August 8, 2018

Documents:

Meeting Agenda

Meeting Minutes

Read-Aheads and Presentations

- *RGSM Population Monitoring Results From February to December 2016 [report not included]*
- *Proposed Approach for PMWG Meeting*
- *RGSM Population Monitoring Objectives*
- *Draft MRGESCP Program Monitoring Plan - Appendix A*
- *Basic Sampling Design and Methods RGSM Population Monitoring Program*
- *Overview of Population Monitoring Program and Database*
- *Scopes of Work [not included]*
- *Approval of 1st Task for Review of the Collaborative Program Fish Monitoring Program for the RGSM: A Proposal for a CPUE Metrics and Methodologies Workshop*
- *Survey of the EC on Fish Population Monitoring Needs Summary Report*
- *Review of Parameters for Hydrological Objectives Memo*
- *Draft PMWG Charge*

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Population Monitoring Workgroup
Meeting Agenda

August 8, 2018 9:00 AM – 12:00 PM
Location: WEST – 8500 Menaul Blvd. NE, Ste. B-342

Conference Call Information:
Phone: (712) 451-0011 Passcode: 141544

9:00-9:15 Call to Order
- Rick Billings Update
- ➢ **Decision**: Approve meeting agenda
- ➢ **Decision**: Approval of June meeting minutes

9:15-9:45 Review of Draft Population Monitoring Work Group Charge for EC.
- ➢ **Action**: Complete review for presentation to the EC on 8/30/18

9:45-10:30 Review of the RGSM Population Monitoring Components
- ➢ **Action**: Decision on how best to consolidate the parts of the plan

10:30-11:30 Completing the Prioritization of the Panel Recommendations
- ➢ **Action**: Path forward for consolidating the information into a format for submittal to the EC

11:30-11:40 Review of Meeting Actions

11:40-11:55 Topics for Next Meeting
- ACOE Presentation
- Other Items

11:55-12:00 Next Meeting Date

12:00 Adjourn

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Population Monitoring Work Group (PMW)
Meeting Minutes

August 8, 2018 9:00 AM – 12:00 PM
Location: WEST – 8500 Menaul Blvd. NE, Ste. B-342

Decisions

- ✓ Present current analysis completed by Rich Valdez and manuscript by Mick Porter before re-prioritizing the Hubert Panel Recommendations

Action Items

WHO	ACTION ITEM	DUE DATE
Eric Gonzales (Reclamation)	Provide contract RGSM Population Monitoring SOW to group for alignment of PMW population monitoring plan with SOW.	ASAP
WEST	Include references in the Population Monitoring Work Group draft charge.	ASAP
WEST	Send Shay Howlin's CV to the work group.	ASAP
WEST	Begin glossary of monitoring terms, start from ASIR report and pass to work group for additional terms.	ASAP
All	Review "DRAFT Population Monitoring Work Group (PMW) Charge" and give feedback.	8/20/18
WEST	Incorporate work group review of charge and attach it to the July 13, 2012 document and consolidate into a format for submittal to the EC.	8/23/18

Next Meeting

- The next PMW meeting is TBD for the September/October timeframe.
  - Have Charles Yackulic (U.S. Geological Survey) and Shay Howlin (WEST) in attendance at the meeting.
  - Present analysis completed by Rich Valdez and manuscript by Mick Porter.

Welcome and Updates

- Dave Wegner, Science Coordinator for WEST, opened the meeting. The chair, Rick Billings, could not be present. Dave began with a brief review of the meeting's agenda.
- Thomas Archdeacon, U.S. Fish & Wildlife Service, provided an update on ongoing fish salvage which Thomas indicated will continue until no fish are found or conditions limit access.
  - He noted that they had observed approximately 85,000 fish, of which approximately 65,000 were alive and rescued (or about 50 fish per mile). He added that with the hot weather, the fish have been in really bad condition with practically no young of year found.
  - Salvaged fish are put upstream in San Acacia, or other spots not expected to dry.

Review of Draft Population Monitoring Work Group Charge for EC

- Active work groups were requested by the Executive Committee (EC) to develop and present charges and work plans through 2018 at the June 28, 2018 EC meeting. At that time, it was requested that the PMW further develop their charge for EC approval. Rick and Dave had worked on developing a draft charge based on past work group discussions, and it was distributed for the work group's consideration.
    - One participant noted that there was an earlier document, *Attachment 3, Approval of the 1st Task for Review of the Collaborative Program Fish Monitoring Program for the Rio Grande Silvery Minnow*, dated July 13, 2012, which gave a more robust Population Monitoring scope. The group agreed that was a good document, and it was suggested that it could be attached to the charge in order to help the EC understand where the work group is in the process. More specifically:
        - The work group completed Task 1, holding the panel workshop, and reviewed and prioritized recommendations. They then participated in another RGSM workshop (the Noon panel) that included some discussion of monitoring the species, and included the relevant recommendations from Noon et al. in their evaluation.
        - To begin Task 2, analysis, it was requested that WEST administer the work group's meetings, and that an additional statistical expert be brought in. In the discussion on who that might be, the group was reminded that both WEST, through the PASS contract, and Charles Yackulic, currently under contract with the Albuquerque Bernalillo County Water Authority (ABCWUA), have statistical expertise. WEST has worked on assembling an approved dataset of the population monitoring information while Rich Valdez, representing the New Mexico Interstate Stream Commission (NMISC), has done a number of statistical analyses on the dataset.
        - The work group now intends to catch up on what has been done for analyses, obtain ideas from Charles and a WEST statistician, and then discuss what should be next steps to complete the charged tasks.
    - It was also suggested that someone provide a brief summary of what ASIR has said they have changed in their sampling design and methodology, based on the Hubert et al. recommendations, and evaluate these changes. The group then should discuss how to address this.

- WEST will revise the draft charge to include references and append the Attachment 3 document.
- The work group will review and make comment on the charge document by August 20, 2018.
- WEST will incorporate work group review comments and revise the charge for submittal to the EC.

Review of the RGSM Population Monitoring Components

- Dave Wegner was asked to get clarification from U.S. Bureau of Reclamation (Reclamation) on the components of the RGSM population monitoring plan. Dave summarized the monitoring plan he received in response from Reclamation in a July 31 memo-style document to present to the work group. With the memo, Dave included four attachments given to him from Reclamation.

  Attachment 1: Appendix A Rio Grande Fish Community Monitoring (from the MRG ESA CP2006 Program Monitoring Plan).

Attachment 2: Appendix A Population Monitoring Protocol (Dudley et al. 2018). (Also referred to as the SOW appendix A RGSM Pop Mon 2018.)

Attachment 3: Basic Sampling Design and Methods Rio Grande Silvery Minnow Population Monitoring Program, Working Meeting of the Population Monitoring Workshop Planning Committee, September 9, 2014; an overview developed by Rich Valdez to characterize the population monitoring program and data at Working Meeting #1 of the Population Monitoring Workshop Planning Committee; September 9, 2014.

Attachment 4: Overview of Population Monitoring Program and Database dated September 2014; also an overview developed by Rich Valdez to characterize the population monitoring program and data at Working Meeting #1 of the Population Monitoring Workshop Planning Committee; September 9, 2014.

It was then discussed how best to consolidate the parts of the plan.

- Attachment 1 and 2 were considered the closest thing to a monitoring plan. Attachment 1 was of historical interest but not a current or complete rendition. It was suggested the Dudley et al. 2018 SOW (Attachment 2) is the document that should be used to make it current.
- Use the Reclamation RGSM Population Monitoring SOW (the contract SOW from December 2017) to be consistent with what Reclamation is contracted for. Some of the Hubert report recommendations that were easy to follow were implemented by Reclamation and then brought into the new contract. The Program Annual Report can also be used to reflect parts of the plan.

- Dave then presented the primary and secondary objectives of population monitoring as stated in the recently updated *Rio Grande Silvery Minnow Population Monitoring Results from February to December 2016* report.

  He then asked the questions: Are these the right objectives to be addressing in the monitoring program? The charge is to take the recommendations from the panels and workshops (some of which the authors of the report indicate they have already embraced) and evaluate whether the prioritized recommendations match what the monitoring program is already doing or if recommended refinement or revision are appropriate recommendations for the PMW to make. Are refinements to the monitoring program appropriate and why? (This gets to the EC task.) What questions need to be posed to the EC in respect to the level of precision they want from the monitoring program? Each level of precision requires a certain amount of information, analyses and fish handling. With a highly variable species (RGSM) there is a trade off in reading too much into the data and at what level does fish handling impact the fish itself? A table of options for EC consideration and PMW recommendations was suggested.
  - In response, some members say there is a disconnect between what Reclamation and the work group members believe to be the role of the PMW. Others questioned that point. Examples were given and discussed and it was agreed that it would be up to the EC to decide the role of the PMW, and that might include analysis of the data. It was agreed that it could also be reconciled when this group comes to a better understanding of what it thinks the best monitoring would be. Thus, first look at the data then look at how a population monitoring program may be modified for particular reason(s). After that it can be brought back to the 2016 Biological Opinion (BO); however, this group should be focused on the science and not on the BO.

- Eric Gonzales will provide the contract RGSM Population Monitoring SOW to the group for alignment of PMW population monitoring plan with the SOW.

- The work group then was asked to discuss the 2016 RGSM population monitoring report from Dudley et al. and the path forward for consolidating the information into a format for submittal to the EC. This also requires an agreement on the level of precision needed for the EC to make a decision.
    - Some of the work group members voiced the opinion that having the most accurate number was important in order to best understand what's going on with the species. Another participant countered that biologists often give numbers that are seen by management as too variable and not useful. The answer should be to present the logic for the recommendation and show the risk with the precision. Managers are interested in the cost associated with the level of precision to make a decision understanding there is a diminishing point of return.
    - One participant offered that this work group should develop two or three alternative sampling designs, put those designs to rigorous statistical analysis to look at behavior and cost of precision.
    - Another participant asked if the group could characterize that well enough for the EC to charge this group to do that? While some said yes, another participant said the group should ask themselves what is the actual management decision being made? While precision is important, the group needs to understand what they want monitoring to do in order to help managers do what they do.

Completing the Prioritization of the Panel Recommendations

- Dave opened the discussion on the prioritization of the panel recommendations by recapping. To date we have a monitoring plan that ASIR is responding to, and is coordinated between agencies and for the BO. This group has been tasked to review what is being done with what agencies need. What has been missing is the endpoint for all the science and analyses. The group had previously undergone prioritization exercises with the panel recommendations, and evaluated where there is overlap between the Hubert and Noon reports. Before doing more prioritization, Dave suggested that the group should review the results of ongoing analysis efforts done by work group members and integrate that information into any future prioritizations.
    - Highest priority are those recommendations we already have data for. Before getting into new data, we should understand the data we already have.
    - In general, the BO is a legal document the PMW should be mindful of. The challenge is getting past the statistical analysis and squeezing more information out of the existing data to get a step or two beyond the BO.
    - The discussion came back to the degree of sensitivity needed by the Program, which resulted in a discussion over the need for a common understanding for terminology.
    - WEST can begin a glossary of monitoring terms that some participants, as well as EC members, might struggle with.
    - WEST will send Shay's CV to the work group.

Present

Name	**Agency**
Thomas Archdeacon	U.S. Fish & Wildlife Service
Lynette Giesen	U.S. Army Corps of Engineers
Eric Gonzales	U.S. Bureau of Reclamation
Grace Haggerty	NM Interstate Stream Commission
Mo Hobbs	Albuquerque Bernalillo County Water Utility Authority
Shay Howlin	Western Ecosystems Technology, Inc.
Debbie Lee	Western Ecosystems Technology, Inc.
Mark Marcus	Assessment Payers Association of the MRGCD
Lana Mitchell	Western Ecosystems Technology, Inc.
Mick Porter	U.S. Army Corps of Engineers
Rich Valdez	SWCA Environmental Consultants
Dave Wegner	Western Ecosystems Technology, Inc.
Charles Yackulic	U.S. Geological Survey

July 31, 2018

To: **Population Monitoring Work Group**

From: **Dave Wegner (for Rick Billings)**

Subject: **Review of the Rio Grande Silvery Minnow (RGSM) Monitoring Plan**

A task assigned to the Population Monitoring Work Group (PMWG) by the Middle Rio Grande Endangered Species Collaborative Program (MRGESCP) Executive Committee (EC) was to *assess and evaluate the existing RGSM Monitoring Program in the context of the recommendations made from the two workshops and the discussions on the use of catch per unit effort (CPUE).*

In the PMWG discussions it has been unclear what constitutes the existing RGSM Monitoring Program. In late June, the PMWG sent the U.S. Bureau of Reclamation (Reclamation) a list of questions to help address the uncertainties that emerged from the June 20, 2018 PMWG meeting. Reclamation made a good faith effort to address the PMWG's questions. From their response it was clear that several tasks need to be accomplished by the PMWG in order to respond to the EC and chart a path forward.

The topical areas below represent the initial tasks, which from a process perspective, make sense that the PMWG tackle. They are meant as a starting point for PMWG discussion and to stimulate discussion. The intent is that at the PMWG meeting on August 8th the group will work through these topics and tasks. [Note: If these issues are off base, the PMWG can work to rectify the tasks, approaches, or sequences as necessary]. The desire is that after the meeting, the group can assemble a definitive game plan and have an understanding of how the PMWG will meet the EC charge, address Reclamation's expectations, and identify who will take the lead on the various tasks.

I. Assembling the RGSM Existing Population Monitoring Program (PMP)

In early July, in an effort to get the proper set of documents together to complete the task, the PMWG asked Reclamation for assistance in assembling the information. Enclosed are four documents that Reclamation provided, that from their perspective form the basis of the RGSM PMP. Reclamation believes that the MRGESCP wrote the PMP in 2006.

- Question 1: If the 2006 document (Attachment 1) is a correct rendition of the existing RGSM PMP, then the PMWG will use that document to complete the assessment.

- Question 2: If the 2006 is not a correct rendition of the existing RGSM PMP, then the PMWG will need to look at how the four documents that Reclamation provided fit together to provide a complete understanding of the PMP. [Note: If the PMWG believes that the RGSM PMP is more than the 2006 document, the PMWG will need to provide logic and justification as to why.]

For the PMWG to complete its task the questions above will need to be answered and reasoning provided before the group can move on.

The following four documents are attached:

- Attachment 1: 2006 PMP – Appendix A Population Monitoring.doc
- Attachment 2: SOW appendix A RGSM Pop Mon 2018.doc
- Attachment 3: 1_Basic Sampling Design and Methods 9-10-2014.pdf
- Attachment 4: 5_Overview of the Pop Mon Program and Database 9-10-2014.pdf

Note: Reclamation also noted that this assessment of the prior RGSM protocols was accomplished by the December 2015 Hubert panel. The group will need to decide if this was accomplished or not.

- **Task 1.** Organize and assemble the appropriate RGSM documents into a coherent set and answer the following:
    - If different from the 2006 PMP then the PMWG will need to provide reasoning.
    - If the PMWG believes that the Hubert panel did not complete the assessment of the RGSM protocols, the group will need to provide reasoning.

II. Evaluate the Existing RGSM PMP within the Context of the Recommendations Made from the Two Workshops

Reclamation and the U.S. Fish & Wildlife Service (USFWS) are maintaining a separation between the activities of the 2016 Middle Rio Grande Biological Opinion (2016 MRG BO) and the MRGESCP. The intent is to keep the two programs separate until some future date when the MRGESCP Adaptive Management Program may assimilate some of the tasks and/or studies. In the interim, the MRGESCP, PMWG can provide counsel to the two agencies and maintain an independent review and recommendation role.

To accomplish the second part of the EC task of *evaluating the existing RGSM PMP within the context of the recommendations made from the two panels,* the PMWG will need to finish efforts on prioritization of the recommendations.

- Summary of Findings by the External Expert Panelists: Rio Grande Silvery Minnow Monitoring Workshop held at the Isleta Casino and Resort, 8-10 December 2015 – Hubert Panel
    - 22 Recommendations (2016)
- Rio Grande Silvery Minnow Critical Scientific Uncertainties and Study Recommendations. June 2017 – Noon Panel
    - 19 Recommendations

At the June 20, 2018 PMWG meeting, the group went through the Hubert recommendations and identified appropriate initial responsible parties for each of the recommendations (see Attachment 5).

- **Task 2.** Perform the same analytical process of walking through the Noon panel and assign responsibility for task completion as appropriate.
- **Task 3.** Combine the Hubert and Noon panel recommendations into one set of recommendations.
- **Task 4.** Prioritize the combined set of recommendations.
- **Task 5.** Assess relationships of the combined set of recommendations in relation to the existing RGSM PMP (Task 1).
    - Review the 2016 MRG BO requirements related to RGSM population monitoring.
- **Task 6.** Evaluate how that analysis might change the existing RGSM monitoring.
- **Task 7.** Evaluate changes in cost associated with any recommended changes in the PMP.

III. Addressing CPUE and Genetics

Embedded within the discussions from the two panels was the issue of CPUE and its use in assessing the RGSM population dynamics. The PMWG has had an ongoing discussion regarding the use of CPUE and genetics in assessing various relationships in the RGSM population. Two recommendations from the Noon panel specifically addressed CPUE. Reclamation indicates that they have incorporated, where possible, CPUE recommendations into the Statement of Work (SOW) (see Attachment 2).

- **Task 8.** Review the SOW (Attachment 2) and determine if the incorporated CPUE recommendations address concerns raised by the panel and the PMWG.
- **Task 9.** Identify from the SOW (Attachment 2) where CPUE could be value added to the RGSM population assessment.
- **Task 10.** Identify outstanding CPUE recommendations with justifications.
- **Task 11.** Identify and prioritize (with justification) RGSM genetics recommendations.

IV. Statistical Characterization of Population Monitoring Data

With the addition of WEST statistical expertise, and with the Charles Yackulic (U.S. Geological Survey) work order in place, the PMWG will need to identify and prioritize (with justification) tasks to be accomplished. Additional support may be provided by Rich Valdez and others as necessary and appropriate.

- **Task 12.** From the tasks accomplished (1-11), identify and prioritize statistical work tasks, determine how it will help address RGSM population understanding, and identify the entity that will take the lead for each task.

V. Summary

The intent of laying out these tasks is to help the PMWG gain a better understanding of the work load, and a tactical approach to gaining knowledge about the RGSM population dynamics. For the upcoming PMWG meeting the goal is to accomplish the following:

- The appropriateness of the above characterization of the tasks and their sequence.
- Determine a timeline and sequence for working on the specific tasks.

From this discussion the following three products will be developed:

1. Planned approach to be presented to the EC on the assigned task to review the existing RGSM PMP in respect to the panels and other available information.
2. A collaboratively assembled RGSM PMP.
3. A response to Reclamation regarding their request for a prioritized list of peer review recommendations.

To keep the PMWG process moving forward while Rick B. and Rich V. recover from their ailments, your input and support is appreciated.

Tier I. Primary Objectives

- Monitor temporal trends in abundance of RGSM at 20 standardized sites
- Evaluate how these trends were affected by changes in annual discharge patterns

[These objectives will help guide us in respect to our primary task set by the EC.]

Tier II. Secondary Objectives [I label them as such because the report refers to them as "additional objectives" - in my mind they are elements of the 2 primary objectives].

- Determine general habitat use patterns
- Document changes in relative abundance among the native and non-native fish
- Determine variations in density estimates based on repeated sampling
- Evaluate changes in site occupancy status across years
- Seasonal and spatial differences in the population structure and abundance of native and non-native Middle Rio Grande fish

The identification of these objectives helped characterize what the existing RGSM population monitoring program is focused on.

Questions we need to be considering in our deliberations:
Are these the right objectives to be addressing in the monitoring program?

Our charge is to take the recommendations from the panels and workshops (some of which the authors of the report indicate they have already embraced) and evaluate whether the prioritized recommendations match what the monitoring program is already doing or if recommended refinement or revision are appropriate recommendations for the PMWG to make.

Are refinements to monitoring program appropriate and why? (This gets to the EC task)

Never hurts to go back periodically and review what the objectives are.

What questions need to be posed to the Executive Committee in respect to the level of precision they want from the Monitoring program?

Each level of precision requires a certain amount of information, analyses and fish handling. With a highly variable species (RGSM) there is a trade off in reading too much into the data and at what level does fish handling impact the fish itself?

What level of precision does the EC want - I would like to lay out for the EC a table of options for their consideration and PMWG recommendations.

APPENDIX A

RIO GRANDE FISH COMMUNITY MONITORING

1.0 PRIMARY GOAL(S) OF MONITORING:

To guide adaptive management of Rio Grande silvery minnow utilizing insights provided by spatial and temporal trends in population monitoring data. This goal is in compliance with Element S of the March 2003 RPA (U. S. Fish and Wildlife Service's Programmatic Biological Opinion).

2.0 SPECIFIC OBJECTIVES AND QUESTIONS:

- Document long-term (inter-annual) and short-term (intra-annual) changes in Rio Grande silvery minnow (RGSM) population and associated fish assemblages.
    - Are there changes in the October RGSM population among years?
    - Are there changes in the October fish assemblages among years?
    - Are there changes in the RGSM population within a particular year?
    - Are there changes in the fish assemblages within a particular year?

3.0 HYPOTHESIS

No formal hypotheses addressed in annual monitoring program. However, data collected during this monitoring program will allow for long-term (multiple years) hypothesis testing.

QUESTIONS ADDRESSED BY LONG-TERM HYPOTHESIS TESTING:

- Are inter-annual (among years) changes in RGSM density during October related to hydrologic and/or other physical variables?
- Are seasonal changes in RGSM density (among years) related to hydrologic and/or other physical variables?
- Are there relationships between RGSM density and the density of other fish species?
- What mesohabitats are selected by RGSM and other species?
- Do silvery minnows use the restored habitat?
- What are the population trends of affected species (SWWFL or RGSM) over time?

4.0 RELEVANT BACKGROUND INFORMATION

During 1992, the Middle Rio Grande was intensively surveyed to determine the distribution and abundance of Rio Grande silvery minnow and the associated fish community (Platania, 1993). Over 100 sites were sampled twice during that year. Fish populations at 16 of the aforementioned sites were monitored quarterly (February, April, July, October) between 1993 and 1997. Monitoring did not occurred in 1998. Bimonthly monitoring (February, April, June, August, October, and December) was initiated in 1999 and continued through 2001. In 1999, sampling occurred at 15 sites, but increased to 20 sites in 2000. In 2002, monitoring frequency increased to monthly. Sampling has been conducted monthly at the same 20 sites from 2002 through 2006.

Following formation of Middle Rio Grande Endangered Species Collaborative Program in 2001, the Science Subcommittee of the Program drafted a Science Plan. Continued monitoring of Rio Grande silvery minnow was identified in the Science Plan as an essential element of the Program. Broadly, monitoring involves two efforts. One effort is to document the annual reproductive success of Rio Grande silvery minnow and the second is to monitor monthly the status of the Middle Rio Grande post-larvae population of Rio Grande silvery minnow.

Population status monitoring occurs monthly at 20 locations in the Middle Rio Grande. The metric used as a measure of status is number of Rio Grande silvery minnow individuals per unit area sampled. Reproductive success monitoring occurs at one site in each reach (Angostura, Isleta, and San Acacia). Number of eggs captured per unit time per volume water sampled is the metric used to monitor reproductive success. The overarching purpose of the monitoring effort is to document long-term trends in population status of Rio Grande silvery minnow. Neither monitoring program is intended to evaluate success of individual projects that might be implemented for benefit of Rio Grande silvery minnow.

The Rio Grande silvery minnow Recovery Plan (U. S. Fish and Wildlife Service, 1999) outlined specific research objectives (1.4.1. Determine distribution and extent of nonnative fish species; 1.4.3. Determine relationship between flow regimes and nonnative fish species population viability; 4.1. Develop and implement a long-term monitoring program to identify changes in the endangered and other native fish species populations, status, distributions, and habitat conditions) that will be addressed, in part, through continuation of the Rio Grande fish community monitoring program. The 29 June 2001 Programmatic Biological Opinion required that regular fish population monitoring continue at sites in the Middle Rio Grande (Section I.2.E. Federal Actions, Additional Environmental Commitments). The aforementioned document specifically stated that "monitoring is required to evaluate decision making" (pg. 47) and is a critical component of adaptive resource management. The most recent Programmatic Biological Opinion (March 2004) reaffirmed the need for and commitment to continued monitoring of Rio Grande silvery minnow.

The March 2003 U. S. Fish and Wildlife Service's Programmatic Biological Opinion contains the following regarding monitoring:

> *Page 18, Line 22: • Monitoring is required to evaluate decision making*
> *Page 18, Line 27: • Monitoring and evaluation of contemporaneous dynamic variables is required to adapt management practices to new circumstances. Without monitoring, innovation is discouraged, new knowledge is applied too slowly, and inefficiencies persist to the detriment of natural resources and the public.*
> *Page 20, Line 12: Under the Section: Environmental Commitments - Subsection Rio Grande silvery minnow: • Reclamation will continue to conduct fish population monitoring at established locations in the Middle Rio Grande between Angostura Diversion Dam and the headwaters of Elephant Butte Reservoir. Pre-and post-construction fish monitoring will continue at constructed and proposed river maintenance sites through the Middle Rio Grande.*

Population monitoring of Rio Grande silvery minnow, *Hybognathus amarus*, and the associated Middle Rio Grande (Cochiti Dam to Elephant Butte Reservoir) fish community has been systematically conducted since 1993. Information generated during this long-term study effort has provided the foundation necessary to assess changes in the Middle Rio Grande ichthyofaunal community. Continuation of the proposed Population Monitoring Program will provide quantitative data necessary for evaluation of temporal and spatial trends in Rio Grande silvery minnow populations and allow for informed faunal assessment and management decisions.

5.0 TARGETED PRECISION OF MONITORING EFFORT

Twenty sites between Angostura Diversion Dam and Elephant Butte Reservoir will be sampled at least nine times per year (=12-consecutive month period; see: Frequency and Timing of Monitoring). This sampling protocol is deemed sufficient, under most conditions, to achieve a 75% probability of detecting a 25% change (alpha = 0.1) in RGSM density.

Determining whether a population is increasing or decreasing is statistically possible only when the sampling protocol provides adequate power to detect such a trend (Gerrodette, 1987). A power analysis of the long-term population monitoring data for fishes in the Middle Rio Grande was conducted using the MONITOR (ver 6.2) software package (Gibbs, 1995). Turbo Pascal 7.0 numerical simulation software was used to estimate the statistical power of the current monitoring program in relation to number of sites sampled, effort within sites, frequency of monitoring, and overall duration of monitoring program.

A total of 500 iterations were performed for each species-specific simulation using January 2003 Middle Rio Grande ichthyofaunal monitoring data. This analysis indicated that population trends (>10%) for most species will be detectable at $\alpha = 0.05$ with power >0.8 under the 2003 sampling methodology (i.e., monthly sampling at 20 sites). Power analysis revealed that, if sites were sampled bimonthly or quarterly, large trends (>10%) would only be detectable for the most abundant taxon (red shiner). The ability to detect trends for less abundant species, including Rio Grande silvery minnow, was severely compromised if sampling frequency was reduced from monthly to bimonthly or quarterly. Reducing sampling frequency from monthly to bimonthly resulted in a seven-fold reduction of statistical power (from 0.750 to 0.100) to detect current trends (5% increase) in Rio Grande silvery minnow populations. Additionally, a bimonthly sampling program with twice the level of sampling effort per site resulted in only a modest increase (from 0.438 to 0.722) in the statistical power to detect a 10% increase in Rio Grande silvery minnow populations. These results suggest that population monitoring should be conducted more frequently than bimonthly in order to detect population trends when the abundance of Rio Grande silvery minnow is very low (e.g., 2003).

As population levels change, so will the effort necessary to detect statistically significant changes. An efficiently designed population monitoring program will be able to detect statistically significant changes of the study taxon or taxa at high and low population levels. Sampling effort should be consistent over the duration of the project and not adjusted annually to compensate for annual changes in population levels.

