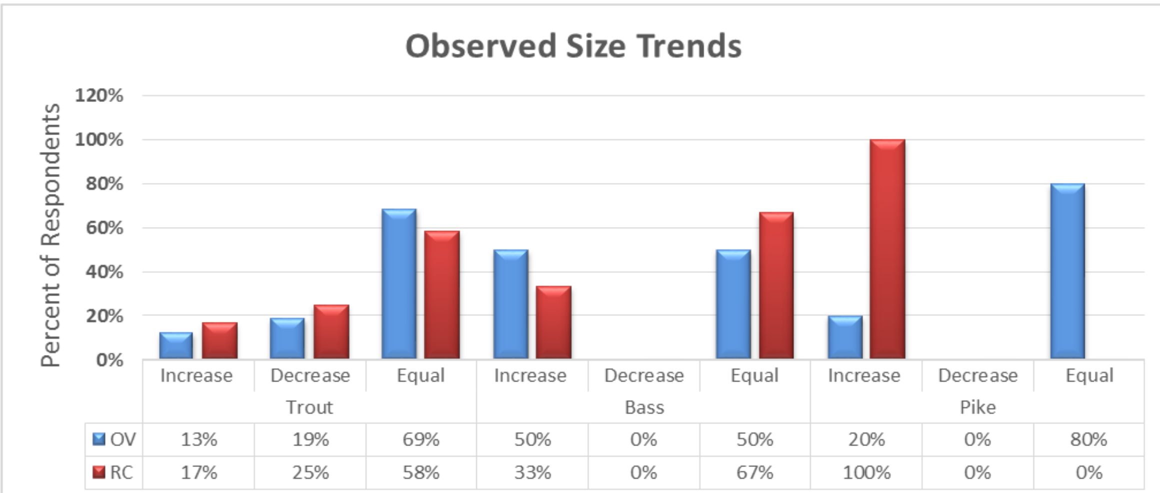


Figure 11. Angler observed size trends by species and reach. OV stands for Orilla Verde, and RC stands for Racecourse.

Enumerated and Anecdotal Angler Survey Results

Question 1. Please describe any changes in fish population that you have observed between 2003 and 2013 for specific areas or for the Rio Grande as a whole.

Question 1 was intended to allow anglers to relate observations regarding their impression of the population characteristic as asked for in the responses for the survey's table. Most of the responses for Questions 1 were able to be incorporated into the tabled responses.

Question 2. Please describe the range of years that your observed changes occurred. (Between 2003 and 2013)

The most common response to this question was that between 2007 and 2009 there was a decrease in the sportfish populations on the Rio Grande, specifically near the Red River. Most of the decrease was attributed by respondents to a mudslide that occurred in the Red River drainage that substantially increased turbidity. There were other stories of mudslides reducing trout populations in the early 1980's as well. Anglers perceived that trout populations rebounded within a couple of years and size increased within a few more years. Other respondents were less able to offer specific changes associated with specific years.

Question 3. What do you think caused the changes you observed?

Anglers have inherent bias, and which affects their responses to this question. The responses enumerated in Table 5 display the differing feelings about the physical river conditions. Some respondents felt that lower water temps and lower water flows were good for fishing, while most perceived the potential threats of diminished water quality to overall fishery health. The question was not intended to skew negative, but it seems like people identify more negatives than positive.

Enumerated Results

	Positive	Negative
Warmer water temps	2	7
Lower water levels	3	6
Piscivory		3
Otter predation	1	3
Increased pressure		6
Turbidity /Sediment		4
Enforcement		4
Rafters		2
Resource Competition		1

Table 5. Summary of angler responses of their explanation of causes of changes in fish populations.

Question 4. Have you observed anything else that you think would help this survey?

This question was rarely answered, and when it was the responses related to previous responses, therefore, most of the results from this question ware combined with question 3 results. However, a few of the respondents related some concepts:

"…otters preying on trash fish increases numbers of trout."

"Something should be done about the erosional sedimentation from the Red River."

"…it is the most mysterious river I've ever fished."

"…the shooting ranges near the river might put lead into the water."

Comparison of Electrofishing and Angler Survey

Number of fish comparison

Orilla Verde

In the Orilla Verde reach, electrofishing found that the trout catch decreased by 22% for Brown trout and 0% for Rainbow. Catch per unit effort decreased 88% for Brown trout and 46% for Rainbow trout. 12% of the angler survey responses said trout populations increased, 41% said decreased, and 47% said equal. For the Smallmouth bass, electrofishing describes the percent catch as increasing by 787%. Catch per unit effort increased 61%. 50% of the angler survey responses said bass populations increased, and 50% said equal. Although a small sample of bass anglers was completed, anglers identified the increase in bass population numbers. For Northern pike, electrofishing describes the percent catch as increasing by 100%. Catch per unit effort decreased 45%. 80% of the angler survey responses said pike populations increased, and 20% said equal. Although a small sample of pike anglers was completed, anglers identified the increase in pike population numbers.

Racecourse

In the Racecourse reach, electrofishing found that the trout catch decreased by 63% for Brown trout and 33% for Rainbow. Catch per unit effort decreased 91.5% for Brown trout and 64% for Rainbow trout. 58% of the angler survey responses said trout populations increased, and 42% said decrease. For the Smallmouth bass, electrofishing describes the percent catch as increasing by 1233%. Catch per unit effort increased 38%. 100% of the angler survey responses said bass populations increased. Northern pike are not caught on the Racecourse while electrofishing, nor are they frequently targeted in this reach.

Middle Box

In the Middle Box reach, electrofishing describes the trout catch decreased by 31.3% for Brown trout and 24.5% for Rainbow. Catch per unit effort decreased 59.4% for Brown trout and 75% for Rainbow trout. 40% of the angler survey responses said trout populations increased, and 40% said decrease, and 20% said equal. When asked about the fish kill in particular, respondents said that the trout population started to rebound in 2009-2010.

Size of fish Comparison

Orilla Verde

In the Orilla Verde reach, electrofishing found the trout mean length decreased by 9% for Brown trout and increasing 11% for Rainbow. Size class analysis describes Brown trout as having increased one size class and rainbow two sizes. 13% of the angler survey responses said trout size increased, 19% said decreased, and 69% said equal. Angler response is close to the electrofishing data. For the Smallmouth bass, electrofishing found the mean length as decreased by 24%. 50% of the angler survey responses said bass size increased, and 50% said equal. For Northern pike, electrofishing found the mean length decreased by 27%. 20% of the angler survey responses said pike size increased, and 80% said equal.

Racecourse

In the Racecourse reach, electrofishing found the trout mean length increased by 15% for Brown trout and increasing 46% for Rainbow. 17% of the angler survey responses said trout populations increased, 25% said decreased, and 58% said equal. For the Smallmouth bass, electrofishing found the mean length as decreased by 19%. 50% of the angler survey responses said bass size increased, and 50% said equal. Northern pike were not caught on the Racecourse while electrofishing, nor are they frequently targeted by anglers in this reach.

Middle Box

In the Middle Box, electrofishing found the trout mean length decreased by 9.6% for Brown trout and increasing 2.6% for Rainbow. Size class analysis found Brown trout as decreased three to four size classes and rainbow eight size classes. 13% of the angler survey responses said trout size increased, 19% said decreased, and 69% said equal. For Northern pike, electrofishing describes the mean length as decreasing by 27%. 20% of the angler survey responses said pike size increased, and 80% said equal.

Cost of Angler survey vs. Electrofishing

Cost is a large part of survey method choice for agencies, and although not the focus of this study, a necessary factor to look at when comparing methods or considering mixed methodology.

For the electrofishing surveys on the Orilla Verde and the Racecourse sections of the Rio Grande, 11 days were spent on the River with an average of six people on each survey. Some surveys included assistance from unpaid interns and volunteers. There were never more than two interns and volunteers together on a survey. To compensate for the intern/ volunteer effect, cost of the surveys will calculate five surveyor per survey event. Most surveys take at least eight hours and some take longer. Pay rates are very conservative. Calculations will use an 8 hour day. The survey equipment is used for other projects, but the electrofishing boat was intended for the Rio Grande and the Rio Chama. The boat and the electrofishing equipment cost the BLM approximately $10,000. Clearly this is not an exhaustive list of the expenses of electrofishing. . Each of these methods require data entry and analysis, so these costs are not included here.