While power analysis results indicate that population monitoring occur monthly, it is recognized that sampling from December-February (over-wintering period) consistently provides less biologically relevant information compared with the period from March-November (i.e., spawning and recruitment period). A sampling protocol with nine population monitoring trips per year balances the need for obtaining detailed monthly data, during the period when populations of all fishes change dramatically (April-October), while acknowledging that intensive winter sampling will yield less biologically relevant information (for schedule see: Frequency and Timing of Monitoring).

6.0 MONITORING METHODS

6.1 Monitoring Locations

The principal area of interest in the Middle Rio Grande is the reach between the outflow of Cochiti Reservoir and inflow to Elephant Butte Reservoir which encompasses the known current range of Rio Grande silvery minnow (Figure 1). Five upstream reservoirs and numerous irrigation diversion dams regulate flow in the Middle Rio Grande. Cochiti Reservoir has been operational since 1973, is located 76 km upstream of Albuquerque, and is the primary flood control reservoir that regulates flow in the Middle Rio Grande.
Reach names are derived from the diversion structure at the upstream boundary of that reach of river. In the Cochiti Reach (between Cochiti Dam and Angostura Diversion Dam), the Rio Grande flows through Cochiti, Santo Domingo, and San Felipe pueblos, respectively. Five sampling localities have been

selected in the Angostura Reach (Angostura Diversion Dam to Isleta Diversion Dam) and six collecting sites in the Isleta Reach (Isleta Diversion Dam to San Acacia Diversion Dam). The San Acacia Reach (San Acacia Diversion Dam to Elephant Butte Reservoir) is the longest Middle Rio Grande reach and contains nine sampling localities.

The 20 sampling sites currently being used in this project (Table 1) were not generated as part of a random stratified experimental design but were instead selected. Sample sites being used in the current project were selected (in 1993) from a series of about 100 sites (between Angostura and Elephant Butte reservoir) that had been sampled for fish in 1992. The original 16 sampling sites were chosen for a variety of factors, including access, issues of land ownership, spatial location within reaches and between reaches, and overall suitability for effective and efficient sampling. The vast majority of sites employed in this study have been sampled consistently during the past 13 years with several sites added to increase the spatial extent of sampling (e.g., Angostura Diversion Dam, Isleta Reach, and downstream of San Marcial Railroad Bridge Crossing). Sampling at three of the initial sites (property of the sovereign nation of Isleta Pueblo) had to be discontinued in the mid-1990s due to a lack of permission to access their lands. The three Isleta Pueblo sampling sites were replaced with locations under the jurisdiction of state or federal entities. Fish monitoring sites may, as necessary, be modified based on the need for additional statistical rigor, management needs, changes in river morphology or reservoir (Elephant Butte) elevation or safety and access issues.

Generating a random set of sampling sites for the purpose of this project would not be prudent as it would not be possible to compare past Rio Grande silvery minnow population trends with future trends due to the change in methodology. The principal strength of the current data set is the long-term consistency in monitoring. A long-term and consistent monitoring program is a relatively uncommon attribute, but is invaluable for meaningful ecological studies that generate solid management recommendations. The principal of maintaining consistency of sampling sites over time for the purpose of monitoring animal populations has been well established by the U. S. Long Term Ecological Research Network (http://www.lternet.edu/), a collaborative program involving 1,800 scientists (including the Ecological Society of America) and funded by the National Science Foundation.

6.2 Frequency and Timing of Monitoring Trips

RGSM monitoring will be conducted at least during the following months: February, April, May, June, July, August, September, October, and December.

The vast majority of Rio Grande silvery minnow live only one year and large changes in the abundance and composition of age-classes could occur in a relatively short period (Platania and Altenbach, 1998). Monthly monitoring provided the most rigorous data over the past decade and allowed for detection of statistically significant changes in population levels during periods of low abundance. A sampling program consisting of six monitoring efforts, with multiple samples taken in spring and summer, would provide valuable information especially given the rapid population changes that occur within the short spawning and recruitment period of Rio Grande silvery minnow. This period (spring and summer) also coincides with the time of year when most other Middle Rio Grande fishes spawn and environmental (discharge) variability is at its greatest (e.g., spring runoff, monsoons, irrigation withdrawal). At minimum, a quarterly monitoring program would be necessary to maintain the continuity of the systematic Rio Grande silvery minnow population monitoring effort that began in 1993.

A power analysis performed on 2003 Middle Rio Grande fish population monitoring data (the year Rio Grande silvery minnow density was at its lowest level) indicated that population trends for most fish species, including Rio Grande silvery minnow, would be detectable at $\alpha < 0.05$ if the previously selected

sites (n=20) were sampled monthly. Data collected in 2004 and 2005 validated this hypothesis and documented statistically significant increases in density of Rio Grande silvery minnow from 2003 to 2004 and 2004 to 2005. The results of this analysis demonstrated that current sampling protocols and methodology provided the statistical rigor necessary to detect spatial and temporal trends for Rio Grande silvery minnow and other fish species in the Middle Rio Grande, even during periods when population sizes were low (i.e., during drought periods).

Comparison of temporal changes in fish species abundance (CPUE) obtained from the Rio Grande silvery minnow Population Monitoring Program sampling effort will be evaluated using a linear regression model. This statistical approach will enhance the ability to discern temporal and spatial variability from changes in the abundance of study taxa. Using the extensive data set compiled on the Middle Rio Grande ichthyofaunal community, it will be possible to detect increasing or decreasing temporal trends in native and nonnative fish populations. Identifying and delineating population changes of fishes and assessing the influence of environmental variability (e.g., timing and magnitude of discharge) can lend insights into important mechanisms that regulate species abundance and community structure. Continued monitoring of spatial and temporal changes in the relative abundance of Rio Grande silvery minnow and the associated ichthyofaunal community will help facilitate effective management decisions.

6.3 Number of Samples (=Seine Hauls) per Monitoring Trip

October Sampling: October sampling will be an intensive sampling effort and be the comparison data point for year-to-year analysis. To achieve the desired level of statistical rigor, at least 40 seine hauls will be completed at each of the twenty sampling sites during the October monitoring period. This allows for a statistically robust estimate of population trends at an individual site and exceeds the number of seine hauls needed per reach per sampling occasion necessary to identify changes of <25% (as low as 10%) in the RGSM population density amongst sampling occasions and reaches. October is most indicative of the overall status of the RGSM population because it occurs near the end of irrigation season, during stable autumn baseflow conditions, is prior to cold winter water temperatures (when RGSM are more difficult to capture), individuals have recruited to sub-adult stage and represent the next years spawning cohort.

Other Sampling Occasions: A total of 20 seine hauls will be taken at each site during all other sampling occasions.

6.4 General Description of Sampling Protocol

Fish will be collected by rapidly drawing a two-person 3.1 m (10 foot) x 1.8 m (6 foot) small mesh (<5 mm; 3/16 inch) seine through discrete mesohabitats. Active seine sampling of the broad variety of specific mesohabitats (i.e., backwaters, riffles, etc.) available in the Middle Rio Grande is the most effective methodology to estimate trends in fish populations. The choice of sampling technique was based on having employed and reviewed the efficacy of numerous sampling methodologies (at least eight) in the Middle Rio Grande during the past 15 years. Seining has consistently proved the most effective sampling technique for providing reliable information regarding the structure and composition of the ichthyofaunal community in the Middle Rio Grande. Additionally, seining is considered the most effective technique for collection and quantification of larval to adult stages of small-bodied cyprinids and other similar-sized species from a variety of streams (see Hendricks et al., 1980; Matthews, 1986 [and citations within]; Matthews et al., 1988; Rutherford et al., 1987).

The purpose of confining sampling efforts to specific mesohabitats (versus sampling across mesohabitat types) was to acquire information regarding general habitat use by the Middle Rio Grande fish fauna, including Rio Grande silvery minnow. The mesohabitat type and dimensions will be recorded for every seine haul and used for subsequent data analysis and presentation. The Population Monitoring Program

annual research project report will include a summary of the mesohabitat associations of Rio Grande silvery minnow acquired under this study effort.

Fish will be handled briefly for identification and enumeration prior to being released at the site of capture. Rio Grande silvery minnow will be identified to age-class and measured (total length and standard length) prior to being released at the site of capture. Fish too small to be accurately identified to species in the field (larval fish) will be fixed in 5% buffered formalin and returned to the laboratory for processing and identification. An accounting of retained material will be provided in the final report.

Catch-per-unit-effort (CPUE) will be calculated for each species and each collection as the number of individuals collected per 100 m^2 (surface area) of water sampled (CPUE= #/100 m^2). For purposes of the annual report, catch rate of Rio Grande silvery minnow will be presented for sampling locality, river reach, and collection period. Graphs of fish CPUE will be provided for each sampling locality for the 10 most common taxa in the study area. Comparative figures will be included that summarize the catch rate of fish by reach and collecting period. A detailed appendix providing collection data from each sample will also be provided in the annual report.

The use of CPUE as an index of abundance and technique to monitor trends in populations is well established and used worldwide by ecologists. Likewise, use of CPUE as a metric to determine the status of fish populations is well established in fisheries science. Some of the first important theoretical contributions were provided by the mid-1900s (Ricker, 1940, 1944). The relationship between CPUE and abundance has received considerable attention in the literature (see review by Bannerot and Austin, 1983). Experimental and statistical treatment of the issue has demonstrated that CPUE is a valid index of abundance and that the relationship is one of strict proportionality for single species (Richards and Schnute, 1986). The work of Richards and Schnute (1986, 1992) and other researchers using CPUE in fisheries applications has appeared in internationally important reviews on the general topic of estimating animal abundance (Seber, 1982, 1992). Extensive reviews of the various methods for estimating animal abundance identify CPUE as one of the most widely and well-researched techniques in fisheries science (e.g., Seber, 1992; Schwarz and Seber, 1999).

6.5 Specific Sampling Protocol (Seine Hauls and Mesohabitats)

A total of 20 mesohabitats (one per seine haul) will be sampled at each of the fish population monitoring sites. Mesohabitat types (see Table 2) are discrete areas that share common physical characteristics (e.g., pools, runs, riffles, backwaters etc.). Each seine haul will be made within a discrete mesohabitat (i.e., not across mesohabitats). The full range of available mesohabitat types (primary and secondary) present at the site will be sampled, including areas known to have low densities of fish (e.g., main channel runs). For example, if there are 10 mesohabitat types available at the site, then sampling should include all 10 types. This sampling protocol will ensure that data on the density of RGSM are collected for all available habitats. Analysis of past monitoring data revealed that the percent allocation of sampling effort (by mesohabitat type) was roughly equal among sites and reaches. Future population monitoring efforts should also result in a similar distribution of sampling effort among sites and reaches to ensure comparability among data sets.

6.6 Selection of Seining Locations

Location of individual seine hauls will be selected by the field crew, working in an upstream to downstream manner over the length of the site (ca. 200 m). A similar route will be taken through the

river during each sampling trip to ensure that similar mesohabitats are sampled over time at a particular site. For example, many of the same mesohabitats (e.g., a particular backwater, riffle, or pool) at a sampling site are present and stationary between trips and at a variety of flows. An effort should be made to seine similar mesohabitats during each sampling trip to ensure comparability among data sets. Mesohabitat definitions presented in Table 2 will be used as the basis of habitat sampling. Habitats will be spaced apart to avoid overlap of samples, minimize potential disturbance of fishes in other seined locations, and reduce the likelihood of multiple captures of the same fish in different samples.

6.7 Data Acquisition

The following **Site Specific** data will be recorded on a field data sheet (example attached) during each sampling trip.

Field Number
Date of Sample
Time sampling started and stopped
State
County
Drainage
Sampling Locality
River Mile (determined from USBR 1992 aerial photographs)
Quadrangle
UTM Coordinates
UTM Zone
Coordinate Datum (i.e., NAD 27)
Air Temperature
Shore Description
Water Description
Mean daily discharge (as recorded at nearest USGS gauge)
Substrate
Water Temperature
Secchi Depth
Dissolved Oxygen
Conductivity
Salinity
pH
Method of Capture (seine size and mesh)
Number of Seine Hauls
Total Area sampled
Collectors

The following information will be generated from each seine haul **(sample [seine haul] specific)** and recorded on a sample data sheets (Appendix A-2a and A-2b) during each collection trip.

Field Number (same number as recorded on the above field data sheet)
Sample Number (Seine haul number; transfer this summary information to main field data sheet)
Length of seine haul
Habitat sampled
Presence of fish
Fish species and number in each seine haul
Presence of Rio Grande silvery minnow
Number of Rio Grande silvery minnow by age class
Minimum and maximum length (total and standard) of Rio Grande silvery minnow by age class
Presence of VIE Mark (color and location of mark)
Effort = Total Area sampled (transfer this summary information to main field data sheet)

6.8 Data Compilation and Storage

After each sampling trip, raw data will be entered and appended to the existing RGSM monitoring database. Data collected as part of the Program funded monitoring effort will be provided to the MRGESACP within one month of collection. At the end of the year, data collected will be provided in one standard format as part of a comprehensive database.

6.9 Limitations of Monitoring Methods

Throughout the past decade, the Rio Grande silvery minnow population monitoring program has evolved from its modest origins to meet the changing demands placed on it by resource managers while still providing relevant, quantifiable, and timely information regarding the status of this species both spatially and temporally. Meeting the changing demands on this study program while attempting to fulfill the information needs of resource entities has been accomplished by increasing sampling frequency, increasing the number of sampling sites, or both. During the recent drought (2002-2004) the marked decline in Rio Grande silvery minnow populations necessitated the sampling regime be increased to monthly at 20 sites between Angostura Diversion Dam and Elephant Butte Reservoir. The proven ability of the Rio Grande silvery minnow Population Monitoring Program to provide timely and detailed information on all life stages of this species at both spatial and temporal scales underscores the strength and extreme value of this study. Information gleaned from Rio Grande silvery minnow population monitoring samples is most valuable when viewed collectively and in sequence.

There is considerable variation in the biotic and abiotic components of the Rio Grande over space and time. The most robust comparisons of population trends will likely depend on controlling for this variation to some extent. It is for this reason that past comparisons (all reaches, by reach, or by site) using population monitoring data have focused on trends using a single point in time (October) over multiple years. This type of comparison is likely to yield more meaningful data compared with a single intra-annual (within year) comparison. However, if intra-annual comparisons are viewed in context with the full data set (i.e., a decade of intra-annual comparisons) the seasonal trends become more meaningful and robust.

While current monitoring methods employed for the Rio Grande fish community monitoring program provide a robust estimate of population trends over time, the primary limitations of the methods are that they cannot be used to quantify total population size. Quantification of population size requires that a whole set of additional assumptions (e.g., random site selection, random sampling, standardizing comparisons etc.) be met in order to provide an unbiased estimate of total numbers. Although the initial Rio Grande silvery minnow Population Monitoring Program was never designed to provide a population estimate of this species, performance of the aforementioned program should not preclude concurrent investigations that provide an estimate of the number of Rio Grande silvery minnow. With establishment of the Middle Rio Grande Endangered Species Act Collaborative Program, considerable discussion regarding the most parsimonious method and metric for quantifying the population of this species has occurred. A question often posed is if a sampling methodology could be developed that would provide a statistically defensible estimate of the total number of silvery minnow at a single point in time (e.g., October of each year).
The effort to provide such an estimate is ongoing and should be useful in both comparing to population monitoring trends over time and in evaluating progress made towards meeting quantitative recovery goals (e.g., 500,000 RGSM in the San Acacia Reach).

6.10 Data Summary and Analysis

Catch-per-unit-effort (CPUE) of each fish species, from each individual seine haul, will be calculated from the raw data. Mesohabitat type, RGSM age-class and/or marked with VIE, and seine mesh size will also be recorded for each haul. Additional data on physical parameters, site location, and sampling time will also be recorded and summarized. Data will pooled as appropriate so that results of this RGSM and fish community monitoring can be compared to that collected in the past.

Summary statistics will be provided to complement the existing and tables and figures in the final report. Comparisons will be made spatially (sites and reaches) and temporally (seasons and years). The primary focus of comparisons will be on the October sampling period but other comparisons will be made during other important periods (e.g., pre-spawning and post-spawning). Descriptive statistics (e.g., mean, median, interquartile range, standard deviation) will be used to summarize the large amounts of data, which will also be presented in the appendix, generated by the Population Monitoring Program. This method of statistical analysis (like the presentation of figures) is simply a more convenient way to summarize this extensive data set for ease of interpretation.

7.0 REPORTING

- The monitoring database, in a program approved standard electronic format, will be delivered to the MRGESACP within one month of collection
- Electronic copies of all raw data collected during Program funded activities for the period of the contract will be appended to the RGSM long-term database and delivered to the MRGESACP within two months of the last contracted monitoring period.
- Electronic copies of the annual report summarizing the monitoring data and documenting major findings.

REFERENCES

Bannerot, S. P., and C. B. Austin. 1983. Using frequency distributions of catch per unit effort to measure fish-stock abundance. Transactions of the American Fisheries Society 112:608-617.

Gibbs, J. P., S. Droege, P. Eagle. 1998. Monitoring populations of plants and animals. BioScience 48:935-940.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68:1364-1372.

Hendricks, M. L., C. H. Hocutt, and J. R. Stauffer, Jr. 1980. Monitoring of fish in lotic habitats, p. 205-231. In: C. H. Hocutt and J. R. Stauffer, Jr. (eds.). Biological Monitoring of Fish. D. C. Heath, Lexington, Massachusetts.

Matthews, W. J. 1986. Fish faunal structure in an Ozark stream: stability, persistence and a catastrophic flood. Copeia 1986:388-397.

Matthews, W. J., R. C. Cashner, and F. P. Gelwick. 1988. Stability and persistence of fish faunas and assemblages in three Midwestern streams. Copeia 1988:945-955.

Platania, S. P. 1993. The fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and their habitat associations. Report to the New Mexico Department of Game and Fish, Santa Fe, and U. S. Bureau of Reclamation (Albuquerque Projects Office), Albuquerque, NM. 188 pp.

Platania, S. P. and C. S. Altenbach. 1998. Reproductive strategies and egg types of seven Rio Grande basin cyprinids. Copeia 1998 (3): 559-569.

Richards, L. J., and J. T. Schnute. 1986. An experimental and statistical approach to the question: is CPUE an index of abundance? Canadian Journal of Fisheries and Aquatic Sciences 43: 1214-1227.

Richards, L. J., and J. T. Schnute. 1992. Statistical models for estimating CPUE from catch and effort data. Canadian Journal of Fisheries and Aquatic Sciences 49:1315-1327.

Ricker, W. E. 1940. Relation of "catch per unit effort" to abundance and rate of exploitation. Journal of the Fisheries Research Board of Canada 5:43-70.

Ricker, W. E. 1944. Further notes on fishing mortality and effort. Copeia 1944: 23-44.

Rutherford, D. A., A. A. Echelle, and O. E. Maughan. 1987. Changes in the fauna of the Little River drainage, southeastern Oklahoma, 1948-1955 to 1981-1982: a test of the hypothesis of environmental degradation, p. 178-183. *In*: W. J. Matthews and D. C. Heins (eds.). Community and Evolutionary Ecology of North American Stream Fishes. University of Oklahoma Press, Norman, Oklahoma.

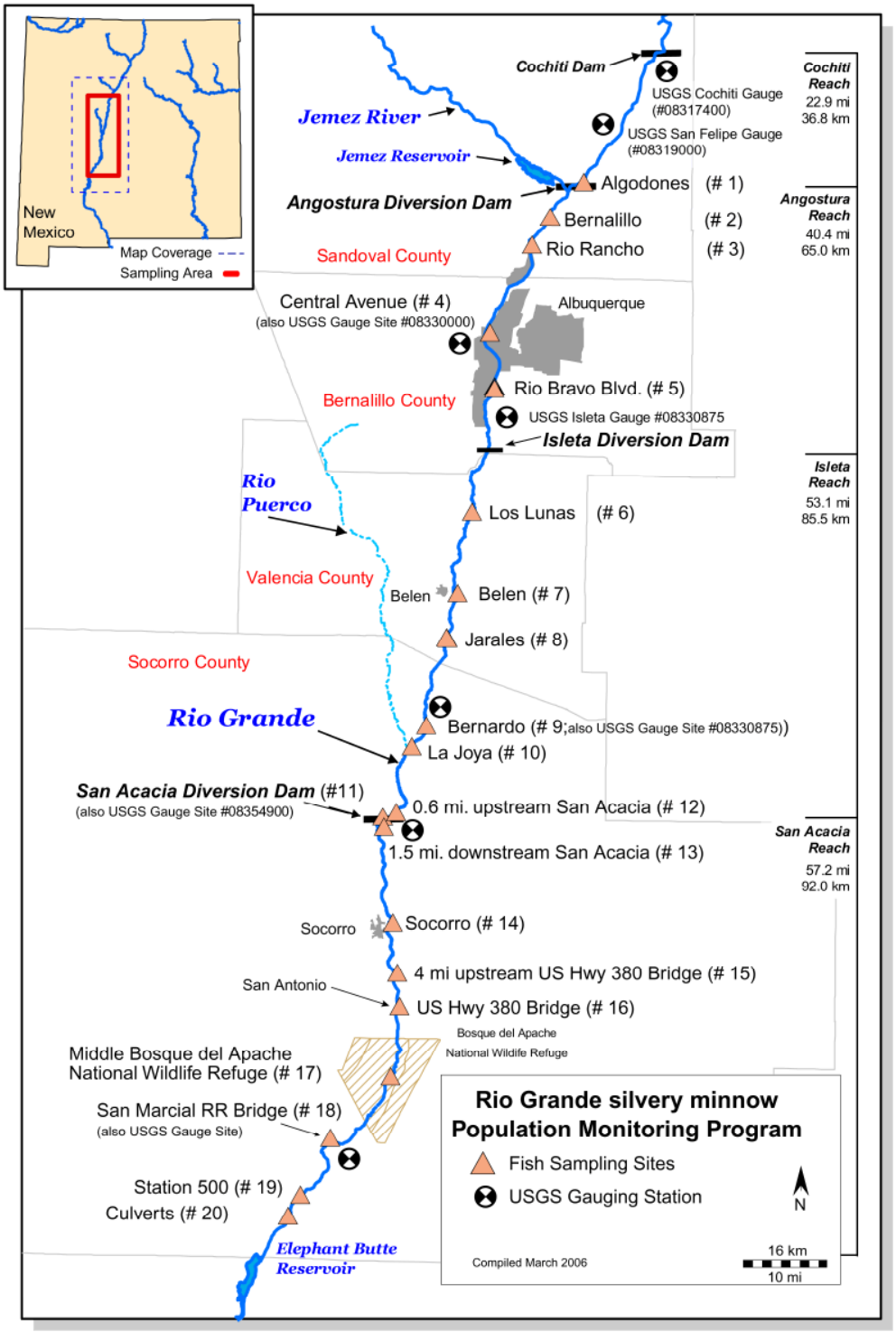
Schwarz, C. J., and G. A. F. Seber. 1999. Estimating animal abundance: review III. Statistical Science 14:427-456.

Seber, G. A. F. 1982. The Estimation of Animal Abundance and Related Parameters. Second Edition, Arnold, London.

Seber, G. A. F. 1992. A review of estimating animal abundance II. International Statistical Review 60:129-166.

U. S. Fish and Wildlife Service. 1999. Rio Grande silvery minnow Recovery Plan. Albuquerque, NM. 141 pp.

Appendix A-1. Map of sampling sites for use in Rio Grande silvery minnow Population Monitoring Program. Site numbers correspond with descriptions in Appendix A-1a.



Appendix A-1.a. Rio Grande silvery minnow Population Monitoring Program fish sampling localities.

Site #	Site Locality			
	ANGOSTURA REACH SITES			
1	New Mexico, Sandoval County, Rio Grande, below Angostura Diversion Dam, Algodones.			
	River Mile 209.7	San Felipe Pueblo Quadrangle		
	UTM Coordinates:	3916006 N	363811 E	Zone 13 NAD 27
2	New Mexico, Sandoval County, Rio Grande, at U.S. Highway 550 Bridge Crossing, (formerly NM State Highway 44 Bridge Crossing), Bernalillo.			
	River Mile 203.8	Bernalillo Quadrangle		
	UTM Coordinates:	3909722 N	358543 E	Zone 13 NAD 27
3	New Mexico, Sandoval County, Rio Grande, ca. 4 miles downstream of U.S. Highway 550 Bridge Crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.			
	River Mile 200.0	Bernalillo Quadrangle		
	UTM Coordinates:	3905355 N	354772 E	Zone 13 NAD 27
4	New Mexico, Bernalillo County, Rio Grande, at Central Avenue (U.S. Highway 66) Bridge Crossing, Albuquerque.			
	River Mile 183.4	Albuquerque West Quadrangle		
	UTM Coordinates:	3884094 N	346840 E	Zone 13 NAD 27
5	New Mexico, Bernalillo County, Rio Grande, at Rio Bravo Boulevard Bridge Crossing (NM State Highway 500), Albuquerque.			
	River Mile 178.3	Albuquerque West Quadrangle		
	UTM Coordinates:	3877163 N	347554 E	Zone 13 NAD 27
Site #	**Site Locality**			
	ISLETA REACH SITES			
6	New Mexico, Valencia County, Rio Grande, at Los Lunas (NM State Highway 49) Bridge Crossing, Los Lunas.			
	River Mile 161.4	Los Lunas Quadrangle		
	UTM Coordinates:	3852531 N	342898 E	Zone 13 NAD 27
7	New Mexico, Valencia County, Rio Grande, ca. 1.0 miles upstream of NM State Highway 309/6 Bridge Crossing, Belen.			
	River Mile 151.5	Tome Quadrangle		
	UTM Coordinates:	3837061 N	339972 E	Zone 13 NAD 27
8	New Mexico, Valencia County, Rio Grande, ca. 2.2 miles upstream of NM State Highway 346 Bridge Crossing (near Transwestern Natural Gas Pipeline crossing), Jarales.			
	River Mile 143.2	Veguita Quadrangle		
	UTM Coordinates:	3827329 N	338136 E	Zone 13 NAD 27
9	New Mexico, Socorro County, Rio Grande, at U.S. Highway 60 Bridge Crossing, Bernardo.			
	River Mile 130.6	Abeytas Quadrangle		
	UTM Coordinates:	3809726 N	334604 E	Zone 13 NAD 27

Appendix A-1.a. (Continued).

Site #	Site Locality			
	ISLETA REACH SITES (continued)			
10	New Mexico, Socorro County, Rio Grande, ca. 3.5 miles downstream of U.S. Highway 60 Bridge Crossing, La Joya.			
	River Mile 127.0	Abeytas Quadrangle		
	UTM Coordinates:	3805229 N	331094 E	Zone 13 NAD 27
11	New Mexico, Socorro County, Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia.			
	River Mile 116.8	La Joya Quadrangle		
	UTM Coordinates:	3792603 N	327902 E	Zone 13 NAD 27
Site #	**Site Locality**			
	SAN ACACIA REACH SITES			
12	New Mexico, Socorro County, Rio Grande, directly below San Acacia Diversion Dam, San Acacia.			
	River Mile 116.2	San Acacia Quadrangle		
	UTM Coordinates:	3791977 N	326162 E	Zone 13 NAD 27
13	New Mexico, Socorro County, Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.			
	River Mile 114.6	Lemitar Quadrangle		
	UTM Coordinates:	3790442 N	325263 E	Zone 13 NAD 27
14	New Mexico, Socorro County, Rio Grande, 0.5 miles upstream of the Low Flow Conveyance Channel bridge, east and upstream of Socorro Wastewater Treatment Plant, Socorro.			
	River Mile 99.5	Loma de las Canas Quadrangle		
	UTM Coordinates:	3771043 N	327097 E	Zone 13 NAD 27
15	New Mexico, Socorro County, Rio Grande, ca. 4.0 miles upstream of U.S. Highway 380 Bridge Crossing, San Antonio.			
	River Mile 91.7	San Antonio Quadrangle		
	UTM Coordinates:	3761283 N	328140 E	Zone 13 NAD 27
16	New Mexico, Socorro County, Rio Grande, at U.S. Highway 380 Bridge Crossing, San Antonio.			
	River Mile 87.1	San Antonio Quadrangle		
	UTM Coordinates:	3754471 N	328914 E	Zone 13 NAD 27
17	New Mexico, Socorro County, Rio Grande, directly east of Bosque del Apache National Wildlife Refuge headquarters, San Antonio.			
	River Mile 79.1	San Antonio, SE Quadrangle		
	UTM Coordinates:	3740839 N	327055 E	Zone 13 NAD 27

Appendix A-1.a. (Continued).