Electrofishing	
$35 x 2 (full time employees) x 9 (hours) x 11 (surveys) =	$6,930
$20 x 3 (people) x 9 (hours) x 11 (surveys) =	$5,940
Discounted electrofishing boat =	$8,000
Total	$20,330

The angler survey was devised and refined over a week and a half, with an average of three hour a day spent on it. Administering the survey took 15 days more, with an average of two hours spent.

Angler survey	
$35 (full time employee) x 3 (hours) x 10 days =	$1,050
$35 (full time employee) x 2 (hours) x 15 days (surveying) =	$1,050
Total for this survey	$2,100
Additional full time employee for full survey 20 days x 35 x 8	$5,600
(For a one time survey) (Example may not reflect time necessary)	
Total for full survey	$6,650

Costs between methods are not comparable. Accomplishing 11 angler surveys with a minimal time spent would cost approximately $73,150. That cost disregards travel.

Conclusions

This project concludes that combining the results from electrofishing and angler surveys can lead to improved understanding of fish populations and dynamics in a high altitude trout stream. Angler surveys provide useful information in four areas:

The first is the historic knowledge of the resource, and knowledge of fish populations prior to electrofishing efforts. This study suggests anglers can provide reliable observations regarding population numbers, but not fish size. While not quantitative it is valuable to providing and improved understanding of the resource. There were some easily identifiable agreements and / or disagreements between electrofishing data and angler survey, but they tended to be vague, even in reaches that had larger survey sizes (Table 6). This is likely due to the subjective bias of the angler's perception of their experience. Significantly larger sample sizes are necessary for angler surveys to be evaluated statistically. This study accomplished 39 surveys and filled 52 responses for the reaches analyzed. As described above, in order for there to be statistical significance, approximately 400 responses would be required.

Secondly, as a tool for identifying mechanisms that affect the resource. Electrofishing data collects information of fish populations for a single day whereas, anglers provide integrated observations that can identify environmental changes that managers may not be aware of. The Middle Box mudslide is an excellent example. While fishermen, at this scale, may not seem good at population structure estimations, they provide assistance in identifying some of the relationships between environmental events and characteristics and fish population.

Orilla Verde Results Compared		
	Electrofish	**Angler Obsevation**
Trout	Decrease number Equal size	Equal or decrease number Equal or decrease size
Bass	Increase number Equal size	Equal or increase number Equal or increase size
Pike	Small samples Small samples	Increase number Same size
Racecourse Results Compared		
	Electrofish	**Angler Obsevation**
Trout	Decrease number Decrease size	Split Number Equal or decrease size
Bass	Increase number Equal size	Increase number Equal or increase size
Pike	Decrease number Increase size	Decrease number Increase size
Middle Box Results Compared		
	Electrofish	**Angler Obsevation**
Trout	Decrease number Decrease size	Split number Split size

Table 6. Agreement of angler survey with electrofishing data.

Third, as a tool for understanding stakeholders. Survey responses produced interesting and useful information about the angler community and overall satisfaction that can be useful to management.

Finally, stakeholder participation is an area of meaning and opportunity. Surveyed participants recognize their involvement in, and contribution to the management of the fishery resource. Engaging anglers adds to their sense of ownership and therefore stewardship. For the scientist, angler survey is an opportunity to engage population and derive the inherent wisdom of people who have enjoyed the resource for many years. Often, educational outreach programs assume that stakeholders need educating, without first engaging their knowledge and concerns. This can lead to outreach programs failing to engage stakeholders. Engaging their knowledge of the resource provides sense of empowerment, and relationship to the resource. These, in combination with knowledge of larger implications and best practices, can foster a stronger sense of stewardship. Question 3 in the survey skewed towards negative responses. Having done all of the surveys, I believe that these responses were not given because of negativity about the fishery. I believe they came from concern and stewardship for the resource rather than condemnation of the resource or the resource management.

Mixed method has additional utility for fisheries study, even at the scale accomplished here. Data from this angler survey can be interpreted as a measure of satisfaction. For anglers targeting trout, angler survey responses would relate a positive experience if they experienced an increased catch and a negative if they experienced a decrease.