Site #	Site Locality			
	SAN ACACIA REACH SITES (continued)			
18	New Mexico, Socorro County, Rio Grande, at the San Marcial Railroad Bridge Crossing, San Marcial.			
	River Mile 68.6	San Marcial Quadrangle		
	UTM Coordinates:	3728347 N	315284 E	Zone 13 NAD 27
19	New Mexico, Socorro County, Rio Grande, at its former (=1992) confluence with the Low Flow Conveyance Channel and ca. 8 miles downstream of the San Marcial Railroad Bridge Crossing, San Marcial.			
	River Mile 60.5	Paraje Well Quadrangle		
	UTM Coordinates:	3718178 N	309487 E	Zone 13 NAD 27
20	New Mexico, Socorro County, Rio Grande, ca. 10 miles downstream of the San Marcial Railroad Bridge Crossing, San Marcial.			
	River Mile 58.8	Paraje Well Quadrangle		
	UTM Coordinates:	3716150 N	307846 E	Zone 13 NAD 27

Appendix A-2.a. Sample data sheet for recording individual seine hauls at each sampling site.

Field Number: ABC06-001__

Sample	Length (m)	Habitat Type	Fish (✓)	RGSM (✓)	Remarks
1	10.3	SCPO-DE	✓	✓	1 RGSM with blue VIE tag located base of left dorsal fin
2	12.4	SCPO	✓	✓	
3	14.4	IP	—	—	no fish taken
4	13.1	MCFL	—	—	no fish taken
5	11.4	MCRU	✓	—	
6	17.2	SCSHRU	✓	✓	
7	11.9	SCPO	✓	—	
8	7.7	MCPO	—	—	no fish taken
9	12.1	MCPO	✓	—	
10	14.6	MCSHRU	✓	✓	
11	9.8	SCPO	—	—	no fish taken
12	11.7	MCED	✓	✓	
13	7.9	MCRI	✓	—	
14	11.1	MCRU	—	—	no fish taken
15	6.5	MCPO	✓	✓	
16	4.9	SCPO	—	—	no fish taken
17	12.4	MCSHRU	✓	—	
18	15.9	MCSHRU	✓	—	
19	3.2	MCSH-DE	✓	✓	
20	14.1	MCSHPO	✓	✓	

Appendix A-2.b. Aquatic mesohabitat types, codes, and definitions for use in Rio Grande silvery minnow Population Monitoring Program.

MESOHABITAT TYPES

HABITATS	CODES	HABITAT DEFINITIONS
	Primary Habitat Types	
Main Channel	**MC**	Section of the river which carries the majority of the flow; there can be only one main channel.
Secondary Channel	**SC**	Any channel not designated as the main channel; there can be none or several secondary channels at a site.
Backwater	**BW**	Water connected to the main or a secondary channel and lacking appreciable flow; often created by a decline in flow which partially isolates a former secondary channel
Isolated Pool	**IP**	A water containing pool that is no longer connected to the main or secondary channel; frequently a former backwater that is no longer connected to the main or secondary channel.
	Secondary Habitat Types	
Run	**RU**	Relatively high velocity water with laminar flow and a non-turbulent surface.
Riffle	**RI**	A reach of shallow and relatively high velocity flow; water surface is irregular and contains waves; generally indicative of gravel-cobble substrate
Pool	**PO**	Portion of aquatic habitat that is relatively deep and with relatively little velocity compared to the rest of the channel.
Flat	**FL**	Typically a mid-channel habitat with a relatively level substrate covered by shallow water and minimal or no surface disturbance.
	Tertiary Habitat Types	
Debris	**DE**	Any habitat that has associated instream cover (e.g., grasses, woody vegetation etc.) within all or part of the total surface area sampled.
Shoreline	**SH**	The shallower, lower velocity portion of a mesohabitats that is adjacent to the shoreline. Although a tertiary habitat designator, this particular code precedes secondary mesohabitat designations (i.e. MCSHRU= shoreline run or SCSHRI= shoreline riffle).

Appendix A-2.b.1. Sample data sheet for recording fish composition of individual seine hauls.

Field Number: ABC06-001

Seine Haul #	CYPLUT	CYPCAR	HYBAMA	PIMPRO	PLAGRA	RHICAT	CARCAR	CATCOM	ICTPUN	GAMAFF	write-in	write-in	write-in
1	14		N=22 18 Age 0 4 Age 1 Age 0 22-32 TL Age 1 40-45 TL	3	1	6			3	33	MORCRY 2	PIMVIG 1	
2	34		N=10 10 Age 0 Age 0 27-33 TL	2	-	-			1				
3	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—
5	22	2	—	13	7				1		AMENAT 1		
6													
7													
8													
9													
10													
11													
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15													
16													
17													
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20													

Appendix A-2.b.1. (cont.) Scientific and common names and species codes of fishes for use in Rio Grande silvery minnow Population Monitoring Program.

Scientific Name	Common Name	Species Codes
Order Clupeiformes		
Family Clupeidae	herrings	
Dorosoma cepedianum	gizzard shad	DORCEP
Order Cypriniformes		
Family Cyprinidae	carps and minnows	
Cyprinella lutrensis	red shiner	CYPLUT
Cyprinus carpio	common carp	CYPCAR
Hybognathus amarus	Rio Grande silvery minnow	HYBAMA
Pimephales promelas	fathead minnow	PIMPRO
Pimephales vigilax	bullhead minnow	PIMVIG
Platygobio gracilis	flathead chub	PLAGRA
Rhinichthys cataractae	longnose dace	RHICAT
Family Catostomidae	suckers	
Carpiodes carpio	river carpsucker	CARCAR
Catostomus commersoni	white sucker	CATCOM
Ictiobus bubalus	smallmouth buffalo	ICTBUB
Order Siluriformes		
Family Ictaluridae	bullhead catfishes	
Ameiurus melas	black bullhead	AMEMEL
Ameiurus natalis	yellow bullhead	AMENAT
Ictalurus punctatus	channel catfish	ICTPUN
Order Salmoniformes		
Family Salmonidae	trouts	
Salmo trutta	brown trout	SALTRU
Order Cyprinodontiformes		
Family Poeciliidae	livebearers	
Gambusia affinis	western mosquitofish	GAMAFF
Order Perciformes		
Family Centrarchidae	sunfishes	
Lepomis cyanellus	green sunfish	LEPCYA
Lepomis macrochirus	bluegill	LEPMAC
Micropterus salmoides	largemouth bass	MICSAL
Pomoxis annularis	white crappie	POMANN
Family Percidae	perches	
Perca flavescens	yellow perch	PERFLA
Percina macrolepida	bigscale logperch	PERMAC
Stizostedion vitreum	walleye	STIVIT

Appendix A-3. Suggested Tables for inclusion in Rio Grande silvery minnow Population Monitoring Program Reporting.

Table X. Summary of the monthly catch of Rio Grande silvery minnow, by site and reach, during the 200x Rio Grande silvery minnow population monitoring program. Numerals in parenthesis, a subset of the total catch, are the number of individual silvery minnow in that sample that were marked with VIE tags (=hatchery reared [stocked] fish).

REACH Site Number Site Name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ANGOSTURA REACH													
1 Angostura Dam	—	—	—	—	—	—	234	100	8	8	—	—	350
2 Bernalillo	—	—	24	6	—	3	142(1)	77	28	28	60(1)	2	370
3 Rio Rancho	—	—	17	42(22)	425	218	74	176	29	7	261(11)	163(70)	1,412
4 Central Ave (Abq)	—	—	3	—	—	12	1	7	1	1	—	26 (6)	51
5 Rio Bravo (Abq)	—	—	1	—	31	1	2	6	—	—	1	1	43
Angostura Reach Total	*—*	*—*	*45*	*48(22)*	*456*	*234*	*453(1)*	*366*	*66*	*44*	*322(12)*	*192(76)*	*2,226*
ISLETA REACH													
6 Los Lunas	1	1	—	—	46	10	12	13	—	1	7	8	99
7 Belen	2	1	—	—	—	—	6	10	3	3	89	12	126
8 Jarales	1	—	—	—	—	—	36	1	5	—	15	—	58
9 US Hwy 60 Bernardo	—	—	—	—	—	6	—	—	—	—	—	1	7
10 South of Bernardo	1	—	—	—	6	10	51	6	7	—	16	—	97
11 North of San Acacia	—	—	—	—	—	51	3	1	—	—	—	—	55
Isleta Reach Total	*5*	*2*	*—*	*—*	*52*	*77*	*108*	*31*	*15*	*4*	*127*	*21*	*442*
SAN ACACIA REACH													
12 San Acacia Dam	—	—	—	—	—	24	4	—	6	18	38	19	109
13 S of San Acacia	1	—	—	1	—	4	1	4	29	5	43	46	134
14 Socorro	—	—	—	—	—	69	5	10	—	7	—	1	92
15 North of US Hwy 380	—	—	—	—	—	—	1	4	—	—	—	—	5
16 US Hwy 380	—	—	—	—	6	—	1	—	—	—	2	2	11
17 Bosque del Apache	1	—	—	—	2	1	—	—	—	—	1	—	5
18 San Marcial	—	—	—	—	—	—	—	1	—	—	—	5	6
19 South of San Marcial	—	—	—	—	1	—	—	—	—	—	—	—	1
20 South of San Marcial	—	—	—	—	—	2	1	—	—	—	5	—	8
San Acacia Reach Total	*2*	*—*	*—*	*1*	*9*	*100*	*13*	*19*	*35*	*30*	*89*	*73*	*371*
MONTHLY TOTALS	7	2	45	49(22)	517	411	574(1)	416	116	78	538(12)	286(76)	3,039

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL

Appendix A-3.1. (Continued).

Table X. Summary of the monthly 200x Rio Grande silvery minnow Population Monitoring Program fish collections.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
HERRINGS													
gizzard shad	—	—	1	—	—	3	1	3	—	—	—	—	8
CARPS AND MINNOWS													
red shiner	1,700	2,565	2,645	2,941	2,249	4,688	2,608	2,659	4,376	3,436	1,674	982	32,523
common carp	2	4	9	—	99	238	28	13	7	7	11	1	419
Rio Grande silvery minnow	7	2	45	49	517	411	574	416	116	78	538	286	3,039
Rio Grande chub	—	—	—	—	—	—	—	—	—	—	—	—	—
fathead minnow	166	193	167	95	407	1,501	896	439	776	447	322	163	5,572
bullhead minnow	—	—	—	—	—	—	—	—	—	—	1	—	1
flathead chub	38	30	79	61	52	105	211	158	138	194	296	234	1,596
longnose dace	2	1	26	99	9	26	91	23	11	24	14	2	328
SUCKERS													
river carpsucker	19	15	84	11	252	856	280	167	59	42	33	24	1,842
white sucker	4	23	128	43	896	479	106	20	2	5	6	3	1,715
smallmouth buffalo	—	—	—	—	—	—	—	—	2	—	—	—	2
BULLHEAD CATFISHES													
black bullhead	—	3	—	—	—	—	—	1	—	—	—	—	4
yellow bullhead	—	—	—	—	—	1	10	12	3	1	—	—	27
channel catfish	49	119	127	42	16	14	156	163	62	60	67	6	881
flathead catfish	—	—	—	—	—	—	—	—	—	—	—	—	—
TROUTS													
brown trout	—	—	—	—	—	—	—	—	—	—	—	2	2
LIVEBEARERS													
western mosquitofish	68	299	282	515	191	2,523	2,281	1,335	1,105	781	108	22	9,510
TEMPERATE BASSES													
white bass	—	—	—	—	—	—	—	—	—	—	—	—	—
SUNFISHES													
green sunfish	—	1	—	1	—	—	—	—	—	—	—	—	2
bluegill	—	—	—	3	1	—	—	1	1	—	—	—	6
largemouth bass	—	—	1	—	1	1	8	—	—	—	1	—	12
white crappie	3	1	—	5	1	1	—	—	—	—	—	1	12
black crappie	—	—	—	—	—	—	—	—	—	—	—	—	—
PERCHES													
yellow perch	—	1	1	—	2	20	—	1	—	—	—	1	26
bigscale logperch	—	—	—	—	—	—	—	—	—	—	—	—	—
walleye	—	—	1	—	—	—	—	—	—	—	—	—	1
TOTAL	2,058	3,257	3,596	3,865	4,693	10,867	7,250	5,413	6,656	5,075	3,070	1,727	57,528

Appendix A-3.1. (Continued).

Table 7. Summary of the monthly 200x Rio Grande silvery minnow Population Monitoring Program fish collections. Values indicate site specific ichthyofaunal composition as the percent of the total catch at that site.

Reach	Isleta Reach					San Acacia Reach						Angostura								
Site Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of fish per site																				
HERRINGS																				
gizzard shad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CARPS AND MINNOWS																				
red shiner	5.1	41.5	37.0	34.0	14.3	6.3	2.4	2.3	7.0	2.9	-	2.0	8.1	12.5	0.6	6.6	0.2	20.8	14.9	16.9
common carp	1.7	1.6	1.1	2.1	71.4	-	1.4	-	2.3	1.4	-	6.9	3.2	0.9	0.6	0.3	0.2	-	4.5	11.3
Rio Grande silvery minnow	5.1	15.4	53.8	29.8	-	84.5	95.5	69.4	82.1	61.0	87.4	74.3	64.5	80.1	97.2	89.3	97.0	7.1	31.3	33.8
Rio Grande chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
fathead minnow	-	-	1.6	-	3.6	2.0	-	1.9	2.1	3.8	8.7	1.0	9.7	1.2	0.6	1.7	0.7	4.2	3.0	5.6
bullhead minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-
flathead chub	-	20.3	2.7	23.4	7.1	-	-	-	0.3	0.5	1.0	3.0	9.7	-	-	0.7	-	-	-	-
longnose dace	11.9	13.8	0.5	8.5	-	-	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-
SUCKERS																				
river carpsucker	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-
white sucker	1.7	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
smallmouth buffalo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BULLHEAD CATFISHES																				
black bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
yellow bullhead	-	-	-	-	-	-	-	-	0.3	-	-	4.0	-	-	-	-	-	-	-	-
channel catfish	-	-	-	2.1	-	-	-	-	1.8	2.4	-	2.0	4.8	2.1	-	-	-	0.5	28.4	4.2
flathead catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	4.2
TROUTS																				
brown trout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LIVEBEARERS																				
western mosquitofish	62.7	3.3	3.3	-	-	7.1	0.7	26.5	4.1	28.1	2.9	4.0	-	3.3	1.1	1.4	1.6	66.5	13.4	22.5
TEMPERATE BASSES																				
white bass	-	1.6	-	-	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUNFISHES																				
green sunfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
bluegill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
largemouth bass	8.5	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
white crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
black crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PERCHES																				
yellow perch	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
bigscale perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
walleye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Site Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Angostura Reach					Isleta Reach						San Acacia Reach								
Site Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of fish per site	59	123	18	47	28	490	291	1756	386	210	103	101	62	337	177	289	437	212	67	71

Appendix A-3.1. (Continued).

Table X. Summary of the 200x Rio Grande silvery minnow Population Monitoring Program fish collections.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE[2]	%FREQUENCY OCCURRENCE[2]
HERRINGS					
gizzard shad	I	8	0.01	4	20
CARPS AND MINNOWS					
red shiner	N	32,523	56.53	20	100
common carp	I	419	0.73	19	95
Rio Grande silvery minnow	N	3,039	5.28	20	100
fathead minnow	N	5,572	9.69	20	100
bullhead minnow	I	1	<0.01	1	5
flathead chub	N	1,596	2.77	20	100
longnose dace	N	328	0.57	10	50
SUCKERS					
river carpsucker	N	1,843	3.20	20	10
white sucker	I	1,715	2.98	7	35
smallmouth buffalo	N	2	<0.01	2	10
BULLHEAD CATFISHES					
black bullhead	I	4	<0.01	3	15
yellow bullhead	I	27	0.05	10	50
channel catfish	I	881	1.53	18	90
TROUTS					
brown trout	I	2	<0.01	1	5
LIVEBEARERS					
western mosquitofish	I	9,510	16.53	20	100
SUNFISHES					
green sunfish	I	2	<0.01	2	10
bluegill	I	6	0.01	3	15
largemouth bass	I	12	0.02	6	30
white crappie	I	12	0.02	7	35
PERCHES					
yellow perch	I	26	0.05	6	30
bigscale logperch	I	-	-	-	-
walleye	I	1	<0.01	1	5
TOTAL		57,528	100	20	100

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=20 sample sites

Appendix A-4. Suggested Analytical Figures for inclusion in Rio Grande silvery minnow Population Monitoring Program Reporting. MONTHLY/CUMULATIVE

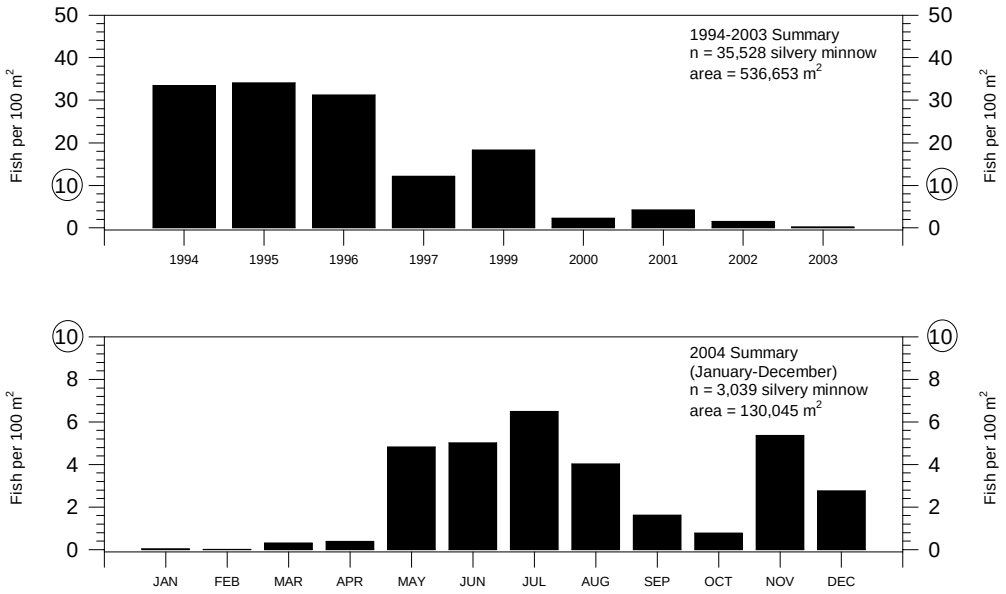


Figure X. Running monthly and annual catch rates (CPUE) of Rio Grande silvery minnow.

Appendix A-4.1. (Continued) MONTHLY/CUMULATIVE

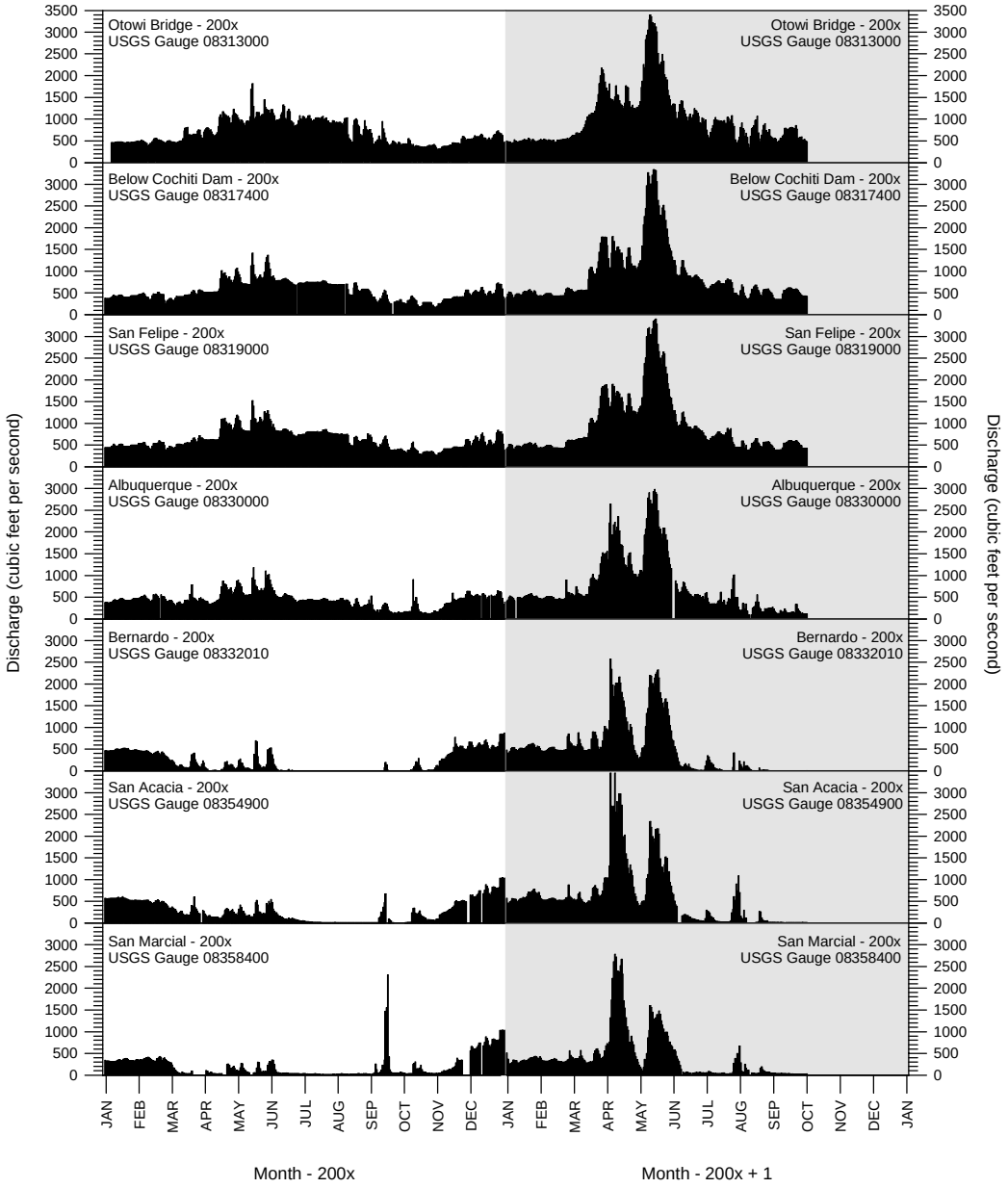


Figure X. Discharge in the Rio Grande from January 200x through December 200x as recorded at seven U. S. Geological Survey (USGS) gauge stations. The Otowi Bridge gauge site is outside of the study area (ca. 25.5 river miles upstream of Cochiti Dam) but is provided for reference. Discharge data are provisional and subject to change.

Appendix A-4.2. (Continued) MONTHLY

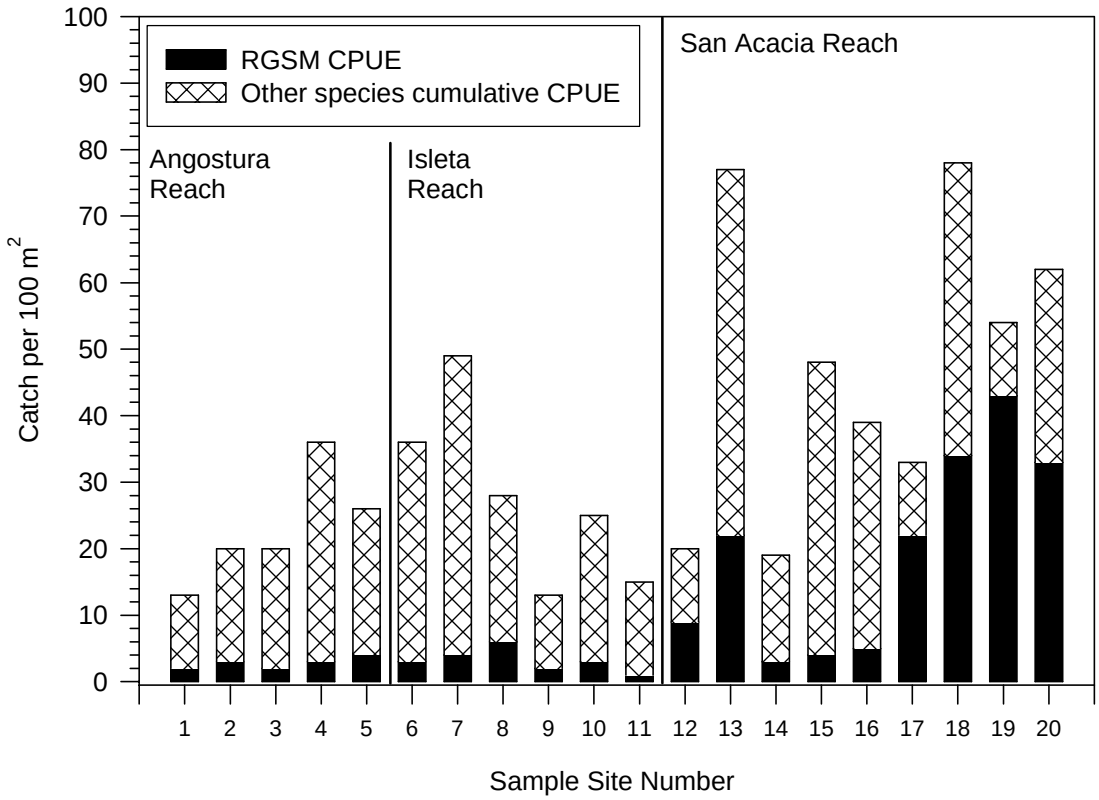


Figure X. Site specific comparisons of catch rates of Rio Grande silvery minnow (RGSM) and the remainder of the ichthyofaunal community during MONTH 200x. Solid vertical bars delineate sampling reaches.

Appendix A-4.3. (Continued) MONTHLY

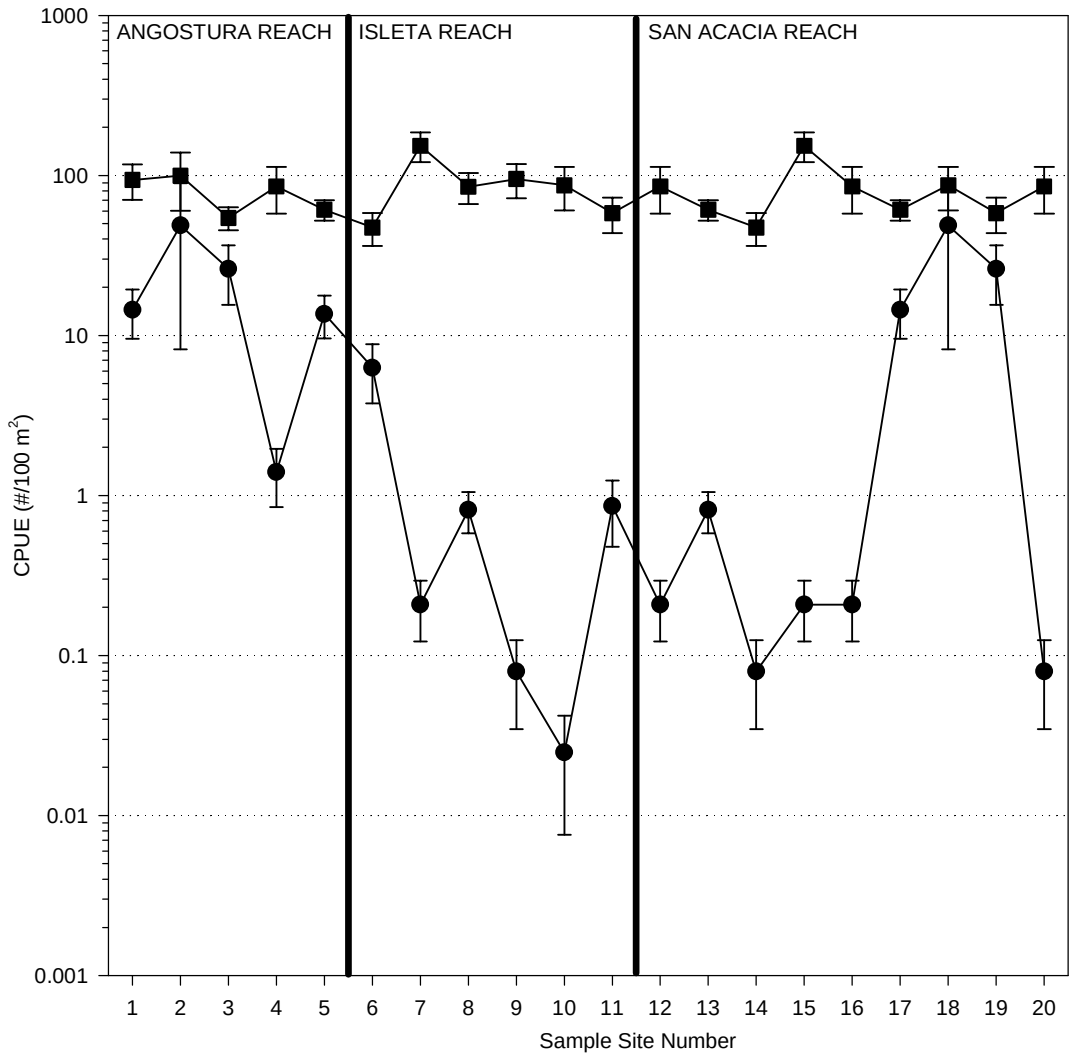


Figure X. Catch rates (CPUE) of Rio Grande silvery minnow (circles) and the total ichthyofaunal community squares) during October, at all sampling sites, by sampling year (1993-1997, 1999-2004). Solid circles or squares indicate means and capped-bars represent the standard error. Dotted horizontal lines represent different order of magnitude.

Appendix A-4.4. (Continued) ANNUAL-TOTAL

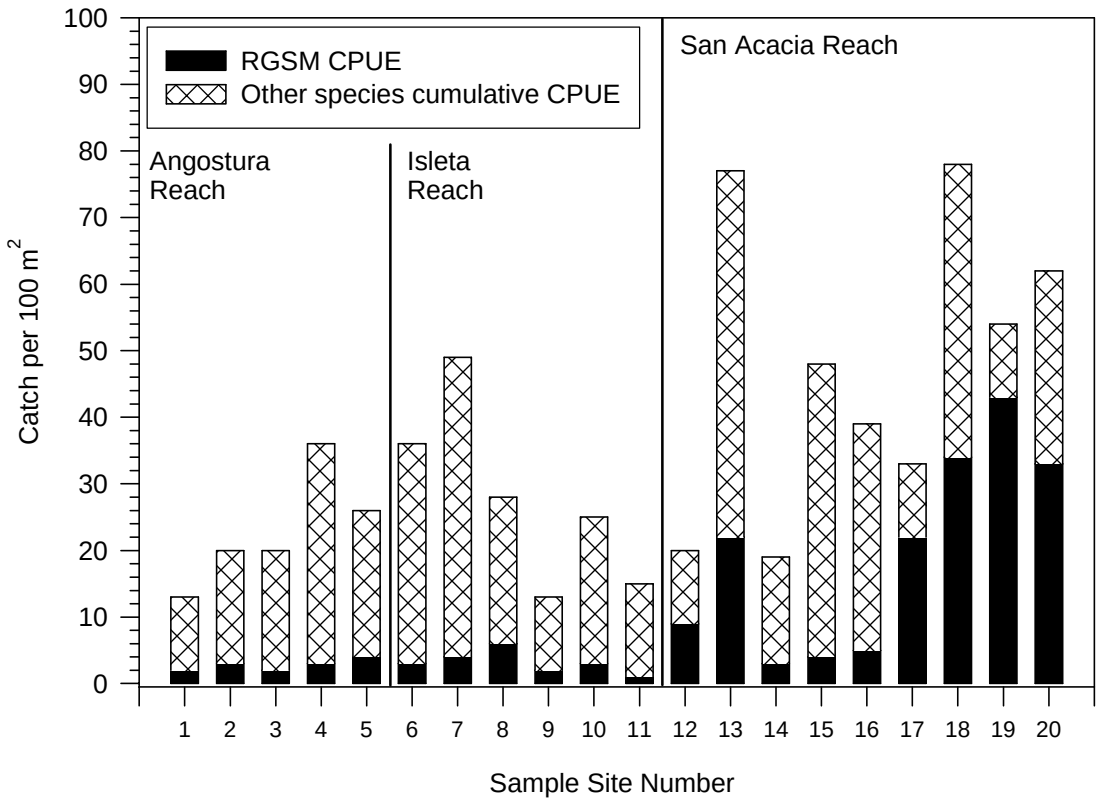


Figure X. Site specific comparisons of catch rates of Rio Grande silvery minnow (RGSM) and the remainder of the ichthyofaunal community during 200x. Solid vertical bars delineate sampling reaches.

Appendix A-4.5. (Continued) ANNUAL - OCTOBER GRAPHIC

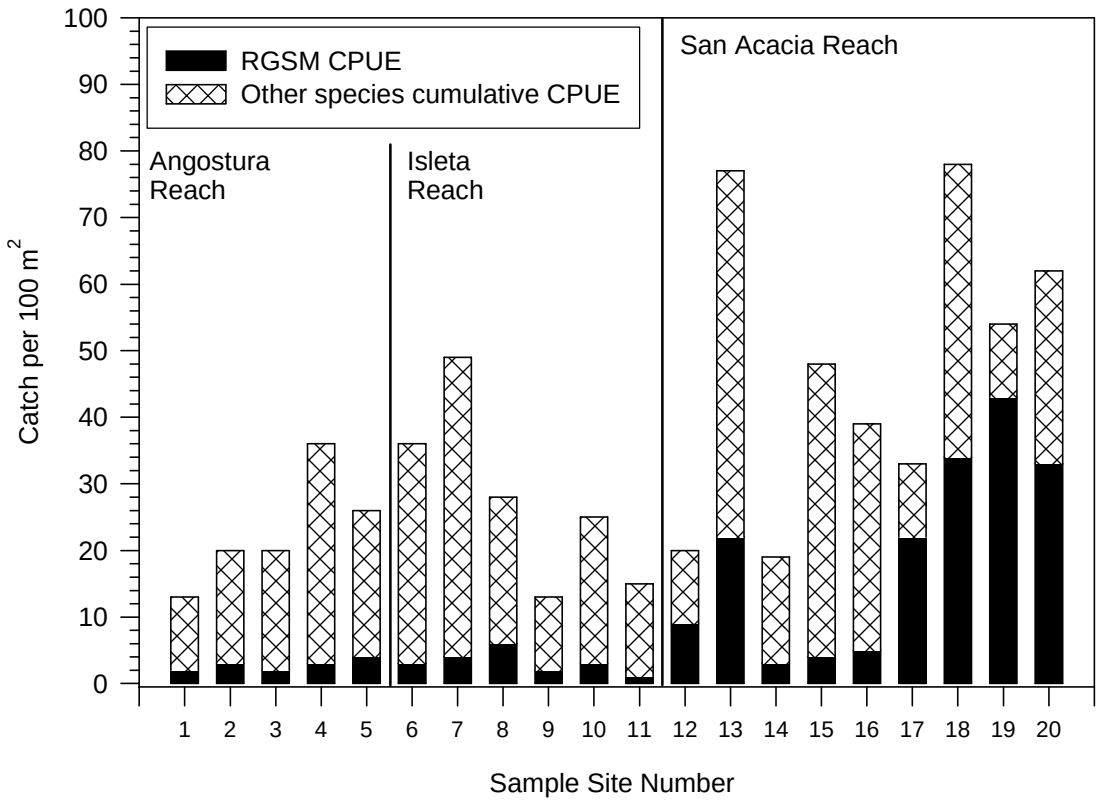


Figure X. Site specific comparisons of catch rates of Rio Grande silvery minnow (RGSM) and the remainder of the ichthyofaunal community during October 200x. Solid vertical bars delineate sampling reaches.

Appendix A-4.6. (Continued) MONTHLY CUMULATIVE/ANNUAL

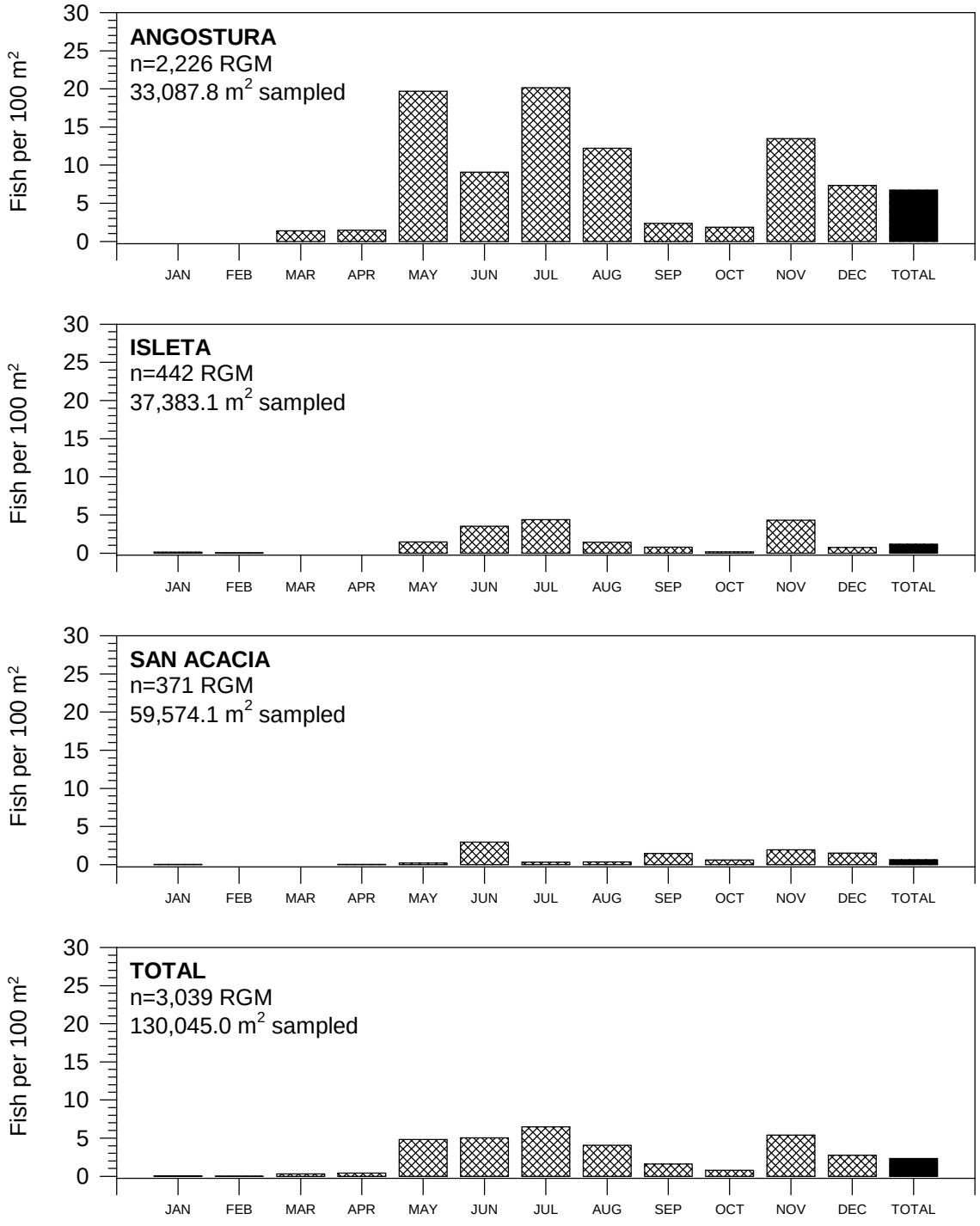


Figure X. Rio Grande silvery minnow (RGM) catch rates by river reach for 200x monthly samples in the Middle Rio Grande.

Appendix A-4.7. (Continued) MONTHLY CUMULATIVE/ ANNUAL

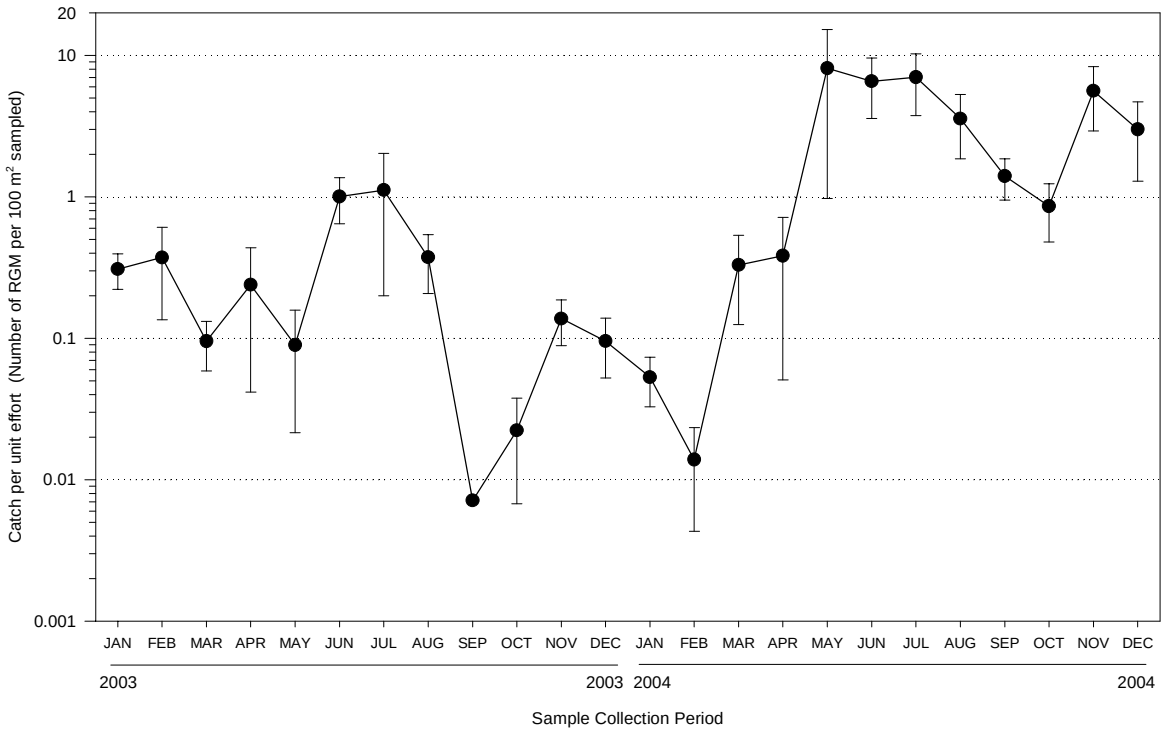


Figure X. Monthly catch rates of Rio Grande silvery minnow during 200x (January-December) and through December 200x at Population Monitoring Program collection sites. Solid circles indicate monthly means (n=20 sites per month) and capped-bars represent the standard error.

Appendix A-4.8. (Continued) MONTHLY CUMULATIVE/ ANNUAL

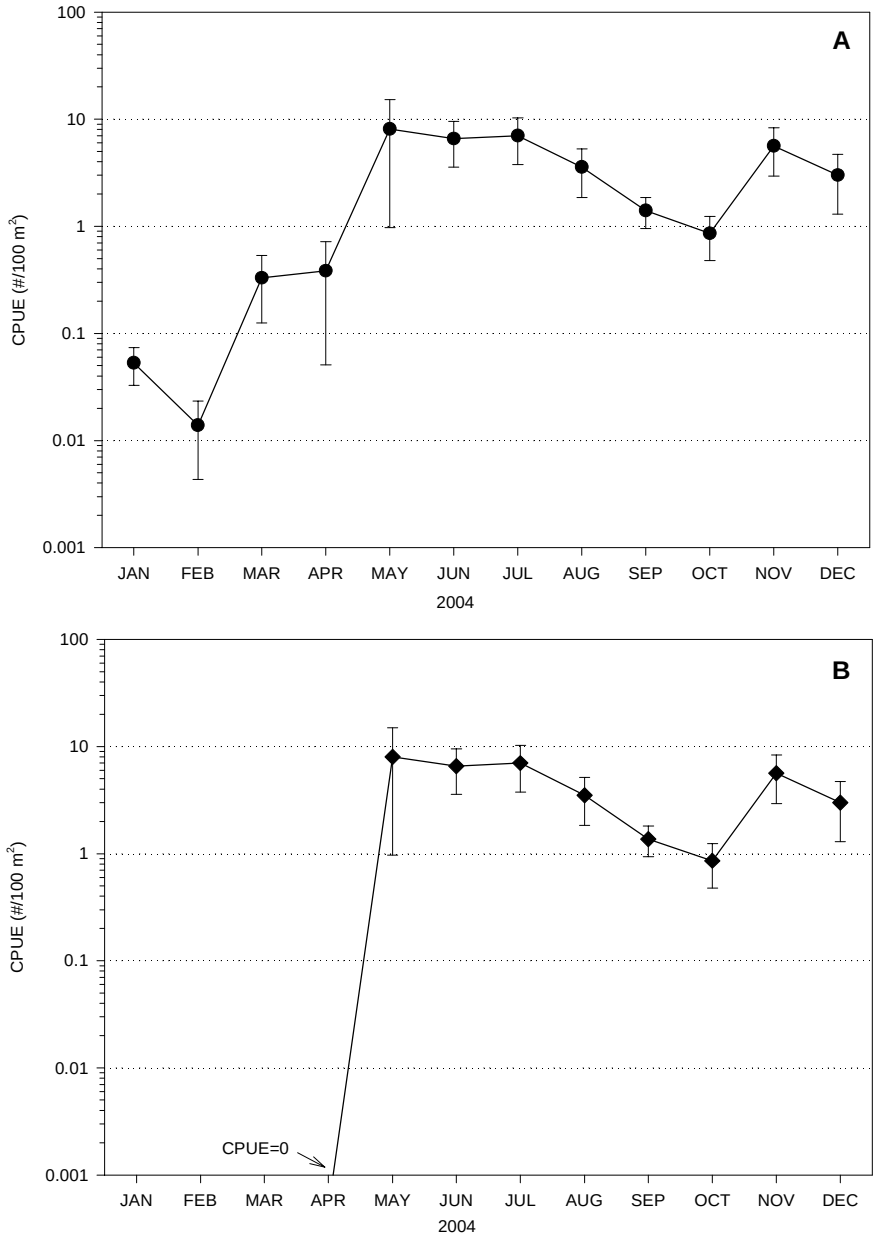


Figure X. Inter-month fluctuations in catch rates of Rio Grande silvery minnow during 200x (**A**=all age-classes including age-0 [circle]; **B**=age-0 only [diamond]). Symbols represent mean value for all sites sampled (n=20); bars represent the standard error. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.9. (Continued) MONTHLY CUMULATIVE/ ANNUAL

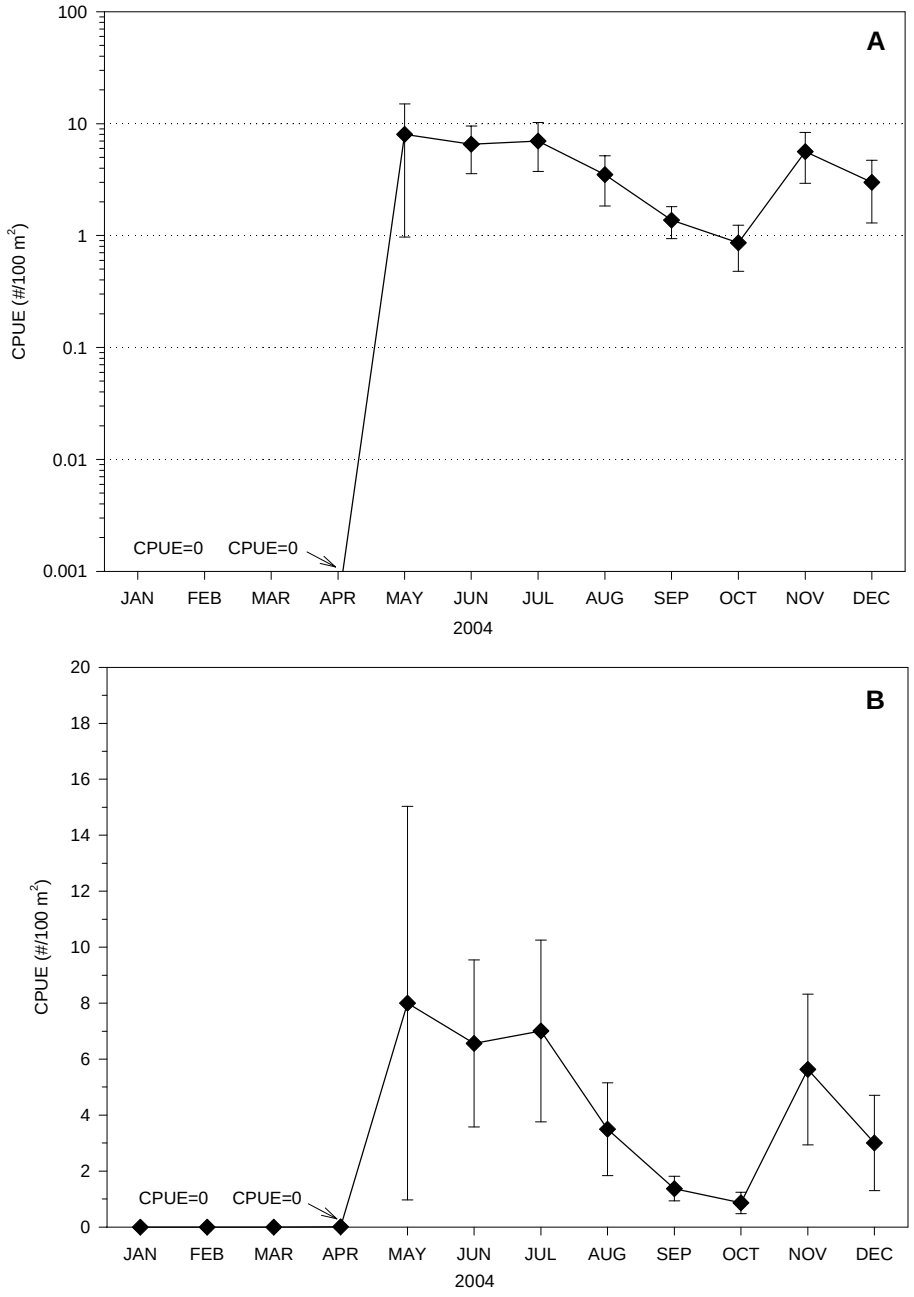


Figure X. Inter-month fluctuations in catch rate of Rio Grande silvery minnow (age-class 0 only) during 200x. Data in Graph **A** are plotted against a logarithmic scale while Graph **B** presents same data plot using linear scale. Solid circles represent mean value for all sites sampled (n=20); capped-bars represent the standard error of the mean. Dotted horizontal lines (Graph **A**) represent different orders of magnitude.

Appendix A-4.10. (Continued) MONTHLY CUMULATIVE/ ANNUAL

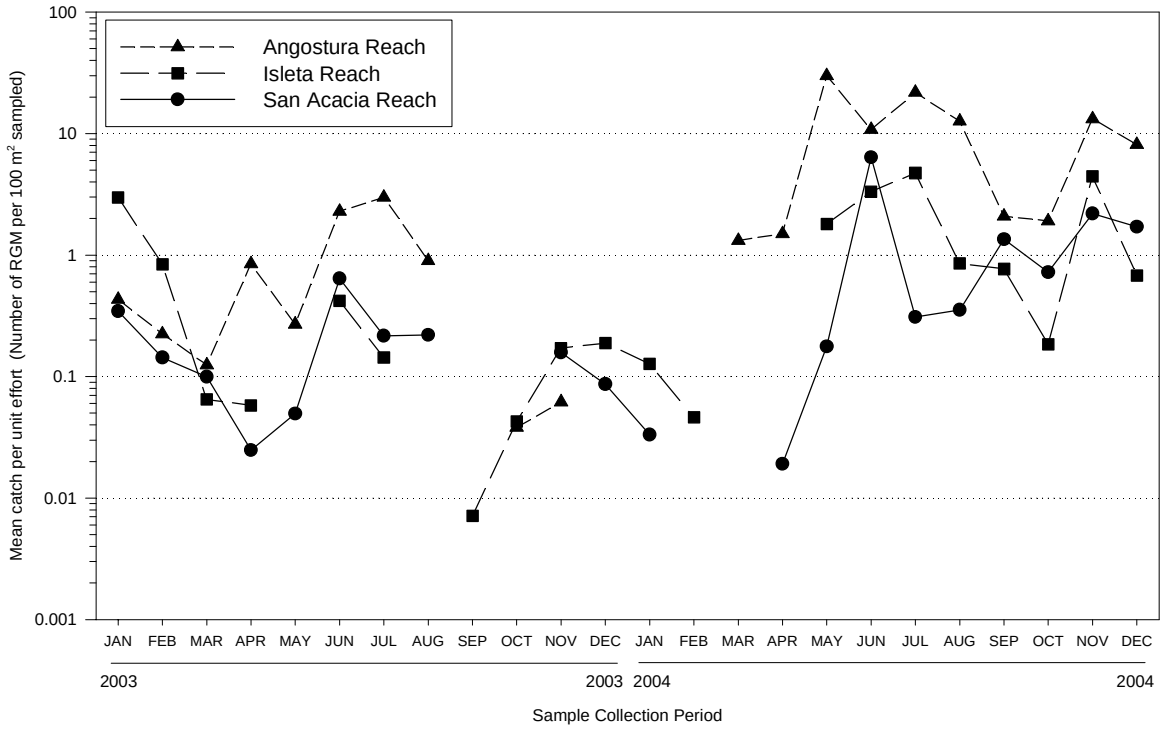


Figure X. Mean monthly catch rates of Rio Grande silvery minnow during 200x (January-December) and through December 200x at population monitoring program collection sites in the Angostura, Isleta, and San Acacia reaches. Missing symbols indicate that no individuals were collected in a particular reach during that month.