There are many variables that are involved with something as complex and dynamic as a lotic fishery. While electrofishing can provide a broad view of the population of fish in a system. Angler surveys can inform managers about the sportfishing experience related to those populations, and therefore reflect angler satisfaction. Neither technique is thorough enough to make decisions about how managers want to spend their time and money.

Recommendations

NMDGF currently has a robust education program in place that continues to grow with new experiences made available. Their programs are designed to promote safety, technical skill, and environmental stewardship. This study can, however recommend a few things.

Brown trout seem to be declining in the Orilla Verde and Racecourse sections of the Rio Grande, and Rainbows exist because of stocking. Concurrently there is an increase of Smallmouth bass. Most anglers are targeting the trout instead of bass, and angler observations reveal that there is a concern about the excessive number of fish that some people take.

The NMDGF and the BLM should promote the lower reaches of the Rio Grande as a wonderful trout *and* Smallmouth bass fishery. This promotion can take place during educational events, surveys, and other angler contacts. Promotion may also take place through existing agency signage and literature.

The BLM Taos Field Office conducts a number of events each year in the interest of educating the public. These events require time and money to produce and often they are under attended. I recommend Individual angler contact by educators across all concerned agencies during which anecdotal observations from the anglers can be recorded and information can be relayed to anglers. These contacts can be concurrent with surveys. Additionally, surveys must allow not only for the observation but the interpretation of the observation. This will inform agencies about necessary educational goals.

It is recommended that agencies increase enforcement or increase the perception of enforcement in these reaches of the Rio Grande in regards to fish take.

It is noted that,

"…inductive reasoning is often referred to as a "bottom-up" approach to knowing, in which the researcher uses observations to build an abstraction or to describe a picture of the phenomenon that is being studied" (Lodico et al, 2010, p.10).

This study recommends researchers adopt this 'bottom up' approach, to the degree possible, with ongoing field contact and attendance of events produced by other entities, including fishing clubs and outdoor groups.

Both qualitative and quantitative research are designed to build knowledge, and they can be used as complementary strategies.

Survey methods such as one employing a Likert scale is a possible way to increase statistical value of surveys.

E.g. Trout have increased in size Disgree 1 2 3 4 5 6 7 8 9 10 Agree

Trout have increased in number Disgree 1 2 3 4 5 6 7 8 9 10 Agree

This angler survey was an exploratory attempt to determine if electrofishing and angler survey data could be correlated. Although it was carefully thought out, it did not ask questions in an appropriate format for statistical analysis. While the anecdotal results of this survey are interesting, it is difficult to derive significant population structure comparisons with electrofishing data. Future surveys should be larger and administered for individual reaches. Future surveys should also answer be tailored to answer specific questions about the fish populations for specific reaches or resources. These surveys should also be administered to test subjects first to clarify response appropriateness to the questions asked, and specific goals of the survey.