Appendix A-4.11. (Continued) ANNUAL

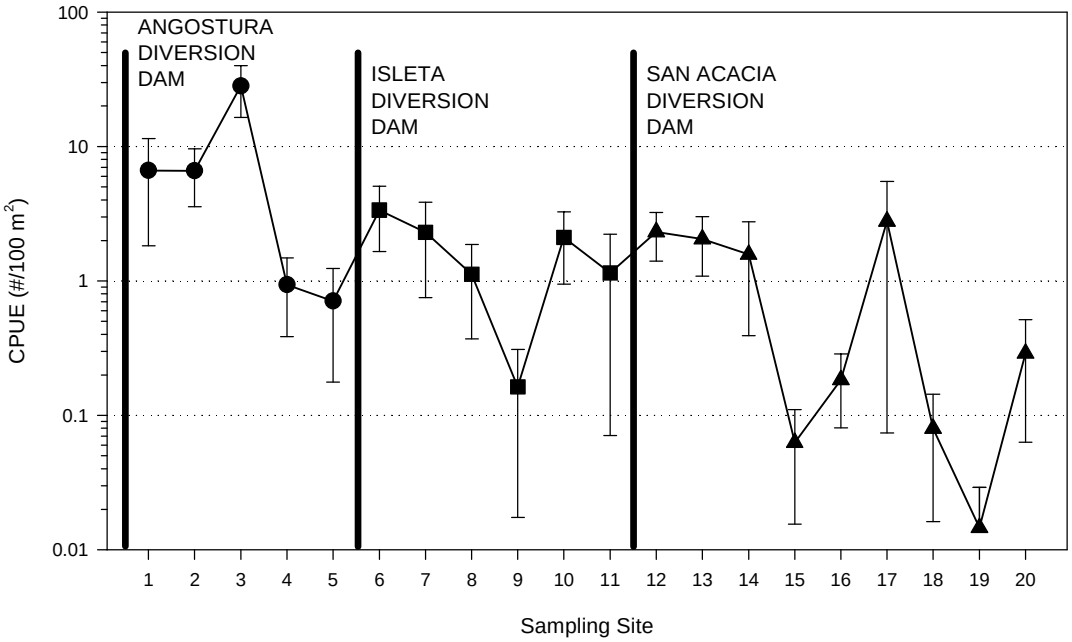


Figure X. Inter-site comparison of Rio Grande silvery minnow catch rates (CPUE) by sampling locality (20 sites) and river reach (Angostura=circle, Isleta=square, San Acacia =triangle) during 200x. Symbols represent mean values for all sampling months (n=12) and bars represent the standard error. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.12. (Continued) ANNUAL

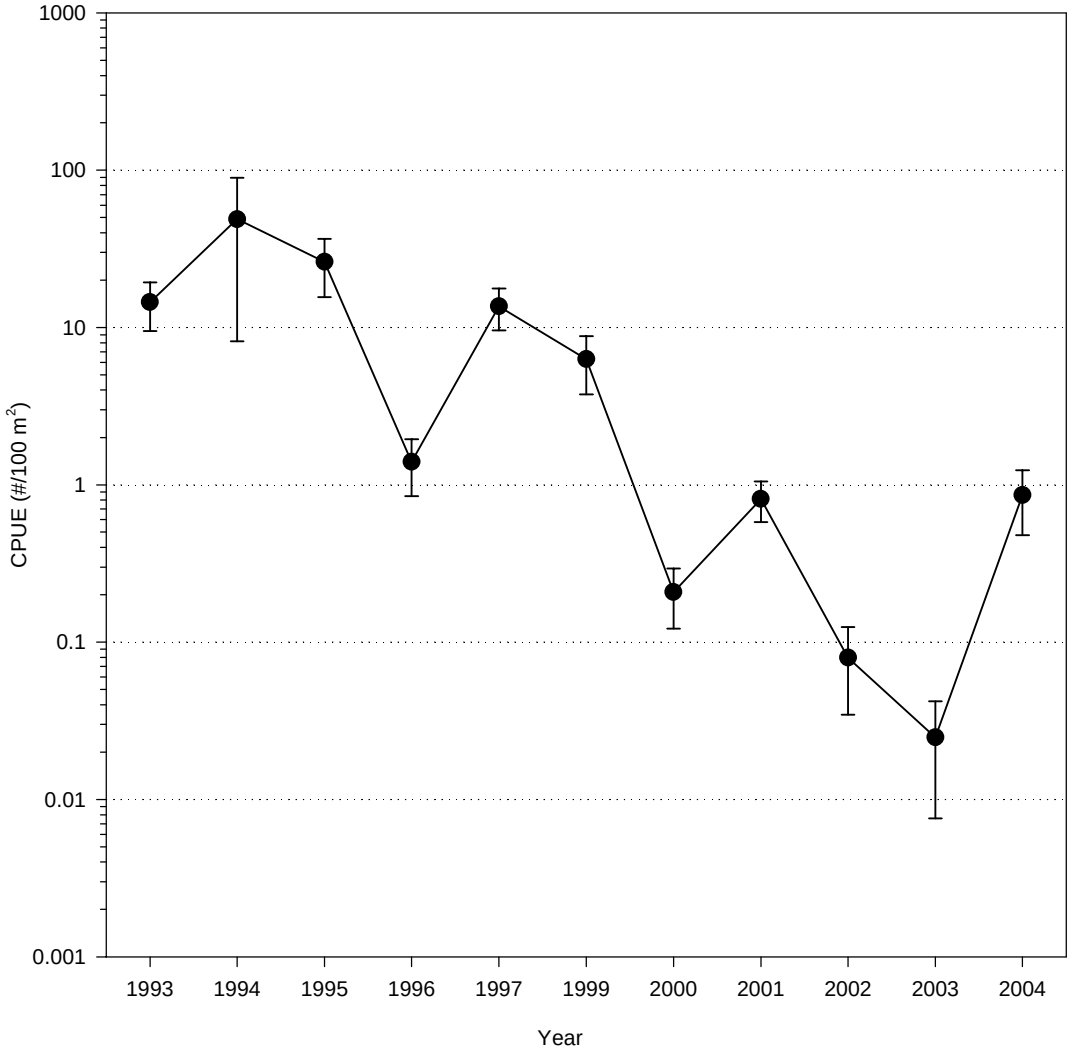


Figure X. Rio Grande silvery minnow catch rates (CPUE) during October, at all sampling sites, by sampling year (1993-1997, 1999-2004). Solid circles indicate means and capped-bars represent the standard error. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.13. (Continued) ANNUAL

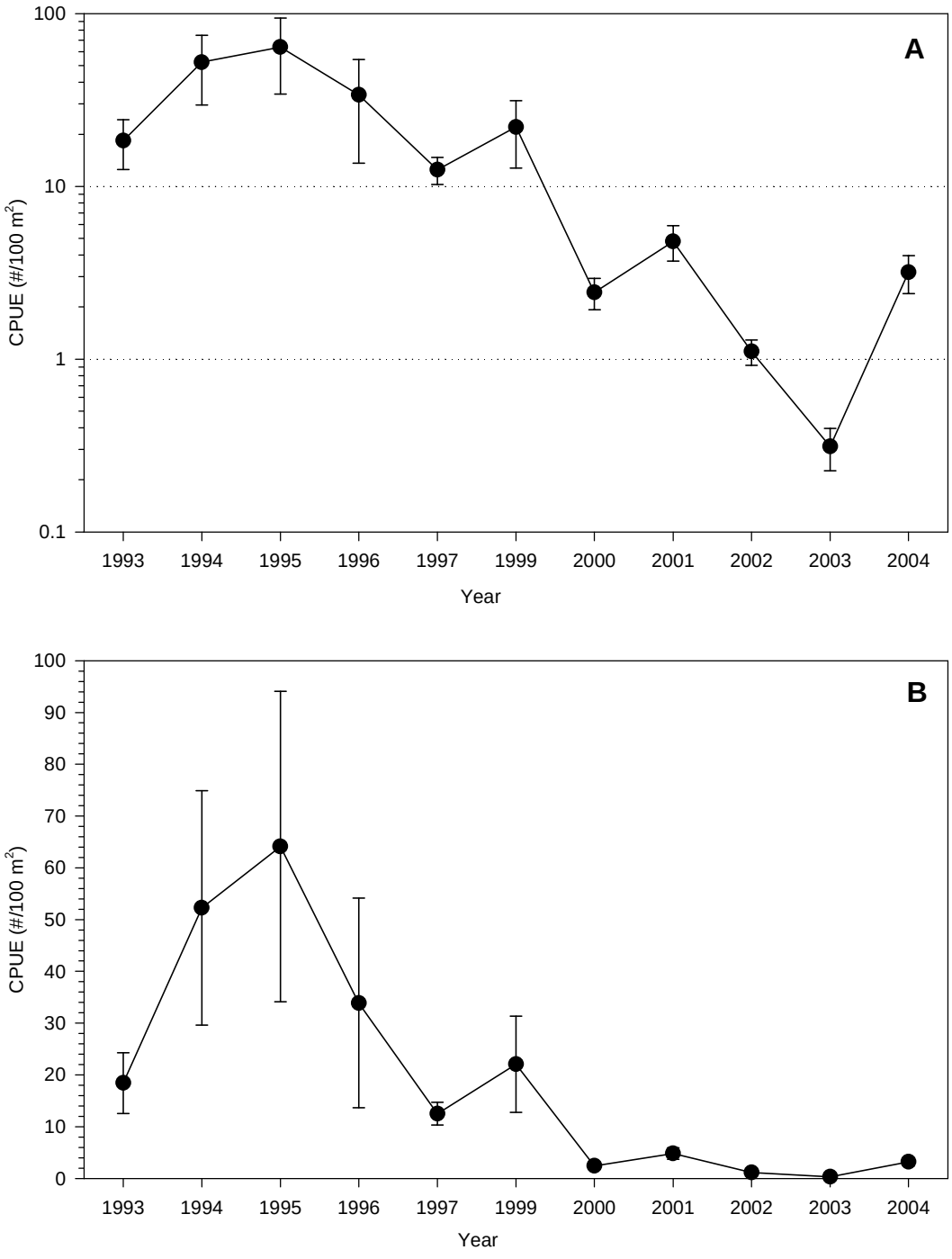


Figure X. Annual Rio Grande silvery minnow catch rates (CPUE), at all sampling sites, by sampling year (1993-1997, 1999-2004). Data in Graph **A** are plotted against a logarithmic scale while Graph **B** presents same data plot using linear scale. Solid circles represent mean value for all sites sampled; capped-bars represent the standard error of the mean. Dotted horizontal lines (Graph **A**) represent different orders of magnitude.

Appendix A-4.14. (Continued) ANNUAL WITHOUT ERROR BARS

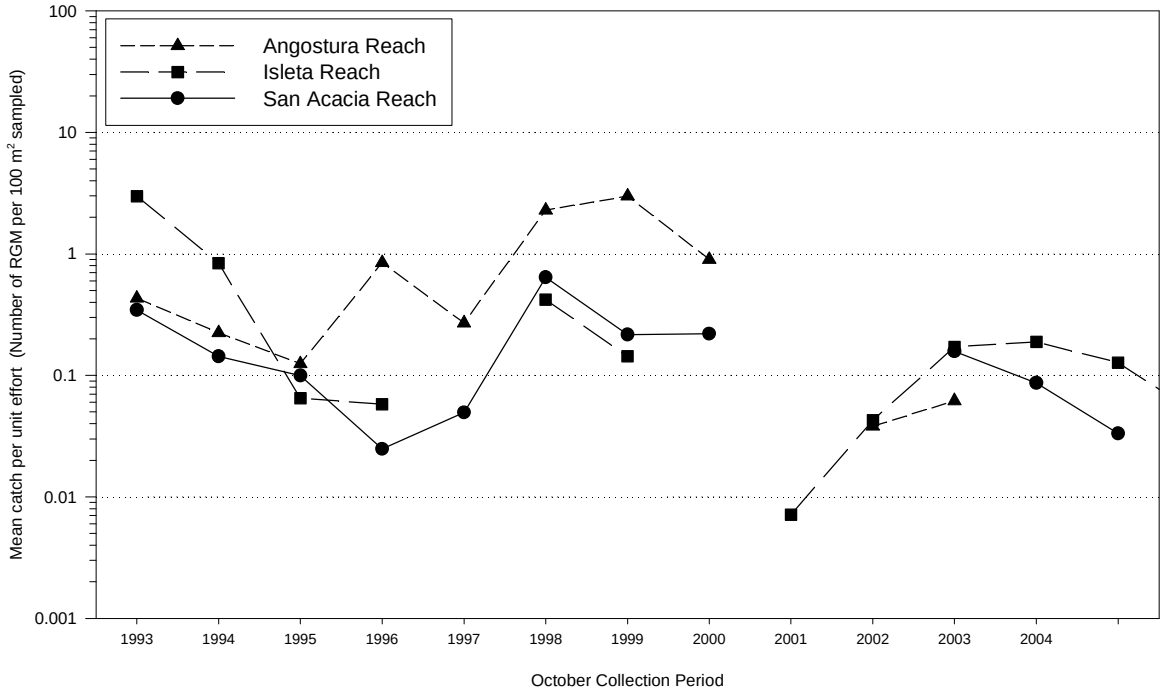


Figure X. Mean monthly catch rates of Rio Grande silvery minnow during 2003 (January-December) and through December 2004 at population monitoring program collection sites in the Angostura, Isleta, and San Acacia reaches. Missing symbols indicate that no individuals were collected in a particular reach during that month. Data are plotted against a logarithmic scale with dotted horizontal lines representing different orders of magnitude.

Appendix A-4.15. (Continued) ANNUAL WITHOUT ERROR BARS

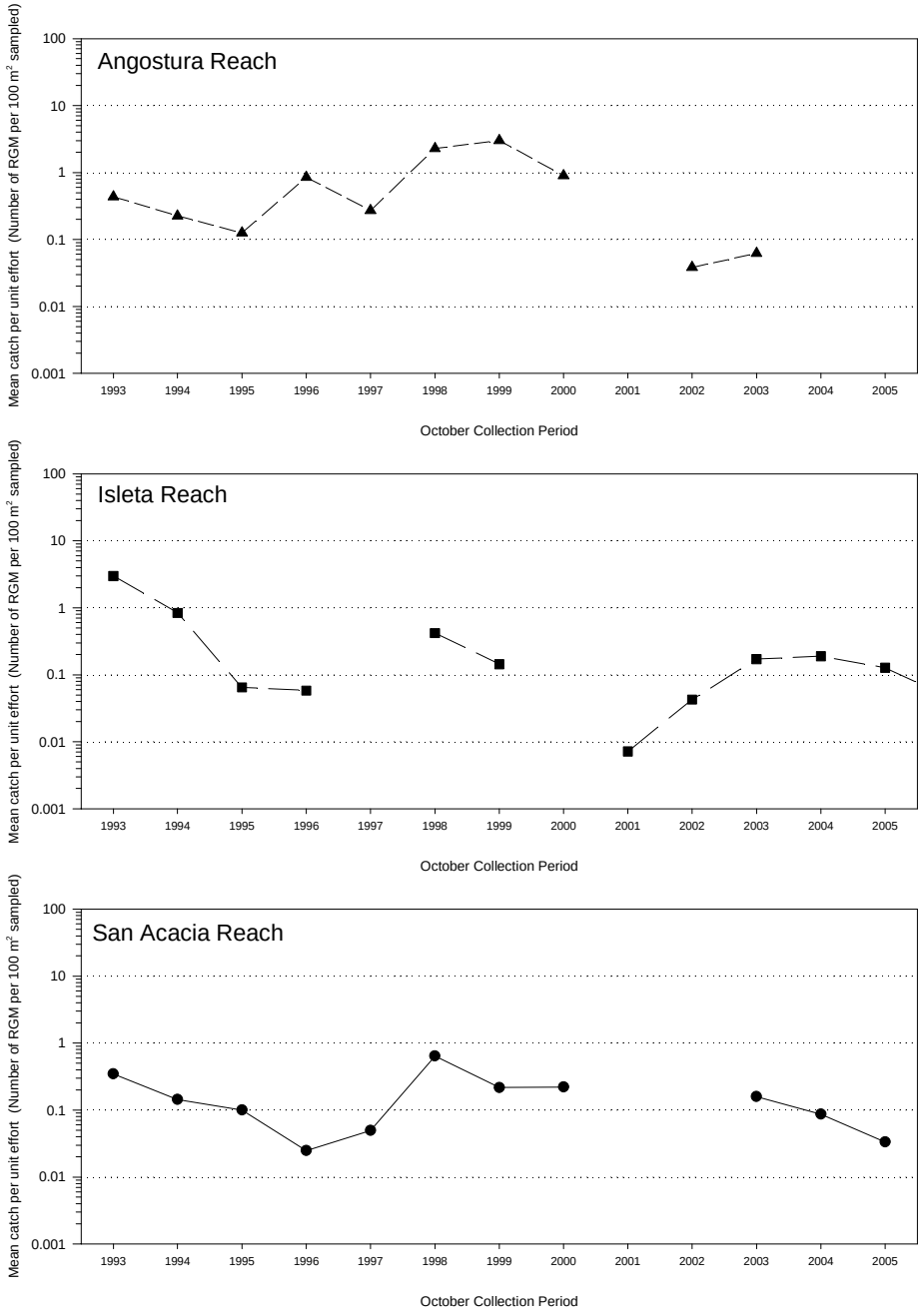


Figure X. Mean monthly catch rates of Rio Grande silvery minnow during 200x (January-December) and through December 200x at population monitoring program collection sites in the Angostura, Isleta, and San Acacia reaches. Missing symbols indicate that no individuals were collected in a particular reach during that month. Solid circles represent mean value for all sites sampled; capped-bars represent the standard error of the mean. Data are plotted against a logarithmic scale with dotted horizontal lines representing different orders of magnitude.

Appendix A-4.16. (Continued) ANNUAL

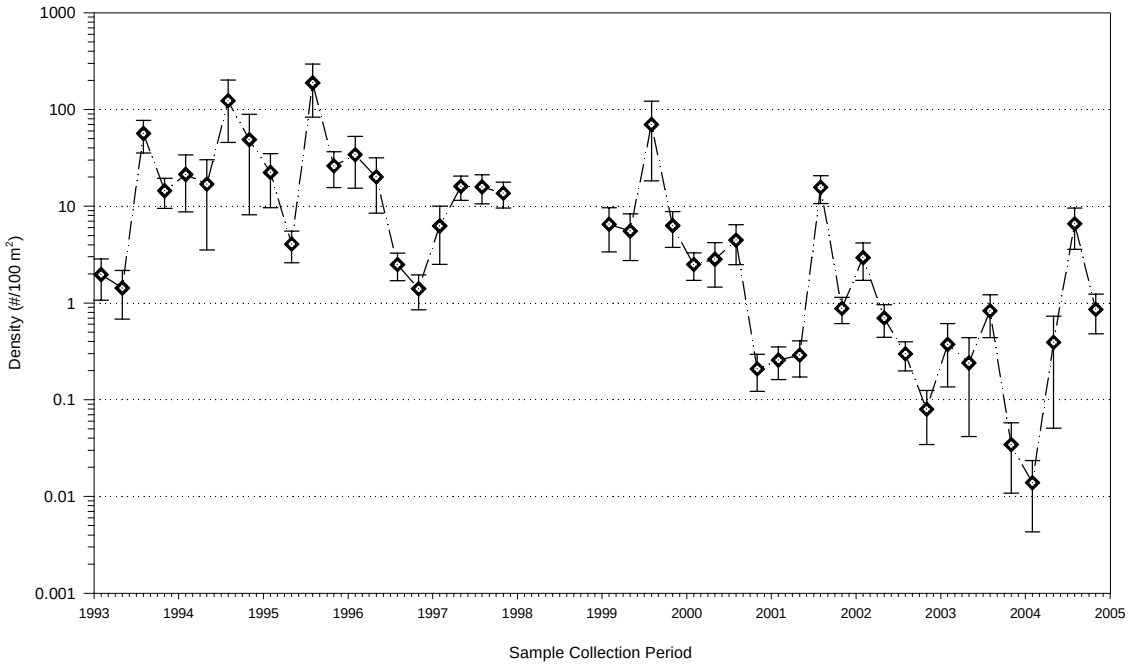


Figure X. Time sequence of Rio Grande silvery minnow catch rates (1993-1997, 1999-2004) at Population Monitoring Program sampling sites. Hollow diamonds indicate sample means for each survey and capped-bars represent the standard error of the mean. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.17. (Continued) ANNUAL

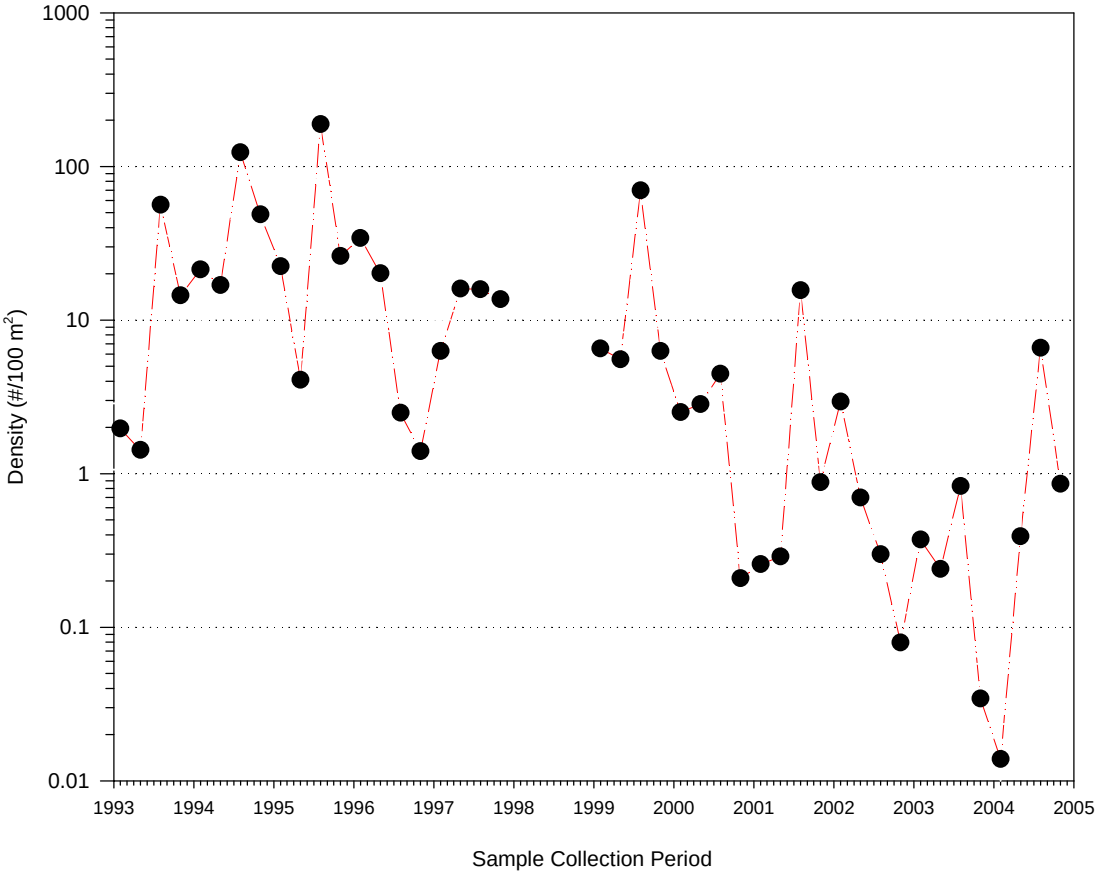


Figure X. Time sequence of Rio Grande silvery minnow catch rates (1993-1997, 1999-2004) at Population Monitoring Program sampling sites. Hollow diamonds indicate sample means for each survey. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.18. (Continued) ANNUAL

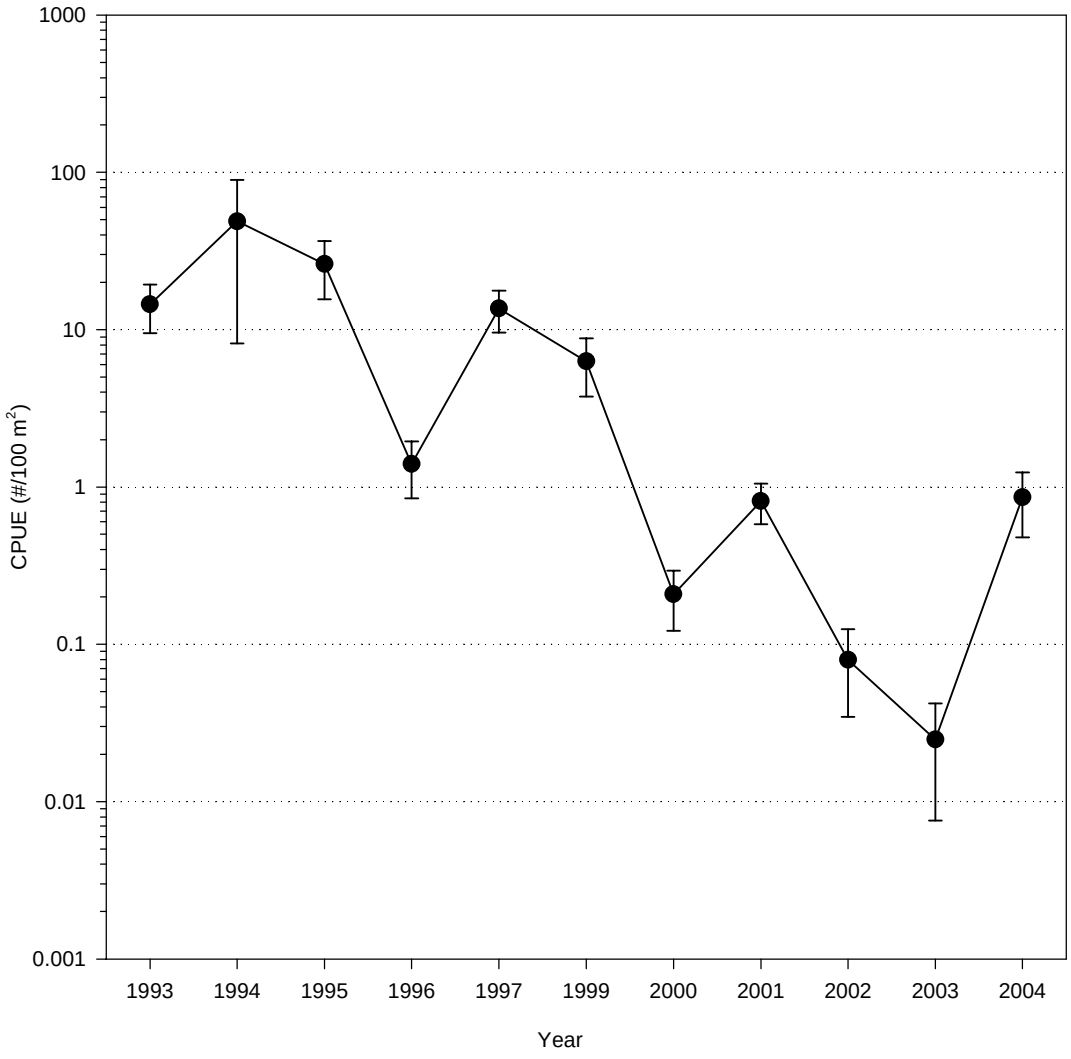


Figure X. Rio Grande silvery minnow catch rates (CPUE) during October, at all sampling sites, by sampling year (1993-1997, 1999-2004). Solid circles indicate means and capped-bars represent the standard error. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.19. (Continued) ANNUAL

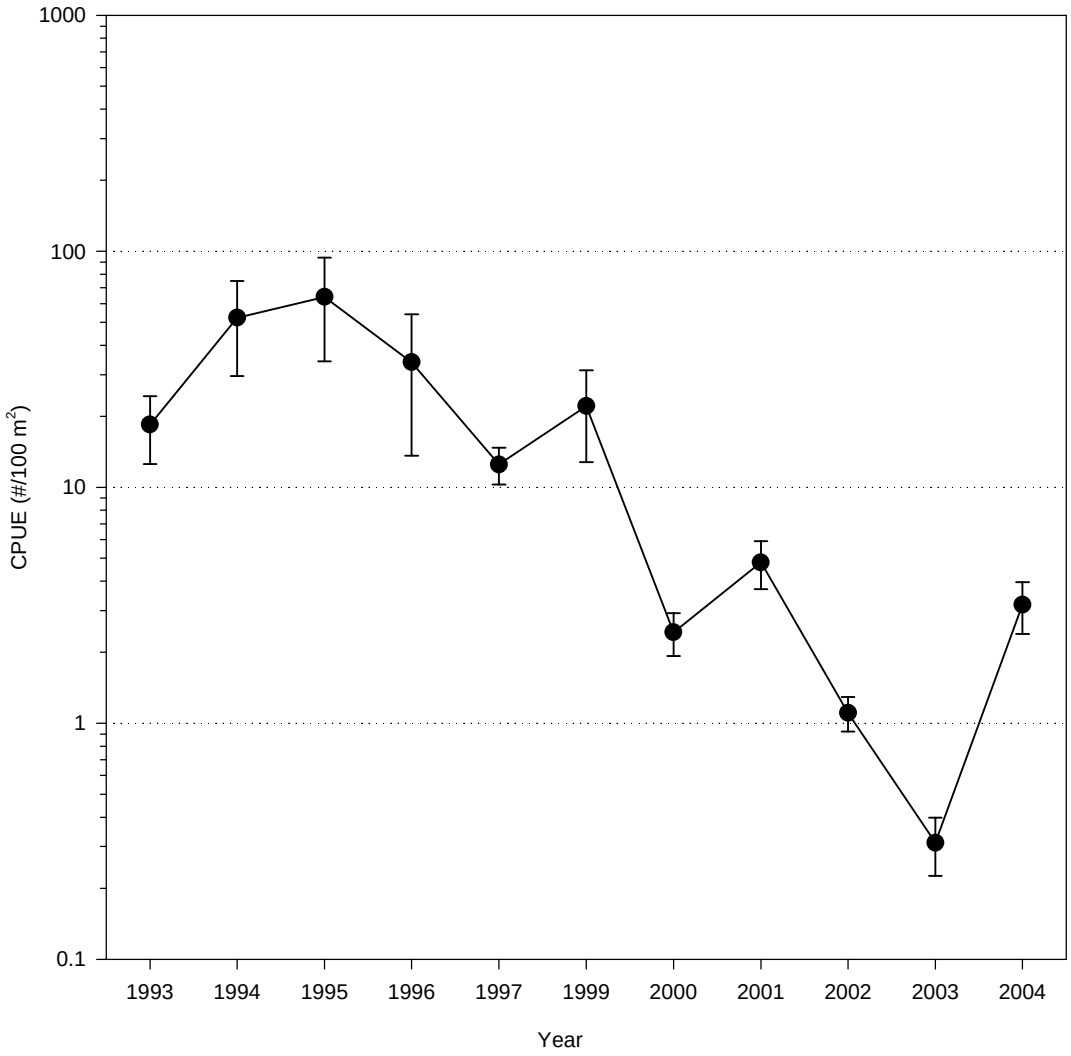


Figure X. Annual Rio Grande silvery minnow catch rates (CPUE), at all sampling sites, by sampling year (1993-1997, 1999-2004). Solid circles indicate means and capped-bars represent the standard error. Dotted horizontal lines represent different orders of magnitude.