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Year	Site Location	Named	Length	UTM datum	Begin		End		WQ Data	Time	notes
Early											
4/1/1962-3/31/1963	Colorado State Line to Rio Chama Confluence								no		Gill net and Dynamite
4/1/1965-3/31/1966	North of John Dunn Bridge								no		Gill nets and dynamite
4/1/1965-3/31/1966	North of Taos Junction Bridge								no		Gill nets and dynamite
4/1/1965-3/31/1966	Rio Arriba-Taos County Line								no		Gill nets and dynamite
4/1/1965-3/31/1966	Velarde Diversion Canal								no		Gill nets and dynamite
Electro					UTMs generated in office 01/16/2014						Start Electrofising
10/6/1981	At Old Gauge station	1. Colorado State Line	200m	Nad 83	436094	4094635	436137	4094435	cfs		Station no longer exists. Assumed start at state line
7/9/1981	At Trail	2. Sunshine Trail	150 m	Nad 83	438107	4077212	438116	4077162	Tmp,Cond		Trail no longer called sunshine. Lee
		3. Ute Mountain									
7/9/81 and 7/10/81		4. Chiflo Trail	150 m	Nad 83	439013	4066395	438956	4066245	Tmp,cond,cfs		Trails may be the same
9/19/81 and10/5/81	200 m Down from bridge	5. John Dunn Bridge	200 m	Nad 83	436412	4043333	436281	4043133	no		2 events
8/11/78 and 10/6/81	At Bridge	6. Taos Junction Bridge	150 m	Nad 83	434131	4021467	434032	4021345	no		
10/7/1981	At La Cieneguilla confluence and downstream from	7. Pilar	100 m	Nad 83	429176	4014373	429132	4014272	no		
2003											
9/11/2003	Site 1 (mile 2)	Costilla Creek	121 m	Nad 83 13S	436096	4092645	436188	4092802	all		Backpack shocker
9/10/2003	Site 2 (mile 10)	Cow Paddy Trail	161 m	Nad 83 13S	437401	4081718	436188	4092802	all		Backpack shocker
9/8/2003	Site 3 (mile 21)	Chiflo Trail		Nad 83 13S	439105	4066275	439180	4066453	all		Backpack shocker
9/9/2003	Site 4 (mile 29)	AboveRed River Confluence	50 m	Nad 83 13S	438020	4055720	438032	4055833	all		Backpack shocker
2004											
9/8/2004	Above Turkey Farm		1060 m	Nad 83 13S	421059	4008697	420031	4008371	none		Raft 5.0 gpp
9/7/2004	TJB Guage Station(hondo gauge)	mile 54.3	620 m	Nad 83 13S	432659	4020224	432260	4019739	none		Raft 5.0 gpp
9/7/2004	Lone Juniper	mile 68	530 m	Nad 83 13S	430979	4017993	430667	4017599	none		Raft 5.0 gpp
9/8/2004	Rio Embudo Confluence	mile 87.6	570 m	Nad 83 13S	417829	4008321	417233	4008326	none		Raft 5.0 gpp
9/7/2004	Rio Grande Spring	mile 63	360 m	Nad 83 13S	433441	4021210	433152	4020969	none		Raft 5.0 gpp
9/8/2004	Taos County Line	mile ~63.5	460 m	Nad 83 13S	422918	4009787	422477	4009606	none		Raft 5.0 gpp
9/7/2004	Taos Junction Bridge	mile ~62.6	400 m	Nad 83 13S	434147	4021471	433799	4021316	none		Raft 5.0 gpp
2005		Corresponds to River Mile			NAD 27 Needs Conversion						
6/14/2005	Mid Box	mile 1 (mile 30)	6 mile	Nad 27 13S	438004	4055873	437957	4054302	none		Raft 5.0 gpp
6/14/2005	Mid Box	mile 2 (mile 31)	6 mile	Nad 27 13S	437957	4054302	437808	4052632	none		Raft 5.0 gpp
6/14/2005	Mid Box	mile 3 (mile 32)	6 mile	Nad 27 13S	437808	4052632	438508	4051234	none		Raft 5.0 gpp
6/14/2005	Mid Box	mile 4 (mile 33)	6 mile	Nad 27 13S	438508	4051234	438182	4049707	none		Raft 5.0 gpp
6/14/2005	Mid Box	mile 5 (mile 34)	6 mile	Nad 27 13S	438182	4049707	437663	4048236	none		Raft 5.0 gpp
6/14/2005	Mid Box	mile 6 (mile 35)	6 mile	Nad 27 13S	437663	4048236	436986	4046896	none		Raft 5.0 gpp
6/14/2005	Mid Box	mile 8 (mile 37)	1 mile	Nad 27 13S	437051	4045356	436921	4043882	none		Raft 5.0 gpp
6/15/2005	Lower Box	mile 10 (mile (39)	1 mile	Nad 27 13S	436217	4042478	435685	4040985	none		Raft 5.0 gpp
6/15/2005	Lower Box	mile 11 (mile 40)	1 mile	Nad 27 13S	435685	4040985	435116	4039580	none		Raft 5.0 gpp
6/15/2005	Lower Box	mile 16 (mile 45)	1 mile	Nad 27 13S	434723	4033505	435451	4032133	none		Raft 5.0 gpp
6/15/2005	Lower Box	mile 17 (mile 46)	1 mile	Nad 27 13S	435451	4032133	435656	4030570	none		Raft 5.0 gpp
6/15/2005	Lower Box	mile 23 (mile 52)	~.3 mile	Nad 27 13S	434410	4022474	434331	4021927	none		Raft 5.0 gpp
2006											
9/25/2006	Bosque Section	mile 1 (63.5-64.5)	1 mile	Nad 83	422809	4009744	421489	4008878	all		Raft 2.5 gpp
9/25/2006	Bosque Section	mile 2 (64.5-65.5)	1 mile	Nad 83	421489	4008878	420010	4008382	all		Raft 2.5 gpp
9/25/2006	Bosque Section	mile 3 (65.5-66.5)	1 mile	Nad 83	421489	4008878	418557	4008460	all		Raft 2.5 gpp
9/25/2006	Bosque Section	mile 4 (66.5-67.5)	1 mile	Nad 83	421489	4008878	417179	4008332	all		Raft 2.5 gpp
9/14/2006	OV	mile 1 (52.5-53.5)	1 mile	Nad 83	434298	4021676	432984	4020872	all		Raft 2.5 gpp
9/14/2006	OV	mile 2 (53.5-54.5)	1 mile	Nad 83	432984	4020872	432048	4019611	all		Raft 2.5 gpp
9/14/2006	OV	mile 3 (54.5-55.5)	1 mile	Nad 83	432048	4019611	431058	4018377	all		Raft 2.5 gpp
2007											
5/22/2007	State Line	mile 1	1 mile	Nad 83 13S	436040	4094644	436213	4093178	all		Raft 2.5 gpp
5/22/2007	Ute Section	mile 3	1 mile	Nad 83 13S	436159	4091671	435649	4090330	all		Raft 2.5 gpp
5/23/2007	Ute Section	mile 6	1 mile	Nad 83 13S	434466	4087541	434607	4087541	all		Raft 2.5 gpp
5/23/2007	Ute Section	mile 8	1 mile	Nad 83 13S	434966	4084794	435510	4083488	all		Raft 2.5 gpp
5/23/2007	Ute Section	mile 10	1 mile	Nad 83 13S	436820	4082795	437126	4081535	all		Raft 2.5 gpp
5/23/2007	~Lee Trail	mile 13	1 mile	Nad 83 13S	437224	4078596	438073	4077256	all		Raft 2.5 gpp
6/12/2007	OV	mile 55	1 mile	Nad 83 13S	430992	4018025	430071	4016867	all		Raft 2.5 gpp
6/12/2007	RC	mile 57	1 mile	Nad 83 13S	428623	4013787	427346	4013013	all		extends into next mile 1/4 of a mile
6/12/2007	RC	mile 61	1 mile	Nad 83 13S	425393	4011191	424080	4010411	all		Raft 2.5 gpp
2008	In 2008 Each site received two passes										
6/16/08 and 6/18/08	Middle box	miles 29-30	2 miles	Nad 83	437974	4055964	437782	4052755	all		Raft 2.5 gpp
6/16/08 and 6/18/08	Middle box	miles 32-33	2 miles	Nad 83	438495	4051275	437515	4048208	all		Raft 2.5 gpp
6/16/08 and 6/18/08	Middle box	miles 35-36	2 miles	Nad 83	436945	4046792	436721	4043806	all		Raft 2.5 gpp
6/17/08 and 6/19/08	Lower box	mile 38-39	2 miles	Nad 83	435399	4040899	435055	4039356	all		Raft 2.5 gpp
6/17/08 and 6/19/08	Lower box	mile 41-42	2 miles	Nad 83	434522	4037977	434689	4034853	all		Raft 2.5 gpp
6/17/08 and 6/19/08	Lower box	mile 44-45	2 miles	Nad 83	434737	4033264	435641	4030286	all		Raft 2.5 gpp
2009											
10/2/2009	Big Arsenic Confluence								all	yes	Survey habitats in Rio Grande with backpack shocker, no block nets
10/2/2009	Bear Crossing								all	yes	Survey habitats in Rio Grande with backpack shocker, no block nets
5/26/2009	OV	mile 52-53	2 miles	Nad 83					all	yes	Raft 2.5 gpp
5/26/2009	OV	mile 56-57	2 miles	Nad 83					all	yes	Raft 2.5 gpp
5/27/2009	RC	mile 60-61	2 miles	Nad 83					all	yes	Raft 2.5 gpp
5/27/2009	RC	mile 63	1 mile	Nad 83					all	yes	Raft 2.5 gpp
5/28/2009	Bosque	mile 65	1 mile	Nad 83					all	yes	Raft 2.5 gpp
5/28/2009	Bosque	mile 67	1 mile	Nad 83					all	yes	Raft 2.5 gpp
2010											
6/15/2010	State line	mile 1	1 mile	Nad 83					all	yes	Raft 2.5 gpp
6/16/2010	Ute Section	mile 6	1 mile	Nad 83					all	yes	Raft 2.5 gpp
6/16/2010	Ute Section	mile 8	1 mile	Nad 83					all	yes	Raft 2.5 gpp
6/16/2010	Ute Section	mile 10	1 mile	Nad 83					all	yes	Raft 2.5 gpp
2011											
6/21/2011	OV	mile 52-53	2 mile	Nad 83					all	yes	Started mile at TJB instead of ~1/2 mile up from bridge
6/22/2011	OV	mile 56-57	2 mile	Nad 83					all	yes	Raft 2.5 gpp
6/23/2011	RC	mile 60-61	2 mile	Nad 83					all	yes	Raft 2.5 gpp
2012											
6/22/2012		Unknown		Nad 83					all	yes	Raft 2.5 gpp
6/27/2012	RC	mile 69-70	2 mile	Nad 83					all	yes	Raft 2.5 gpp