Appendix A-4.20. (Continued) ANNUAL

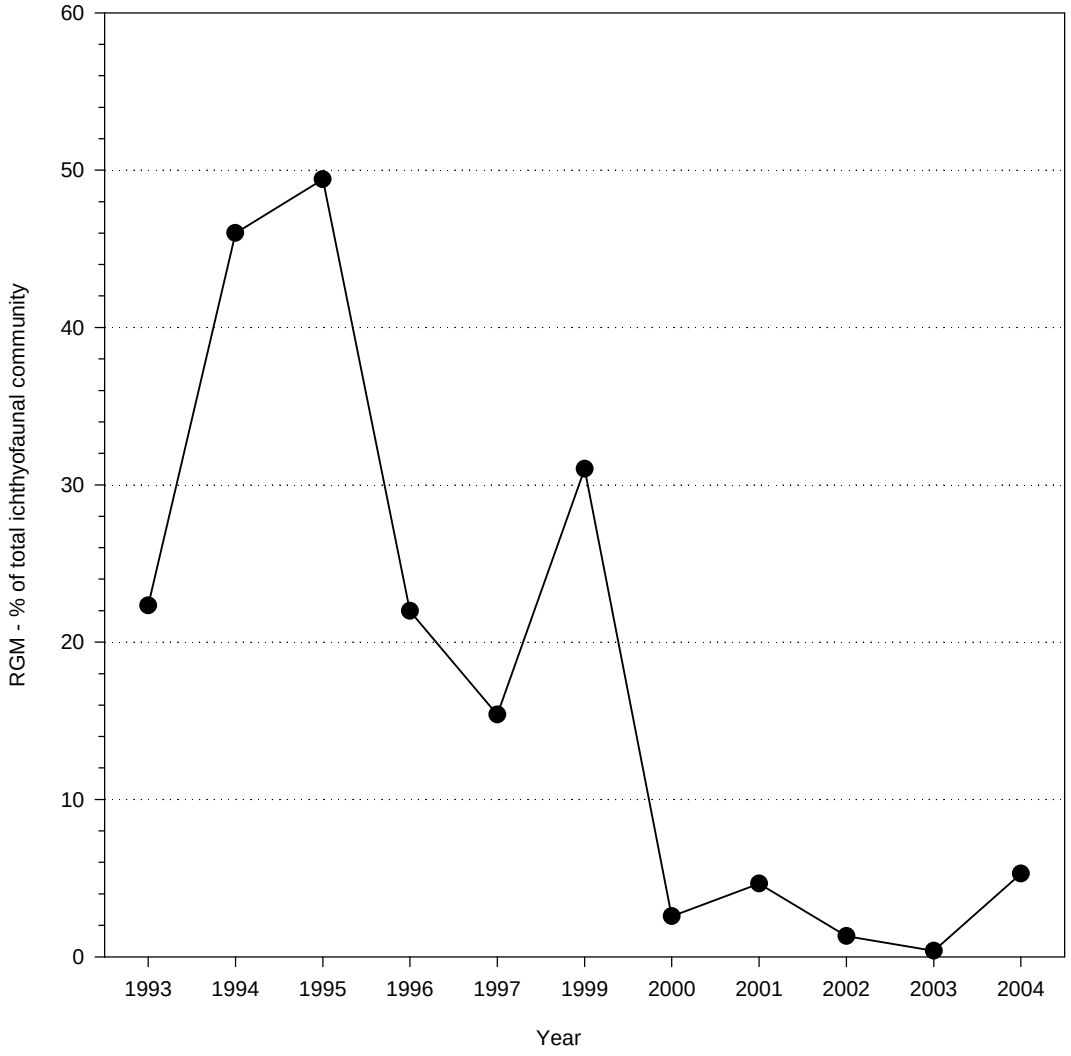


Figure X. Relative abundance of Rio Grande silvery minnow as a percentage of the total ichthyofaunal community by sampling year (1993-1997, 1999-2004).

Appendix A-4.21. (Continued) ANNUAL

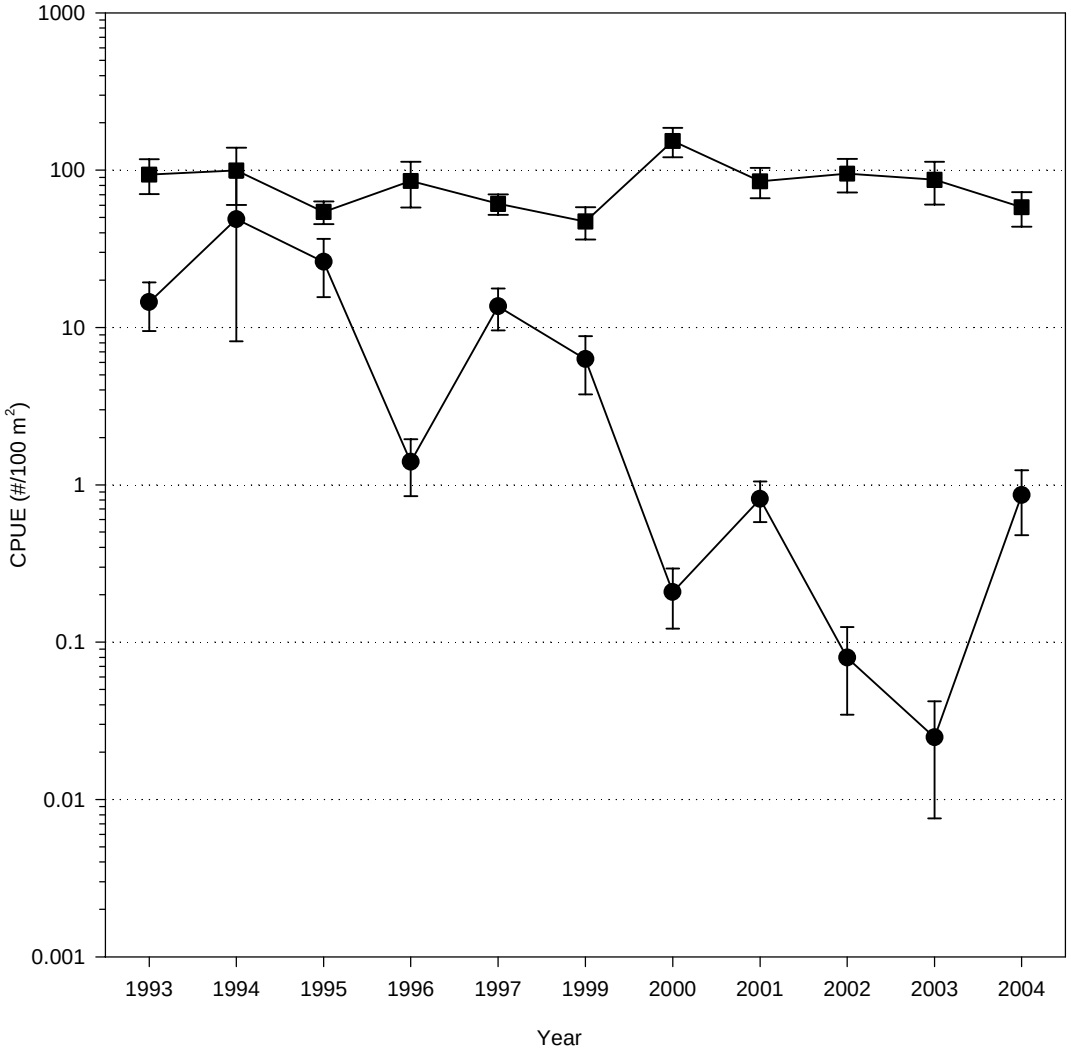


Figure X. Catch rates (CPUE) of Rio Grande silvery minnow (circles) and the total ichthyofaunal community (squares) during October, at all sampling sites, by sampling year (1993-1997, 1999-2004). Solid circles or squares indicate means and capped-bars represent the standard error. Dotted horizontal lines represent different order of magnitude.

Appendix A-4.22. (Continued) ANNUAL

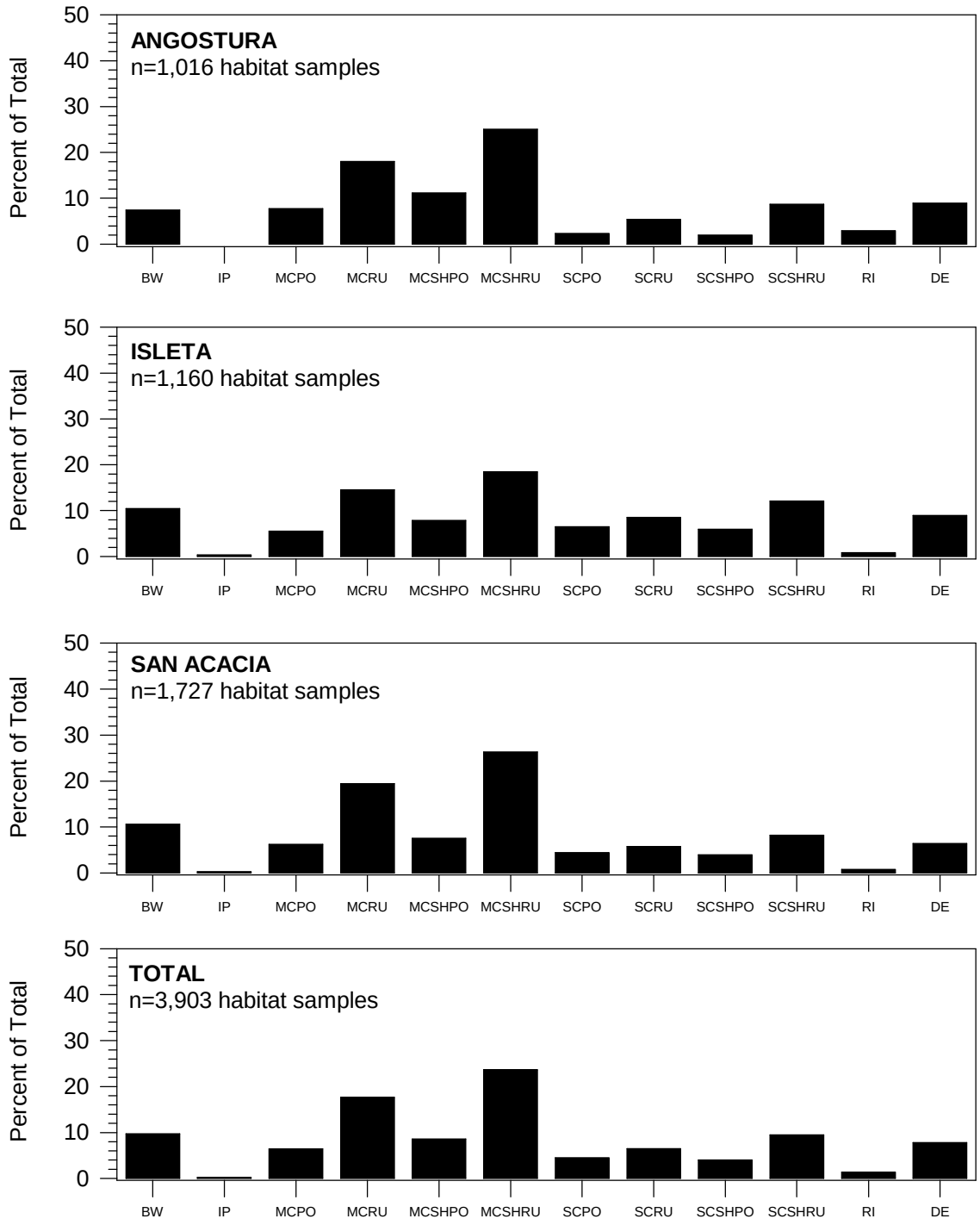


Figure X. Percent total of mesohabitats (see Table A-2a1 for codes) sampled in the Middle Rio Grande as part of Population Monitoring Program during 200x for each river reach and the annual total.

Appendix A-4.23. (Continued) ANNUAL

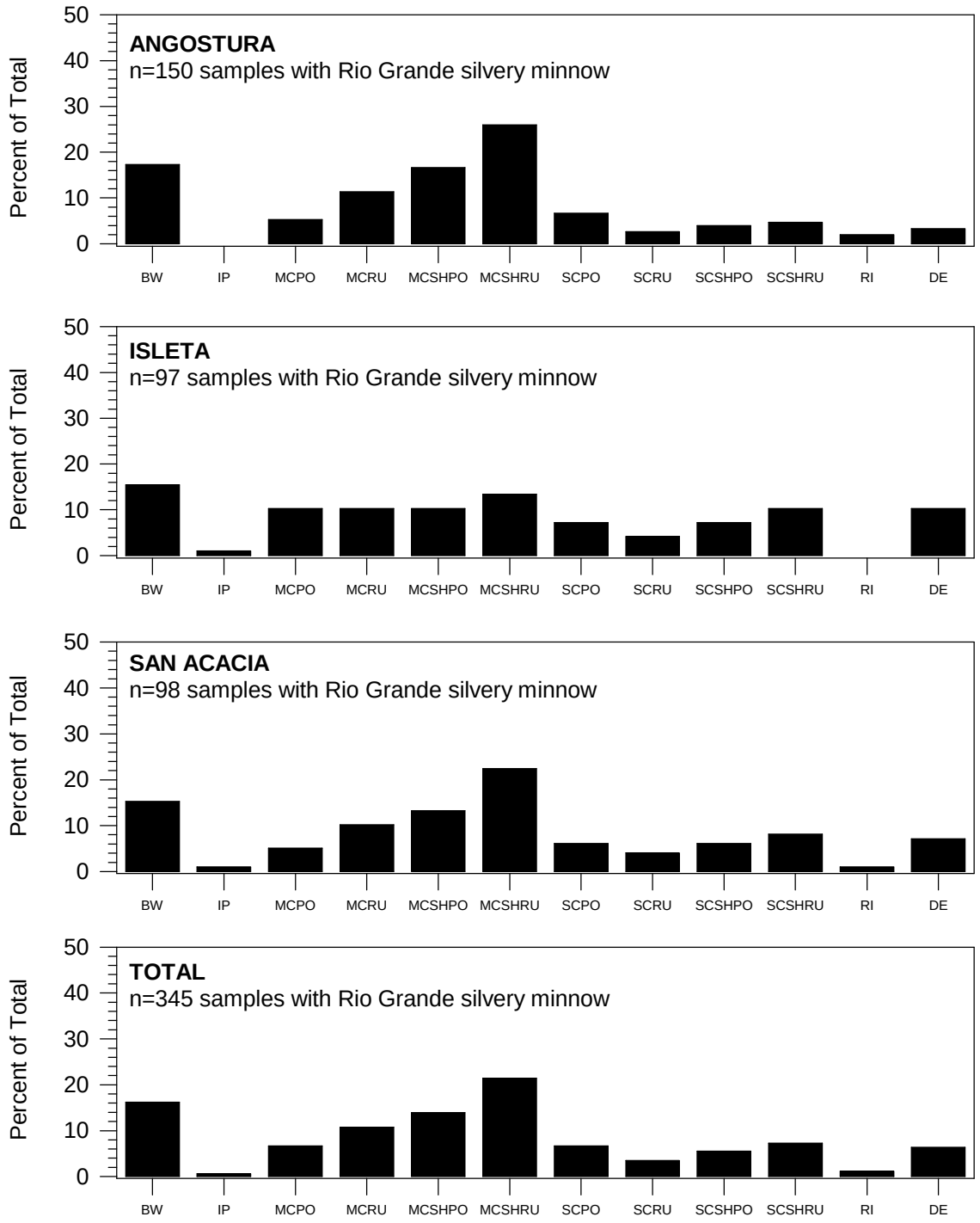
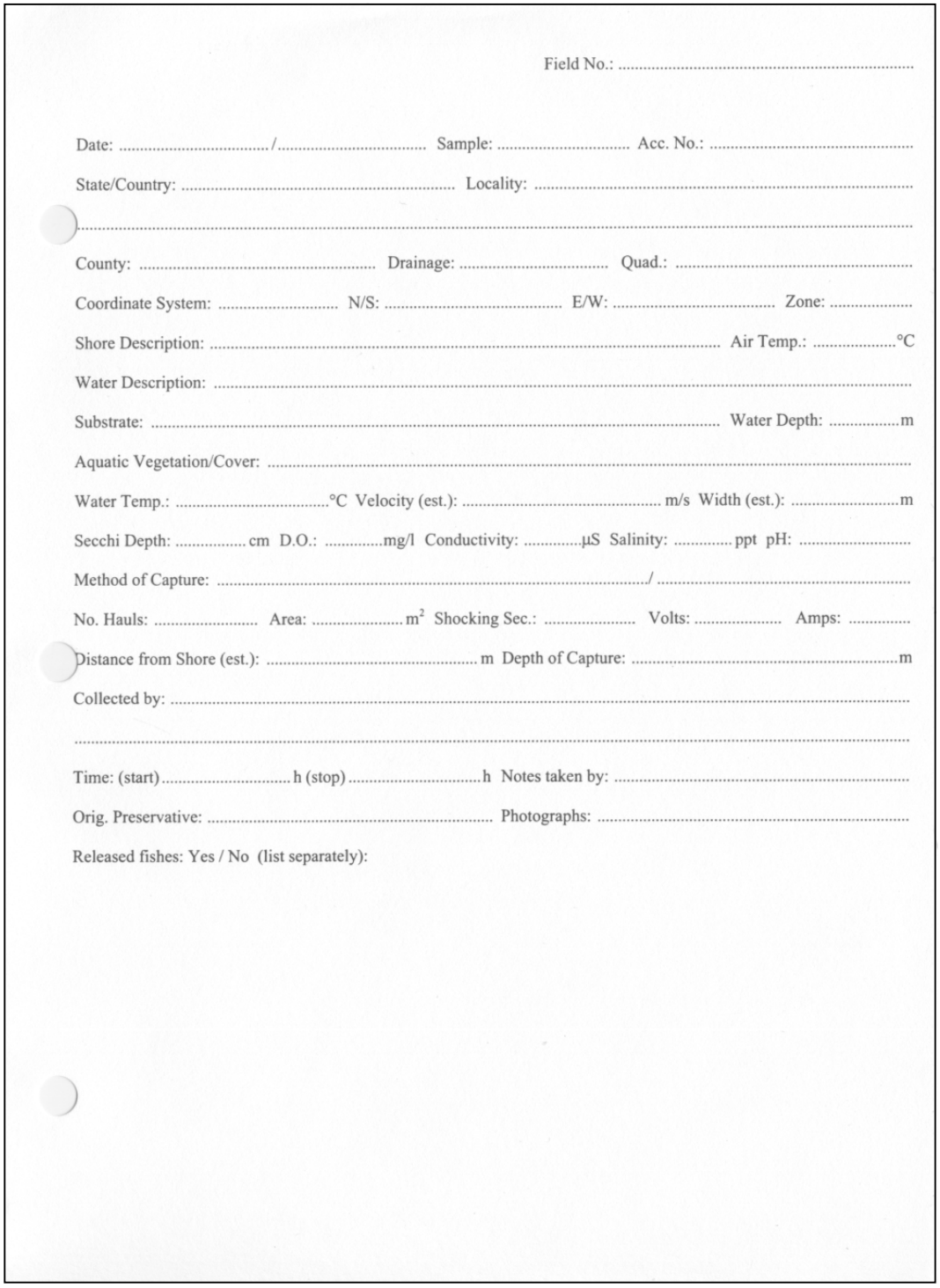


Figure X. Percent total of mesohabitats (see Table A-2a1 for codes) occupied by Rio Grande silvery minnow in the Middle Rio Grande as part of Population Monitoring Program during 200x for each river reach and the annual total.

Appendix A-4.24. (Continued)



Field No.: .....

Date: ...../..... Sample: ..... Acc. No.: .....

State/Country: ..... Locality: .....

.....

County: ..... Drainage: ..... Quad.: .....

Coordinate System: ..... N/S: ..... E/W: ..... Zone: .....

Shore Description: ..... Air Temp.: .....°C

Water Description: .....

Substrate: ..... Water Depth: .....m

Aquatic Vegetation/Cover: .....

Water Temp.: .....°C Velocity (est.): ..... m/s Width (est.): .....m

Secchi Depth: ..... cm D.O.: .....mg/l Conductivity: .....µS Salinity: ..... ppt pH: .....

Method of Capture: ...../.....

No. Hauls: ..... Area: ..... m^2 Shocking Sec.: ..... Volts: ..... Amps: .....

Distance from Shore (est.): ..... m Depth of Capture: .....m

Collected by: .....

.....

Time: (start) ..... h (stop) ..... h Notes taken by: .....

Orig. Preservative: ..... Photographs: .....

Released fishes: Yes / No (list separately):

Figure X. Sample field data sheet.

Basic Sampling Design and Methods
Rio Grande Silvery Minnow Population Monitoring Program
Working Meeting of the Population Monitoring Workshop Planning Committee
September 9, 2014

Objectives of Population Monitoring Program:

"The primary objective of the December 2011 to October 2012 sampling activities was to monitor temporal trends in the abundance of Rio Grande silvery minnow at 20 standardized sites throughout the Middle Rio Grande. Additional objectives included evaluating the influence of discharge patterns on population fluctuations, determining general habitat use patterns, documenting changes in relative abundance among fish species over time, and determining variation in density estimates based on repeated sampling. Seasonal and spatial differences in the population structure and abundance of native and nonnative Middle Rio Grande fishes were also examined." (Dudley et al. 2013)

Outline of Sampling Methods:

- Monthly sampling efforts at 20 sites (see Figure 1).
- April to October and December and February
    - Discrete mesohabitats (< 15 m long).
    - Small mesh seine (3.1 m x 1.8 m, ca. 5 mm mesh).
    - Runs, pools, and shoreline pools sampled four times at each site (when available).
    - Backwaters and riffles sampled two times (when available).
    - Remaining samples (to obtain a total of 18 to 20) taken in shoreline runs.
- April to October
    - Fine mesh seine (1.0 m x 1.0 m, ca. 1.5 mm mesh) used to selectively sample shallow low velocity mesohabitats for larval fish (two samples).
- Mesohabitats with similar conditions, which did not exceed reasonable depths/velocities for efficient seining, were sampled regardless of flow conditions.

Data Recorded

- 1993-2012: "pooled estimates" as the sum of all fish captured at a site divided by the sum of area seined (up to 20 seine hauls per site).
- 2002-2012: "by haul" as the number of fish caught by seine haul and mesohabitat type divided by the area seined.
- Density or catch-per-unit-effort (CPUE) estimated for each species and each sample as the number of individuals collected per 100 m^2 (surface area) of water sampled (i.e., fish per 100 m^2).

- Effort calculated by multiplying seine width during sampling (regular = 2.5 m, larval = 0.25 m) by the length of the seine haul.
- Samples obtained from isolated pools not included in data analyses as densities in these confined mesohabitats were artificially elevated.
- Prior to release, all Rio Grande silvery minnow collected are:
    - Examined for Visible Implant Elastomer (VIE) tags (i.e., stocked fish).
    - Measured (standard length range).
    - Identified to age-class (based on reach-specific standard length and age-length relationships during the same time of year (Dudley et al., 2009; Horwitz et al., 2011).
- Selected water quality parameters (Secchi depth, temperature, salinity, dissolved oxygen, true conductivity, specific conductance, and pH).
- Digital photographs of physical river conditions.

Overview of Data Analysis (overview from description in report)

For 2003-2011 Data (from Dudley and Platania 2012):

- For parametric data analysis, fish CPUE data from all samples were log-transformed (X' = ln(X+1)) based on low observed values and temporal heterogeneity of variance.
- Single factor analysis of variance, with Tukey-Kramer HSD multiple comparison tests, used to evaluate differences in mean catch rates of RGSM among years.
- Kendall's W used to test for the degree of concordance among the annual rank abundance of species (including RGSM) over time.
- Linear and polynomial (e.g., quadratic and cubic equations) regression modeling was used to determine the strength of the relationships among autumnal CPUE (1993-1997, 1999-2011) and hydraulic variables (e.g., peak discharge and days > or < a threshold discharge value).

In 2012, analysis was changed to "mixture models" (from Dudley et al. 2013)

- Mixture models (e.g., combining a binomial distribution with a lognormal distribution) used for RGSM CPUE data with multiple zeroes.
- Long-term data for October (1993–2012) analyzed by fitting a mixture model (see Figures below).
- Long-term mesohabitat data for October (2002–2012) analyzed by fitting a mixture model.
- Coefficient of Variation (CV) for estimated densities of RGSM over time, using both the sampling-site density data (1993–2012; range 0.27 (2009) to 0.81 (1994), median 0.49) and mesohabitat density data (2002–2012; range 0.12 (2008) to 0.73 (2003), median 0.18).

Reports Cited

Dudley, R.K., and S.P. Platania. 2012. Rio Grande silvery minnow population monitoring program results from December 2010 to October 2011. American Southwest Ichthyological Researchers, L.L.C., Albuquerque, NM. Final Report to U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

Dudley, R.K., S.P. Platania, and G.C. White. 2013. Rio Grande silvery minnow population monitoring program results from December 2011 to October 2012. American Southwest Ichthyological Researchers, L.L.C., Albuquerque, NM. Final Report to U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

Note:

This overview was developed by Rich Valdez for the purpose of characterizing the population monitoring program and data at Working Meeting #1 of the Population Monitoring Workshop Planning Committee; September 9, 2014.