Compiled list of Rio Grande Electrofishing Surveys

Upper Rio Grande Angler Survey

This questionnaire is part of a master's degree project at the University of New Mexico in the Water Resources and Community and Regional Planning programs. The project will compare fish population data collected between 2003 and 2013 by the BLM, New Mexico Department of Game and Fish, and U.S. Forest Service with the observations of anglers. The goal of the project is to better understand the fish population of the Rio Grande.

In order to compare angler observations with collected data, this survey is looking for trends over the 10 year period between 2003 and 2013. Please address *specifics* about this time period in the questions below.

Please enter the name of a reach in column **1** and only **1** species or fishing type for each row.

Ute - State Line to Chiflo
Upper Box -Chiflo to Red River
Middle Box- Red River to Rio Hondo
Lower Box- Rio Hondo to Rio Pueblo
Orilla Verde - Rio Pueblo to Pilar
Racecourse – Pilar to Rinconada
Bosque – Rinconada to Velarde
Feel free to include other names for these reaches

Reach	Type of Fishing? Fly, Spin, Bait or Guide?	How many years fishing this section?	Species sought?	Number of days fished per year?	Has the number of fish increased or decreased?	Has size of fish increased or decreased?
Ute	Spin	# of years	Fish Species	# Days Fished	increased/decreased	increased/decreased
Bosque	Fly	# of years	Fish Species	# Days Fished	increased/decreased	increased/decreased

Reach	Type of Fishing? Fly, Spin, Bait or Guide?	How many years fishing this section?	Number of days fished per year?	Species targeted?	Has the number of fish increased or decreased?	Has the size of fish increased or decreased?

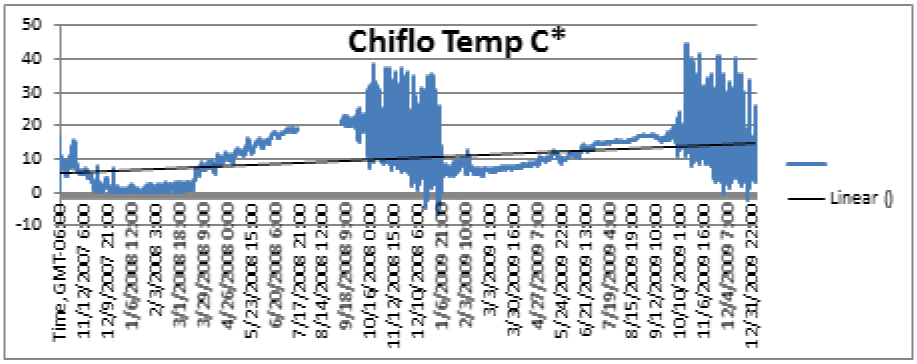
1. Please describe any changes in fish population that you have observed between 2003 and 2013 for specific areas or for the Rio Grande as a whole.