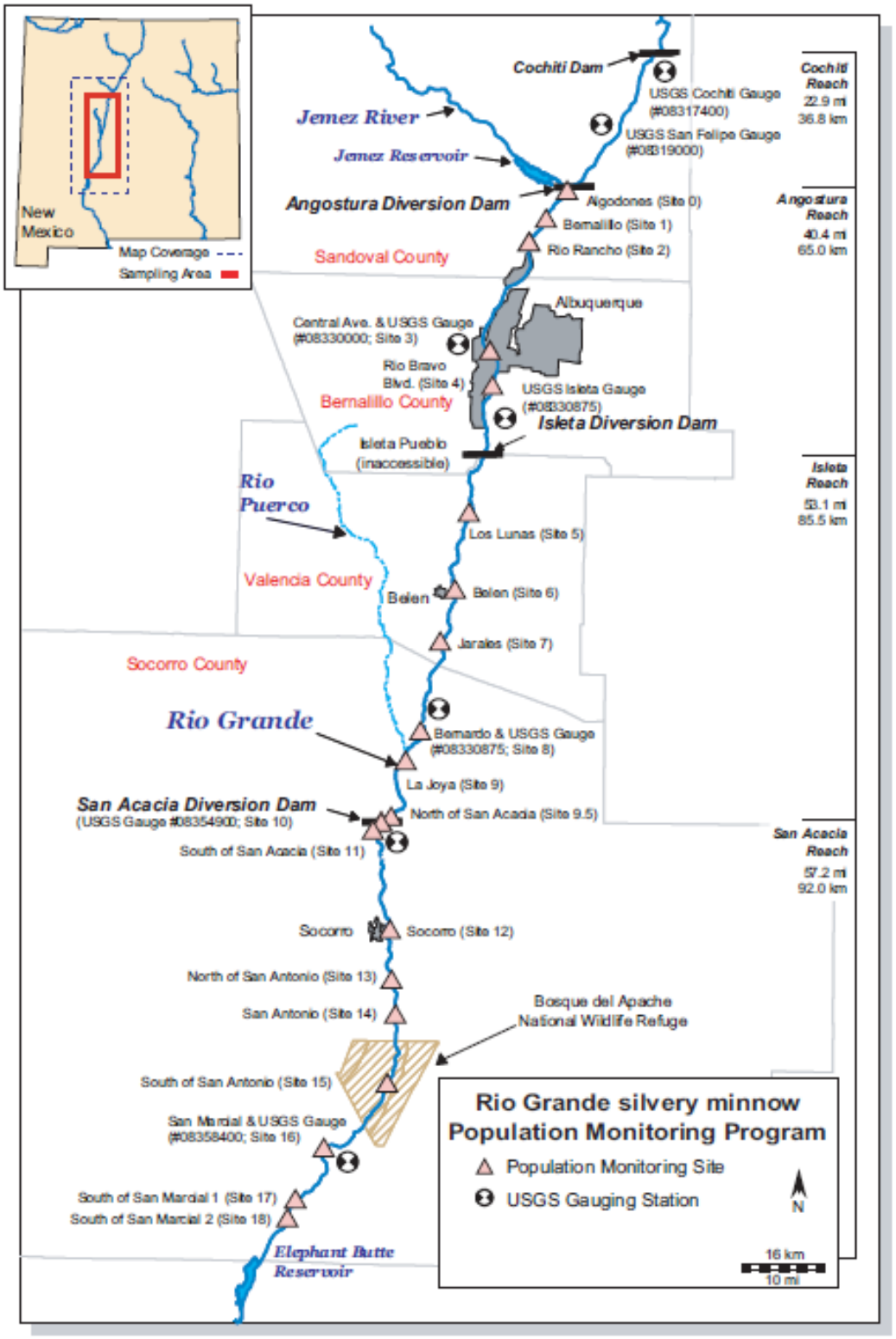


Figure 1. Map of the study area and sampling sites (numbered) for the December 2011 to October 2012 Rio Grande silvery minnow population monitoring program. From Dudley et al. (2013).

From Dudley and Platania (2012)

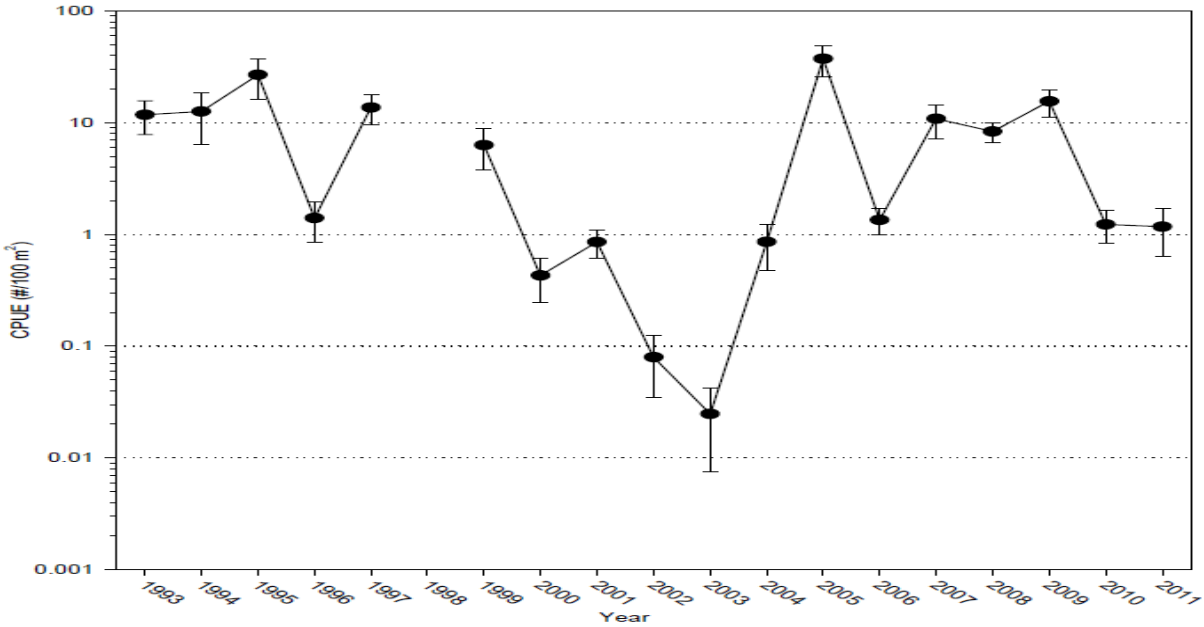


Figure 11. Rio Grande silvery minnow densities (CPUE) during October, at all sampling sites, by sampling year (1993-1997, 1999-2011). Solid circles indicate means and capped-bars represent the standard error. Dotted horizontal lines represent orders of magnitude.

From Dudley et al. (2013)

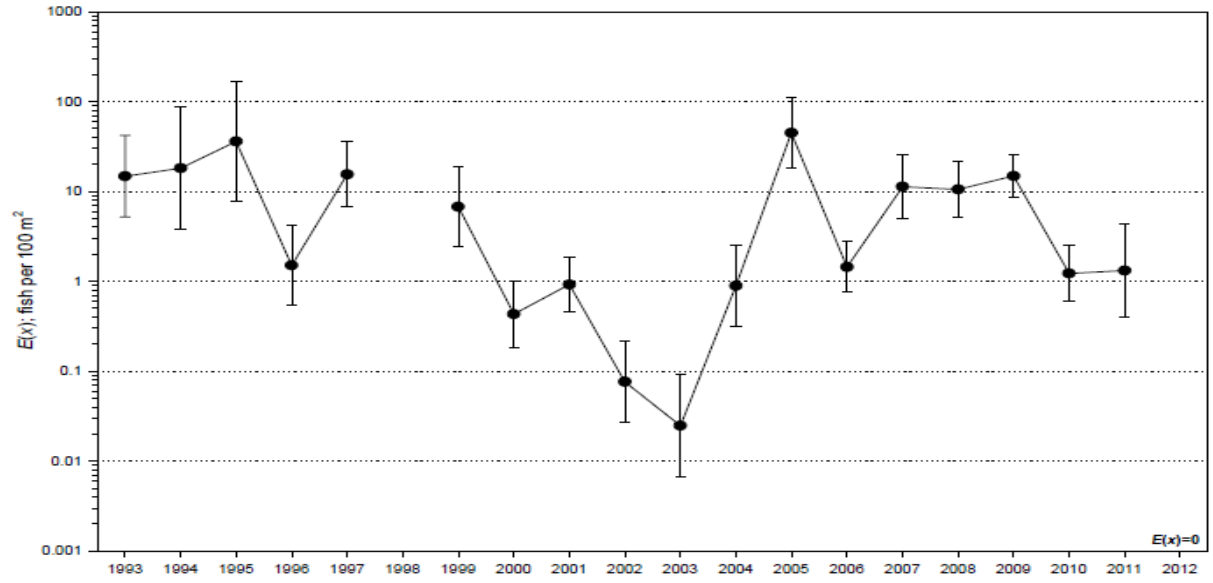


Figure 7. Rio Grande silvery minnow mixture-model estimates ($E(x)$), using October sampling-site density data (1993–2012). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Dotted horizontal lines represent orders of magnitude.

Overview of Population Monitoring Program and Database

Introduction

The Population Monitoring Workshop Planning Committee has been charged by the Middle Rio Grande Endangered Species Collaborative Program with developing and coordinating workshops to evaluate the fish population monitoring program for the middle Rio Grande. An understanding of the monitoring design and the data collected is imperative for the Committee to plan the workshops and identify important issues to be addressed by participating scientists. A working meeting is planned for September 9, 2014 for Committee members to become familiar with the current monitoring program and data characteristics.

This document provides a series of figures developed from the data and a brief overview of each for presentation and discussion at the planned working meeting. The purpose for this document is to familiarize Committee members with the data and to elicit an exchange of information that will lead to a more informed workshop agenda and questions for participating scientists.

This data overview is organized into seven sections (A-G). Each section is entitled as a different aspect of data characteristics. Figures are numbered sequentially within each section to correspond with Excel worksheets containing data computations used to derive each figure. These worksheets and computations will be shared with Committee members at the working meeting.

Each figure below is accompanied by a description and basic indicated questions. Committee members are encouraged to add comments to each figure for discussion at the working meeting.

A. RGSM Data

The focus of the workshops is to evaluate the efficacy of the monitoring program for following the status and trends of the Rio Grande silvery minnow (RGSM). Data used to characterize the population include samples for 1993-1997 and 1999-2013. Additionally, data have been collected provided by seine haul and for population estimates of RGSM. Data are also collected by the U.S. Fish and Wildlife Service for special projects and to determine stocking needs; these data are not provided to Committee members at this time.

The following are the principal and associated datasets provided to the Committee and used for evaluation in this document:

- Provisional Pop Mon Database 1993-2013.xls: This file contains data for all fish collected in the Middle Rio Grande as part of the monitoring program for 1993-2013.
- RGSM 2006-2010 By+Seine+Haul+Pop+Mon.xls: This dataset provides the data by seine haul for the years 2006-2011 of the dataset “Provisional Pop Mon Database 1993-2013.xls”.
- Data for RGSM Estimation 2006-2011: These are the same data as in “RGSM 2006-2010 By+Seine+Haul+Pop+Mon.xls” but include designation of mesohabitats sampled.

B. Temporal Distribution of Data

Figure B-1: Number of Samples by Month, 1993-2013.

- Number of samples by month has varied over time.
- Is there an ideal number of samples collected by month?
-
-

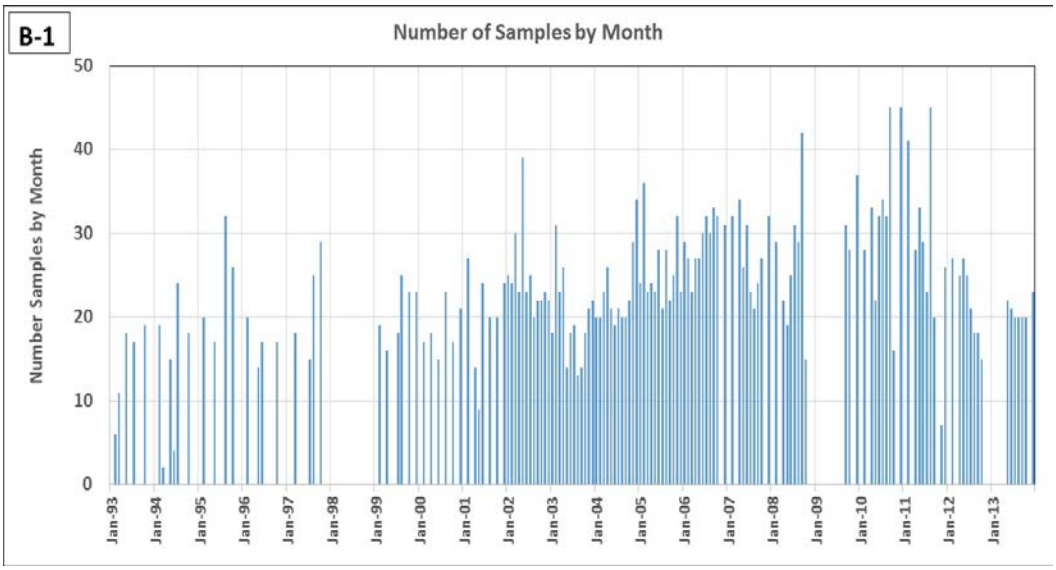


Figure B-2: Number of Months Sampled by Year, 1993-2013.

- Number of samples by year has also varied over time.
- How many months should be sampled each year?
- Do the different number of samples and months sampled affect comparability of CPUE?
-
-

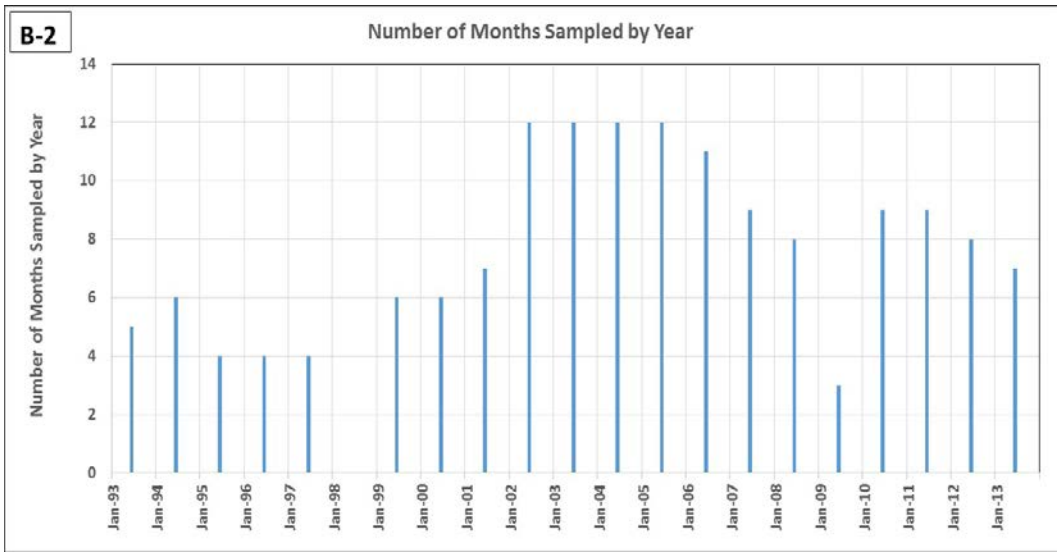
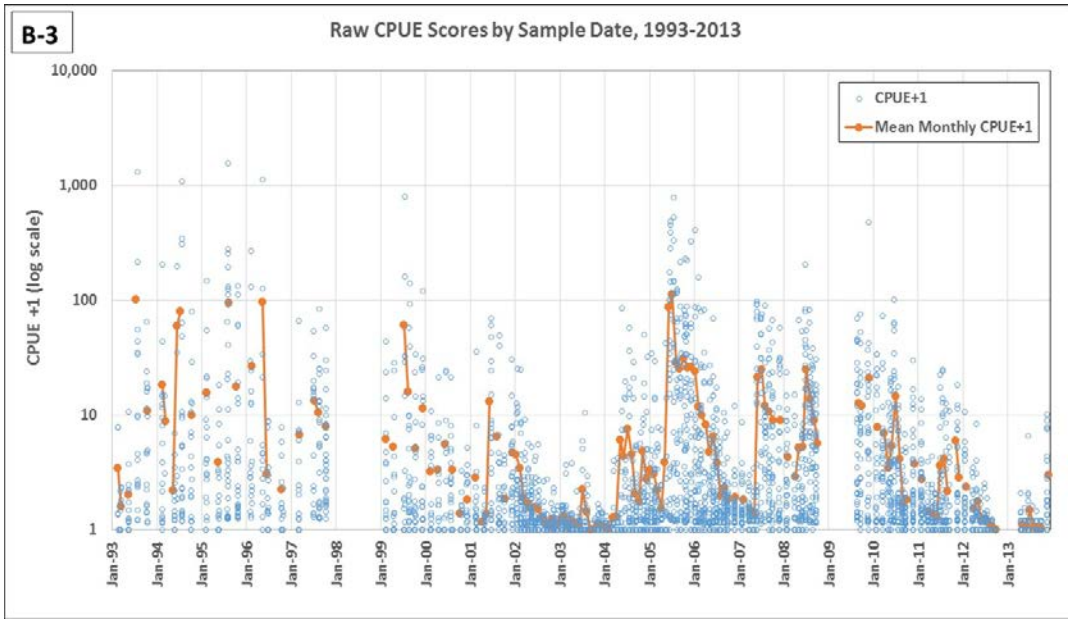


Figure B-3: Raw CPUE Scores by Sample Date, 1993-2013.

- Scatter of raw scores reflects number of samples by month and number of months sampled.
- Scatter of raw scores also reflects the range of data (0-1,547 fish/100 m^2) and variability (note that y-axis is on a $\log_{10}$ scale which makes large numbers smaller and small numbers larger).
- Largest number of samples after Jan-2002 reflect density patterns not evident with fewer samples.
- Red circles and lines show mean monthly CPUE patterns that reflect mortality within a year—and across years; e.g., mid 2005 to end of 2006.
- How many samples should be taken?
-
-



Additional Questions or Comments on Figures B:

C. Spatial Distribution of Data

Figure C-1: Number of Samples by River Mile (Sampling Site), 1993-2013.

- Altogether, 24 sites have been sampled; 4 have been discontinued, leaving 20 fixed locations as sampling sites.
- Should sampling sites be fixed locations?
- Should numbers of samples by site be evenly distributed (note that in recent years, number of samples by site is approximately equal)?
-

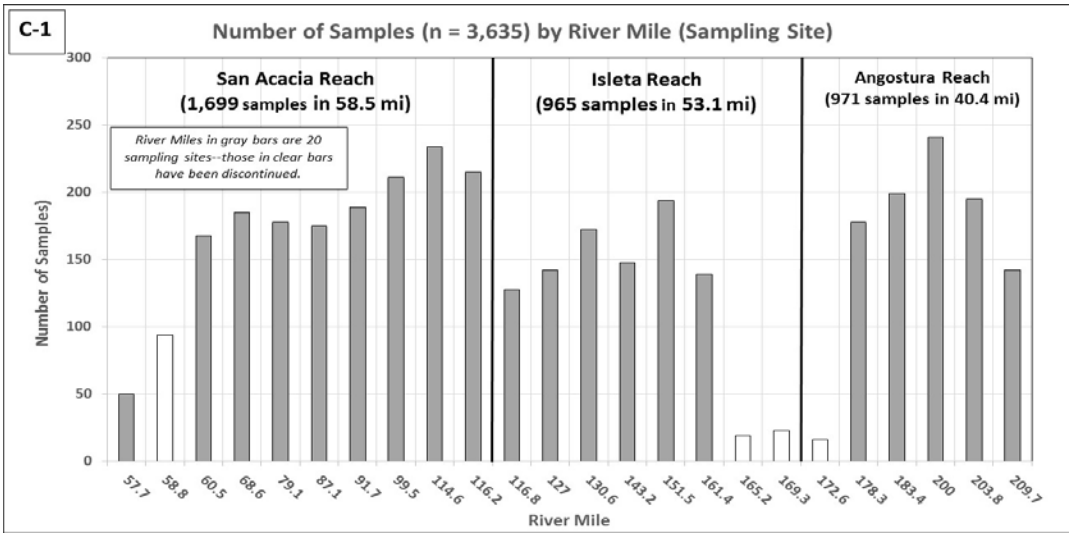


Figure C-2: Number of Samples by Reach and Year, 1993-2013.

- Number of samples over time and by reach have varied; are densities (CPUE) comparable over time?
- Should numbers of samples by site be evenly distributed?
-

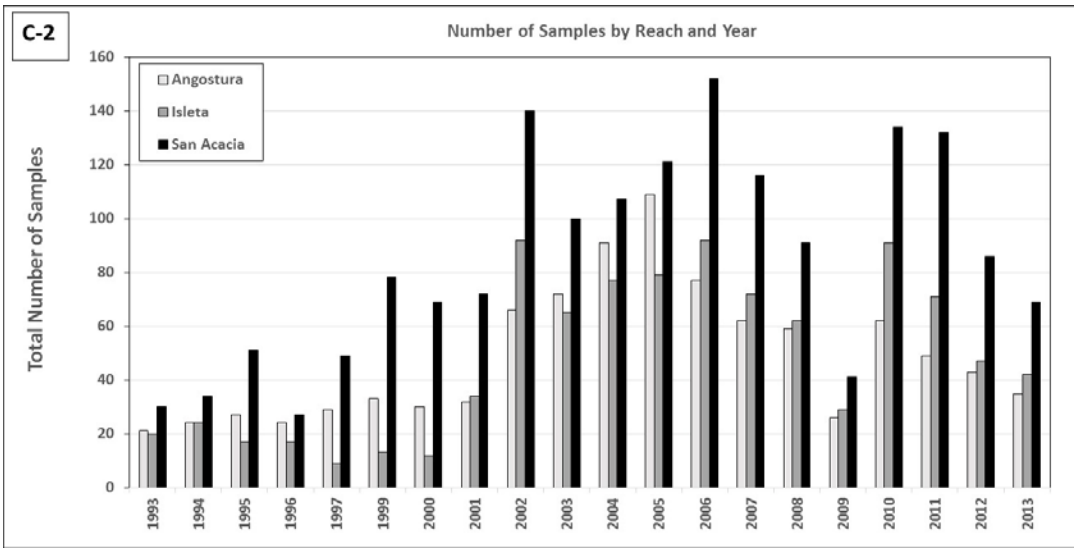


Figure C-3: Raw CPUE Scores by River Mile (Site), 1993-2013.

- Scatter of raw scores reflects number of samples by river mile (sampling site).
- Red circles and lines show mean CPUE for each site.
- Should three reaches be treated as strata for purpose of distributing samples?
-

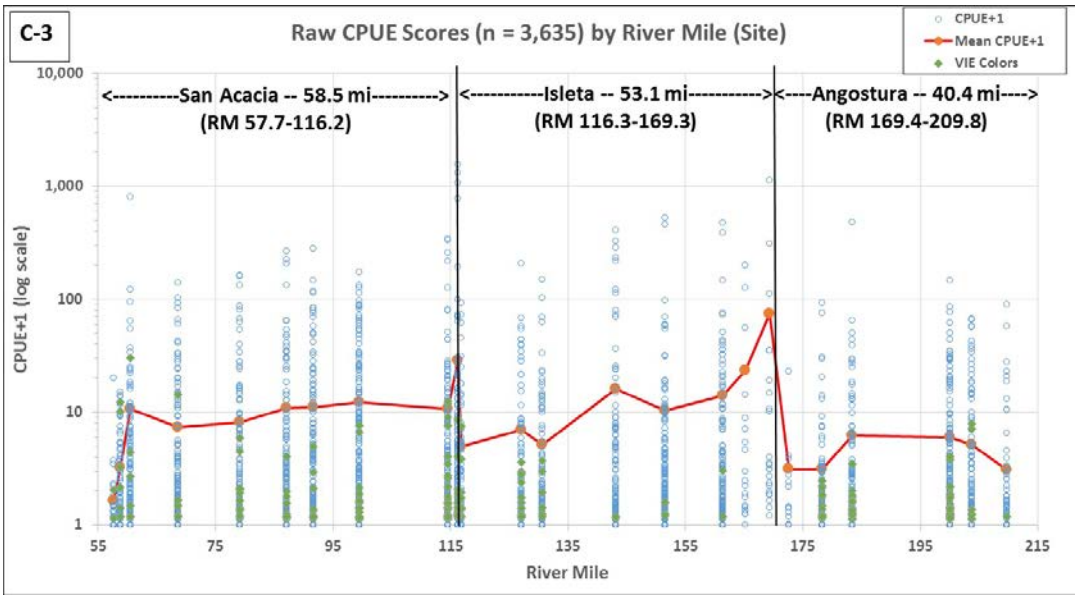


Figure C-4: Raw CPUE Scores by River Mile (Site) for High CPUE Year-2005.

- Is relatively higher density reflected across all stations and reaches?
- Red circles and lines show mean CPUE for each site.
- Should three reaches be treated as strata for purpose of distributing samples?
-

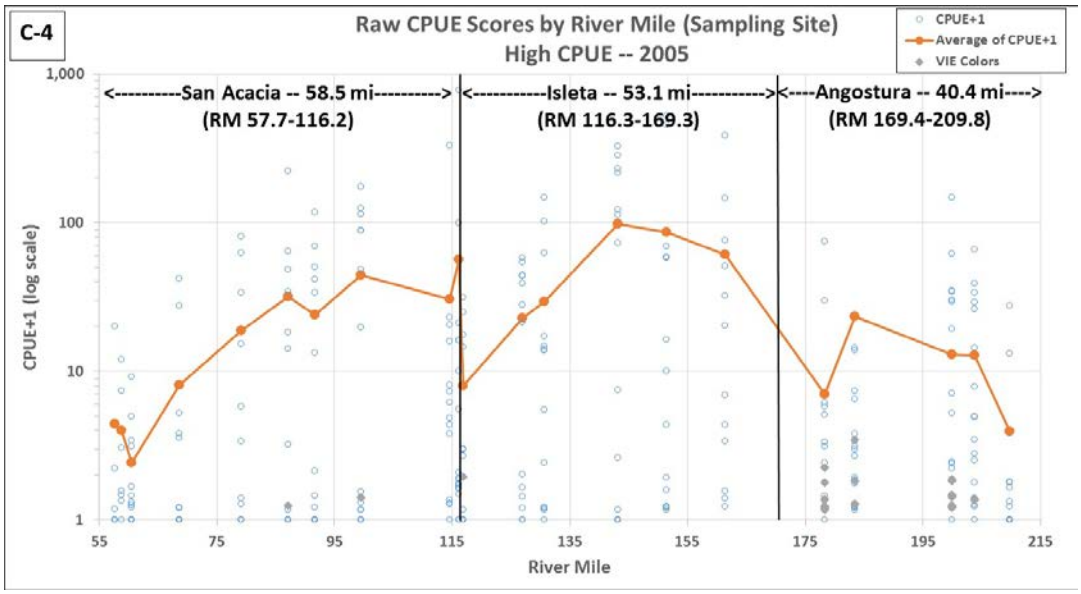
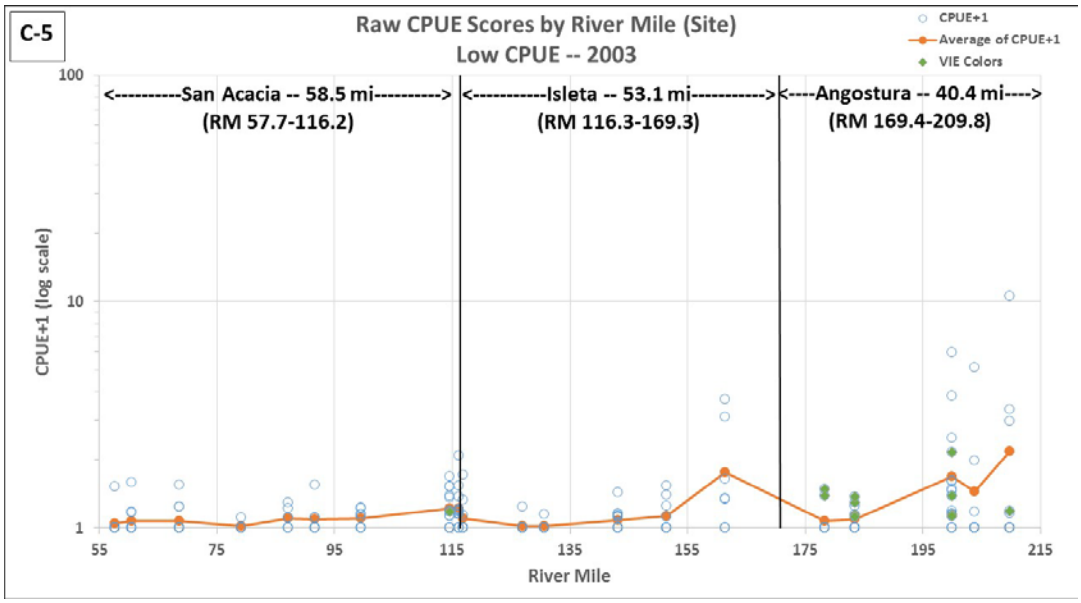


Figure C-5: Raw CPUE Scores by River Mile (Site) for Low CPUE Year-2003.