2. Please describe the range of years that your observed changes occurred. (Between 2003 and 2013)

3. What do you think caused the changes you observed?

4. Have you observed anything else that you think would help this survey?

Mail to Barry Weinstock at PO Box 624 El Prado NM 87529, email barryw01@unm.edu or call 575-770-5921. Or leave here.


Chiflo Temp C*
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4/26/2008 0:00
5/23/2008 15:00
6/20/2008 6:00
7/17/2008 21:00
8/14/2008 12:00
9/18/2008 9:00
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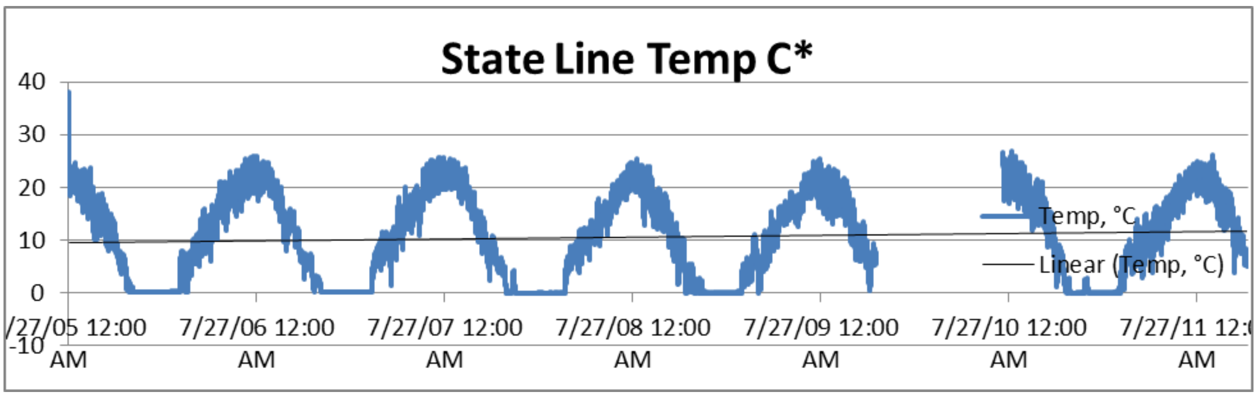
12/31/2009 22:00
Linear ()


State Line Temp C*
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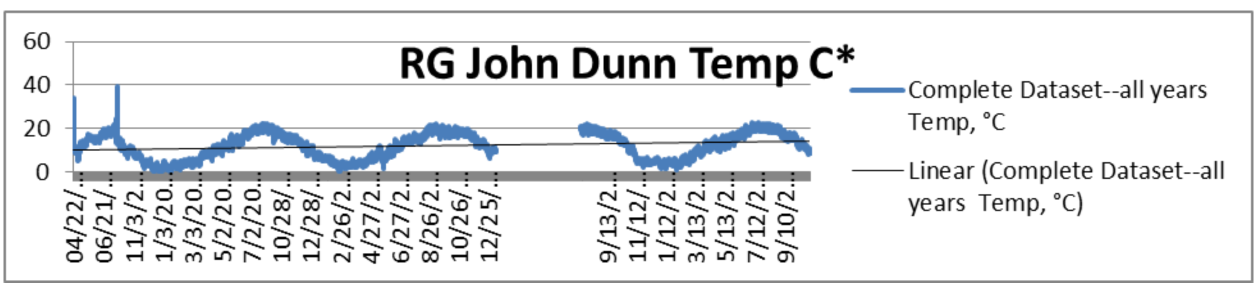
Temp, °C
Linear (Temp, °C)


RG John Dunn Temp C*
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11/3/2…
1/3/20…
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5/2/20…
7/2/20…
10/28/…
12/28/…
2/26/2…
4/27/2…
6/27/2…
8/26/2…
10/26/…
12/25/…
9/13/2…
11/12/…
1/12/2…
3/13/2…
5/13/2…
7/12/2…
9/10/2…
Complete Dataset--all years Temp, °C
Linear (Complete Dataset--all years Temp, °C)