- Is relatively low density reflected across all stations and reaches?
- Red circles and lines show mean CPUE for each site.
- Should three reaches be treated as strata for purpose of distributing samples?
-



Additional Questions or Comments on Figures C:

D. Dispersion and Variability

Figure D-1: Frequency of All Raw Scores, 1993-2013.

- Data are "zero-inflated"—in other words, there are many zero CPUEs where no RGSM were caught in a given sample and a few samples had very high CPUE.
- The total of 3,635 raw CPUE scores range from "0" to "1,547".
- What is causing the high number of zero catches—and is that necessarily bad?
-

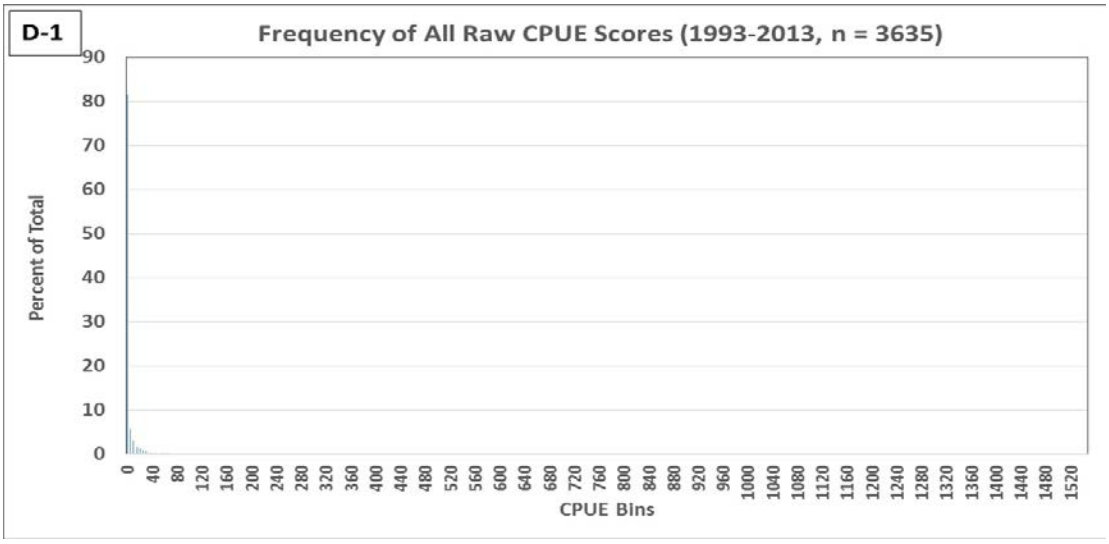


Figure D-2: Frequency of Raw Scores from 0 to 30.

- The figure includes only CPUEs of up to 30 to show the distribution pattern.
- This distribution has a large frequency of small numbers and a small frequency of large numbers (skewed to the right).
- The distribution is generally referred to as a binomial or a negative binomial.
-

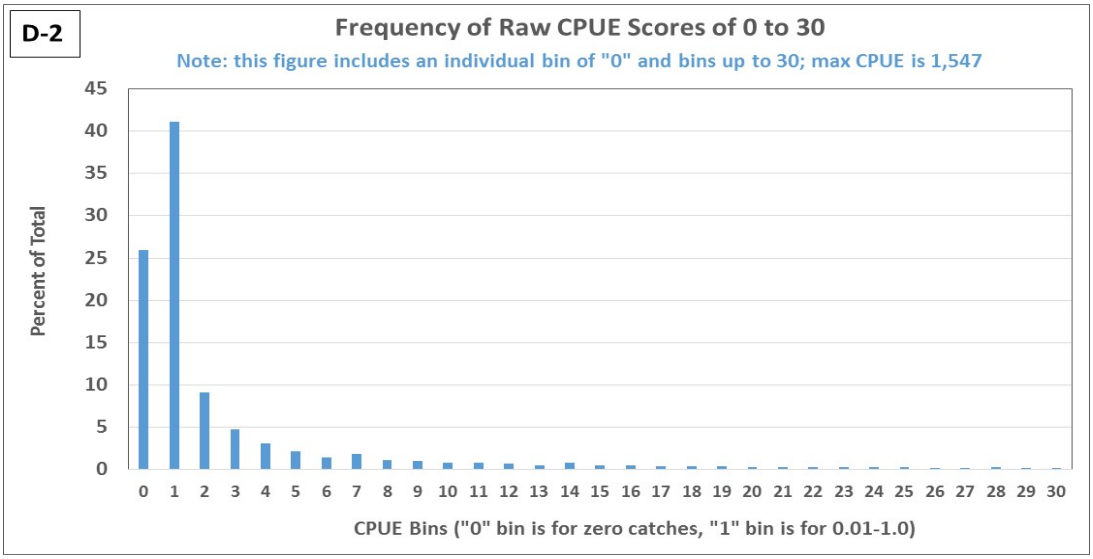


Figure D-3: Mean Monthly CPUE+1, 1993-2013.

- This figure shows the relationship of mean to variance (note the log-log scales).
- The variance increases with the mean and is therefore, heterogeneous, a condition known as heteroscedasticity.
- Heteroscedasticity precludes use of the data in parametric analyses.
- Normality Plot below (see section E) show that the data are not normally distributed.
-

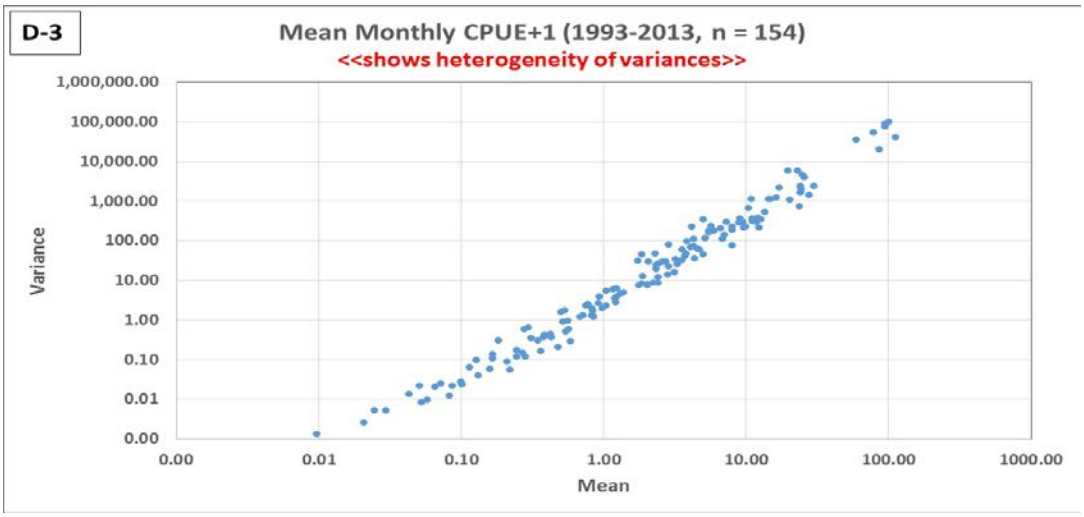


Figure D-4: Mean Monthly CPUE+1, 1993-2013—Ln Transformed Data (n = 154).

- This figure shows the relationship of mean to variance for Ln transformation of the raw scores; log transformation can often reconcile heteroscedasticity.
- As with the untransformed data, the variance increases with the mean and is heterogeneous; hence, heteroscedasticity.
- Normality Plot below also show that the transformed data are not normally distributed.
-

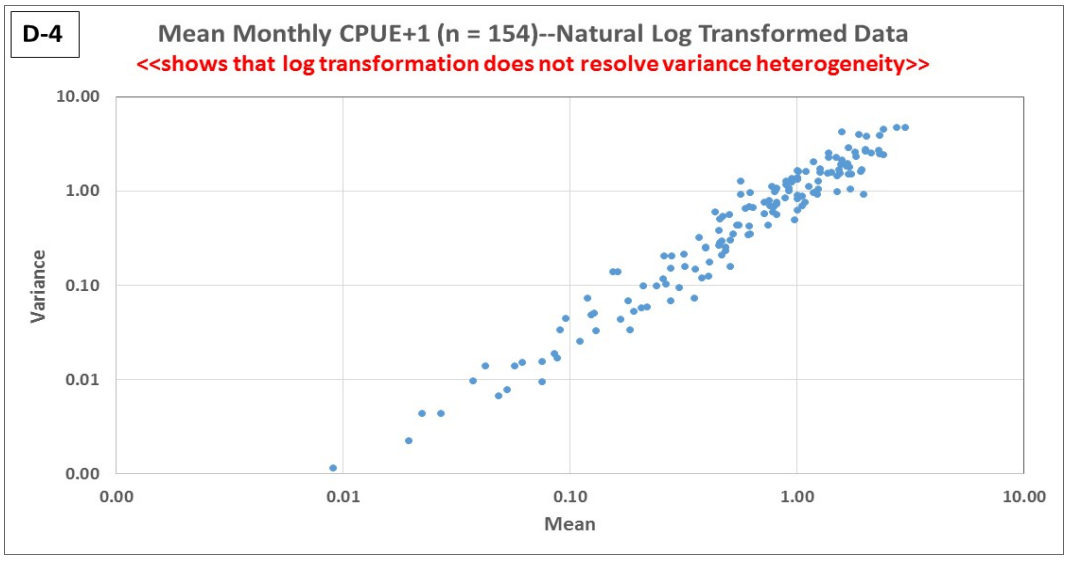
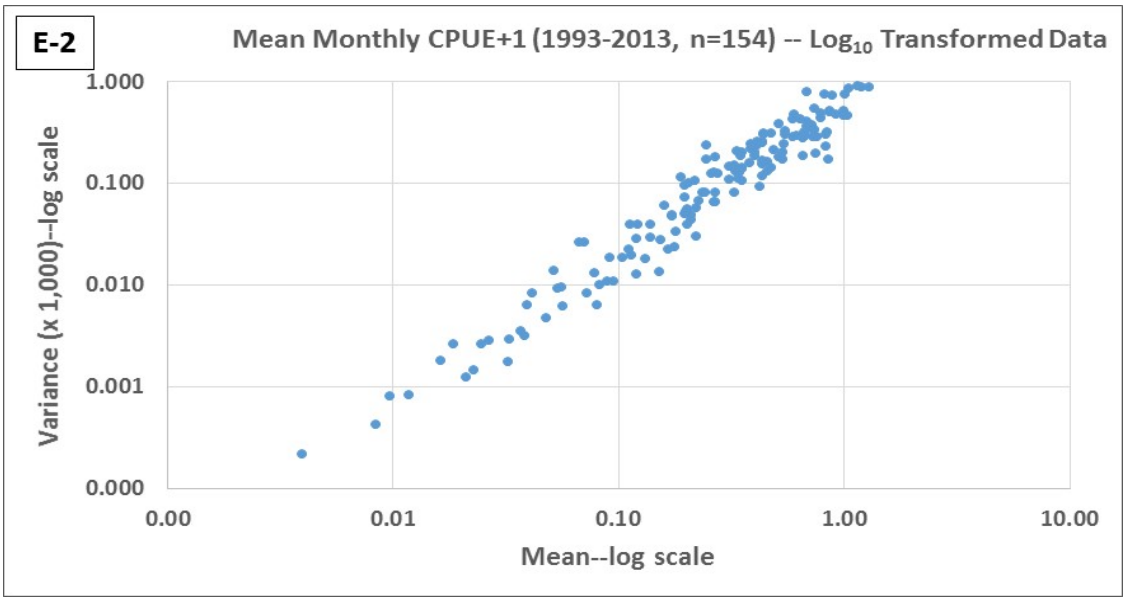


Figure E-2: Mean Monthly CPUE+1, 1993-2013—Log_{10} Transformed Data (n = 154).

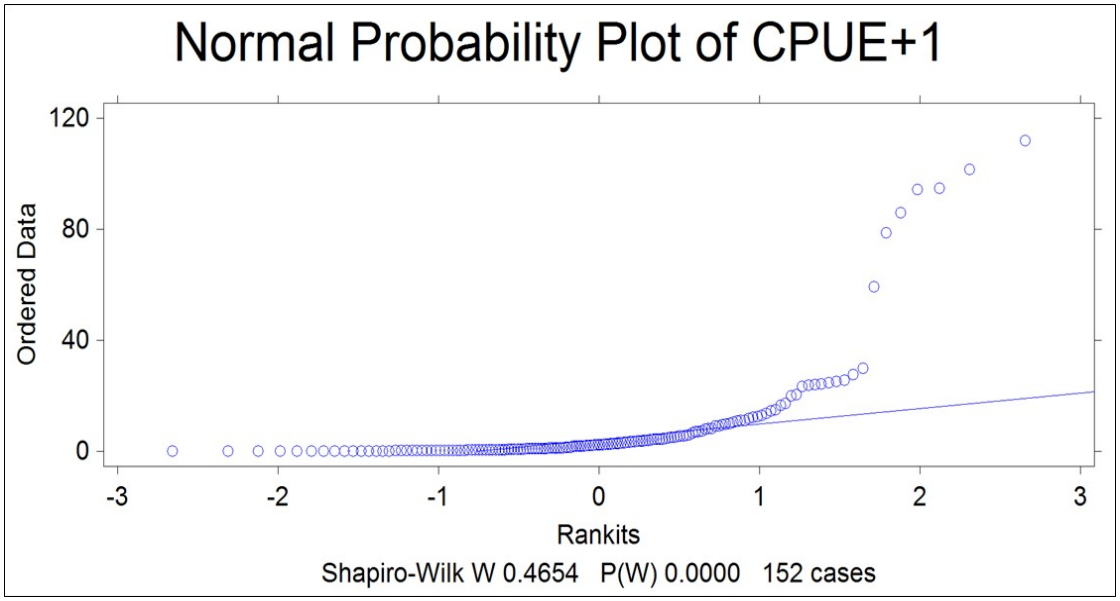
- Figure D-4 shows data transformed with natural logs; Figure E-2 (this figure) shows data transformed with base 10 log.
- Log transformation using natural log or log_{10} yield similar results.
-

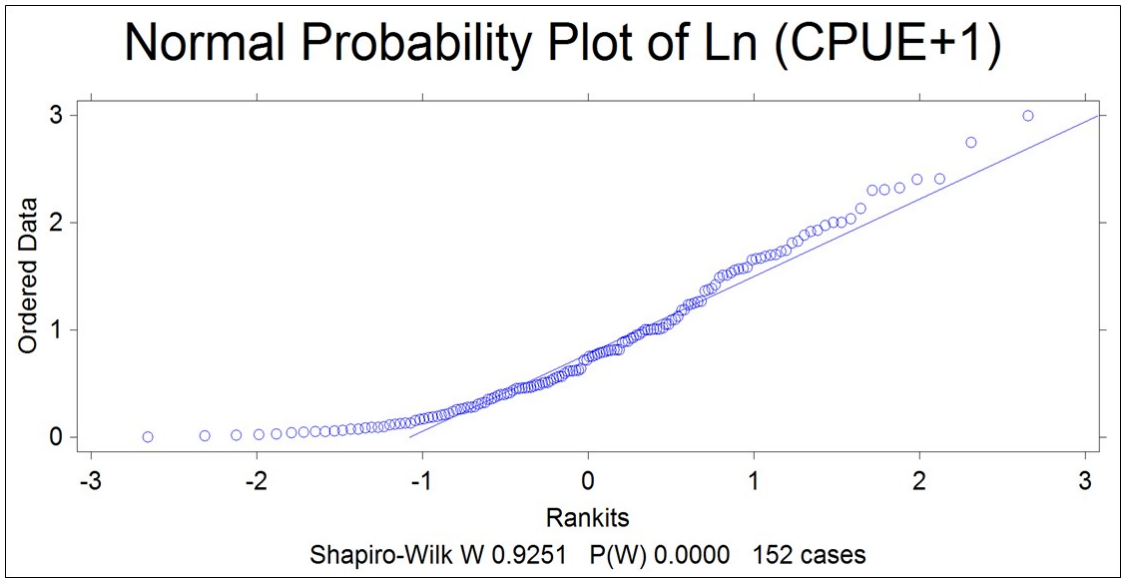


Additional Questions or Comments on Figures D and E:

E. Normality

- The following are Normality Plots and Shapiro-Wilk indices for the untransformed CPUE data (top) and for the natural log transformed data (Ln; bottom).
- Note that the S-W index of 0.4654 and a P-value of 0.0000 indicate that the data are not normally distributed.
- Note however that the S-W index of 0.9251 indicate that the Ln transformed data are normally distributed—but the P-value indicates that the relationship is not significant.
-
-





F. Cohort Survival

Figure F-1: Survival Curves for Age-0 RGSM by Year.

- Exponential functions were computed from mean monthly CPUE of age-0 for 1999-2008.
- These curves illustrate how CPUE can change over time with death of the fish.
- The October Monitoring Window is shown to illustrate how different CPUE could be for the same age fish depending on when the sample is taken.
- In a high density year like 2005, samples taken in June would reflect a CPUE ~105, whereas samples taken in mid-October would reflect a CPUE ~37.
- This figure shows that time of year matters for estimating population density (CPUE).
-

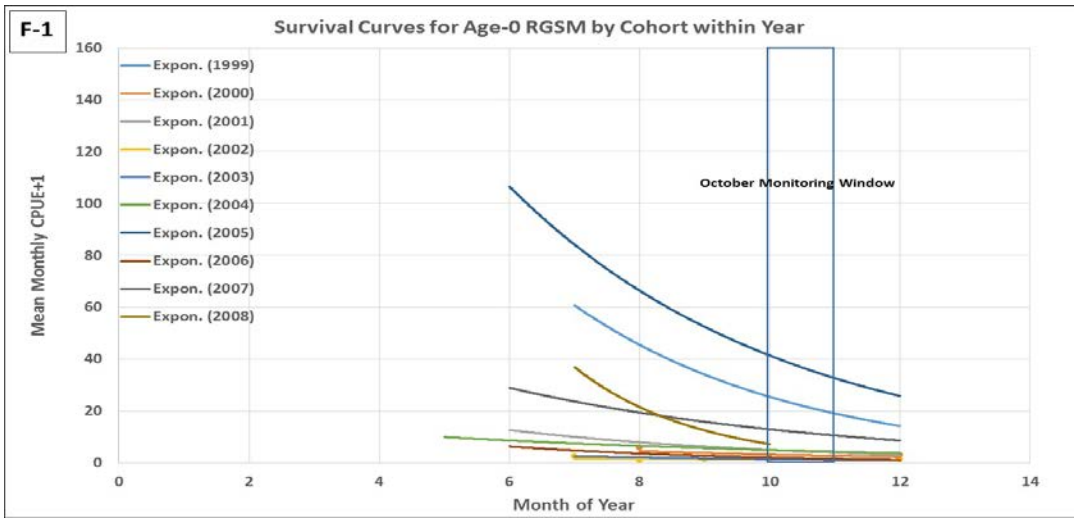


Figure F-2: Survival Curves for Age-0 RGSM by Year.

- This figure shows exponential functions that expand across the year.
- Note here that mortality is so high that few fish are left by spawning in spring.
-

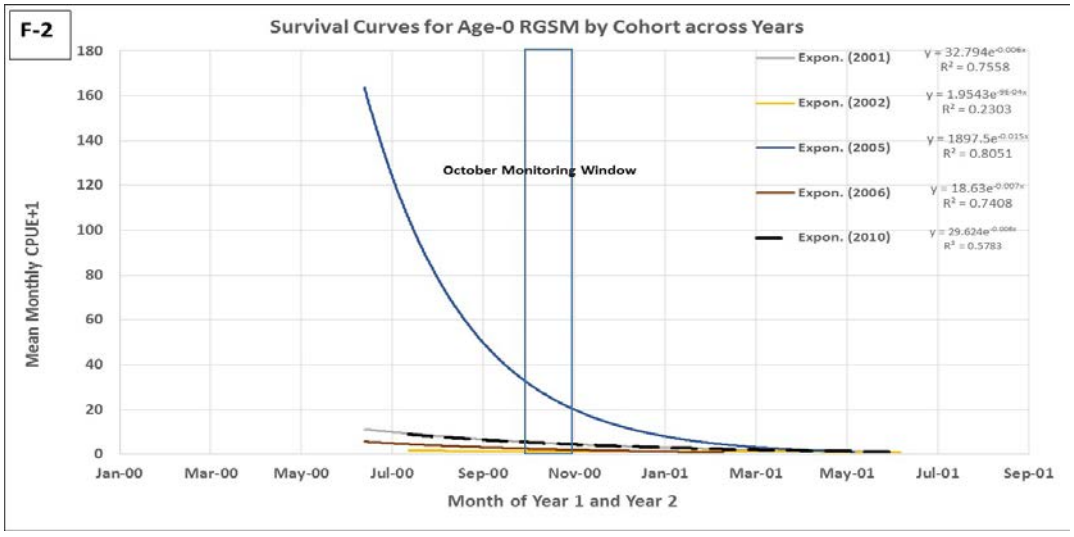


Figure F-3: C.V. for Log Transformed Mean Monthly CPUE+1.

- Coefficient of Variation was computed for mean monthly CPUE to determine when variability was lowest (Jun-Aug and Oct-Dec).
- Should monitoring be done at a time when data variability is lowest?
-
-

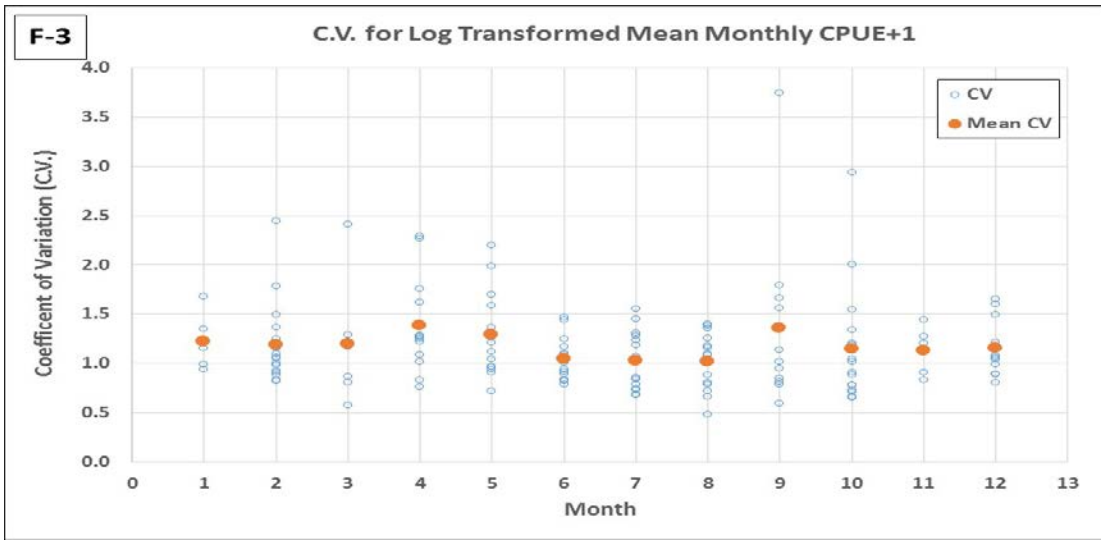
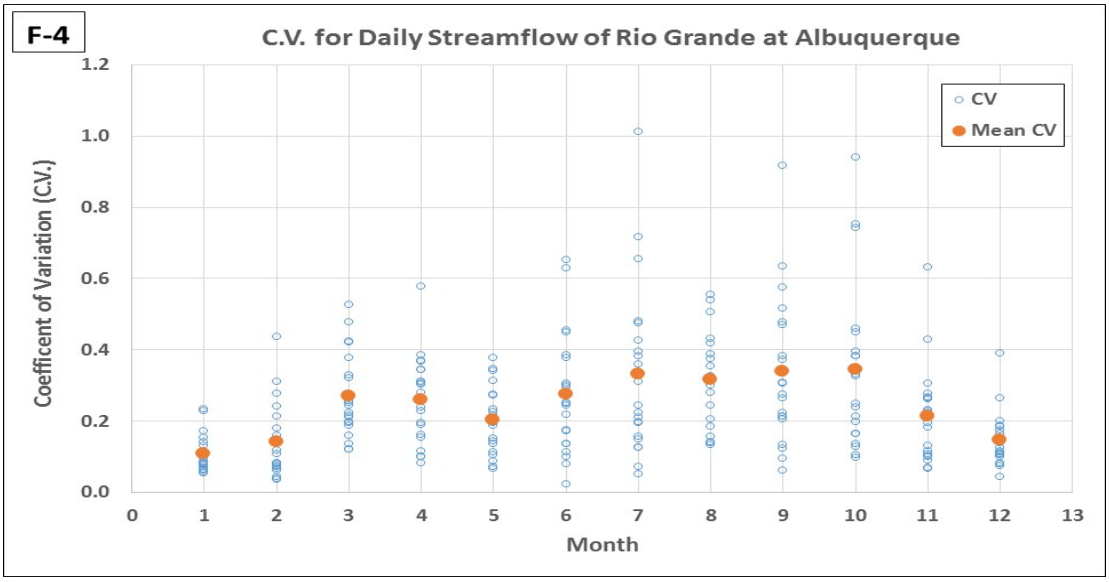


Figure F-4: C.V. for Daily Streamflow of Rio Grande at Albuquerque.

- Coefficient of Variation was computed for daily streamflow to determine when flow variability was lowest (Jan-Feb and Nov-Dec).
- Should monitoring be done at a time when flow variability is lowest?
-



Summary

Hopefully, the figures and bullet statements above will provide Committee members with an improved understanding of the population monitoring program and the database and help to stimulate thought and questions about the program. In summary, here are some highlights that may be offered for consideration by the invited scientists:

1. The numbers of samples over the last 20 years (1993-2013) have varied, especially before 2002. Are the data over the entire time period comparable for determining the status and trend of the RGSM?

2. Fixed locations (i.e., 20 sampling sites) have been used to collect monitoring data. Should sampling locations be fixed or should samples be taken at different locations, such as with a stratified random design?

3. Samples are collected from fixed sampling sites within each of three reaches. Should the reaches be treated as different strata for the purpose of sample allocation?

4. Mean CPUE is based on October or "putative" October samples (i.e., samples taken in adjacent months and included with October samples). Is October the best time of year to sample or would sampling at another time reduce data variability?

5. Samples are collected with individual seine hauls that are distinguished in the database starting in 2006, and mean CPUEs are computed from the "pool" of samples taken at a given sampling site. Should data of each seine haul be used to compute mean CPUE rather than the pool of fish divided by the pool of square meters seined?

6. Over 25% of the CPUEs are zeros, where no RGSM were caught in a given seine haul. Should sampling design be refined to reduce the number of zero catches?

7. The large number of zeros in the CPUE data preclude parametric analysis (even when the data are log-transformed). Is resolving the distribution of the data with a model or mixture model the most appropriate approach?

8. The zero-inflated data preclude computation of mean and variance and a mixture model combining the binomial distribution with the lognormal distribution was introduced in 2013 (see Figure S-1). Is this the best solution for estimating mean CPUE and variance, or would another model be better suited (e.g., Poisson)—and is this approach using a predictor model practical for managers to understand?

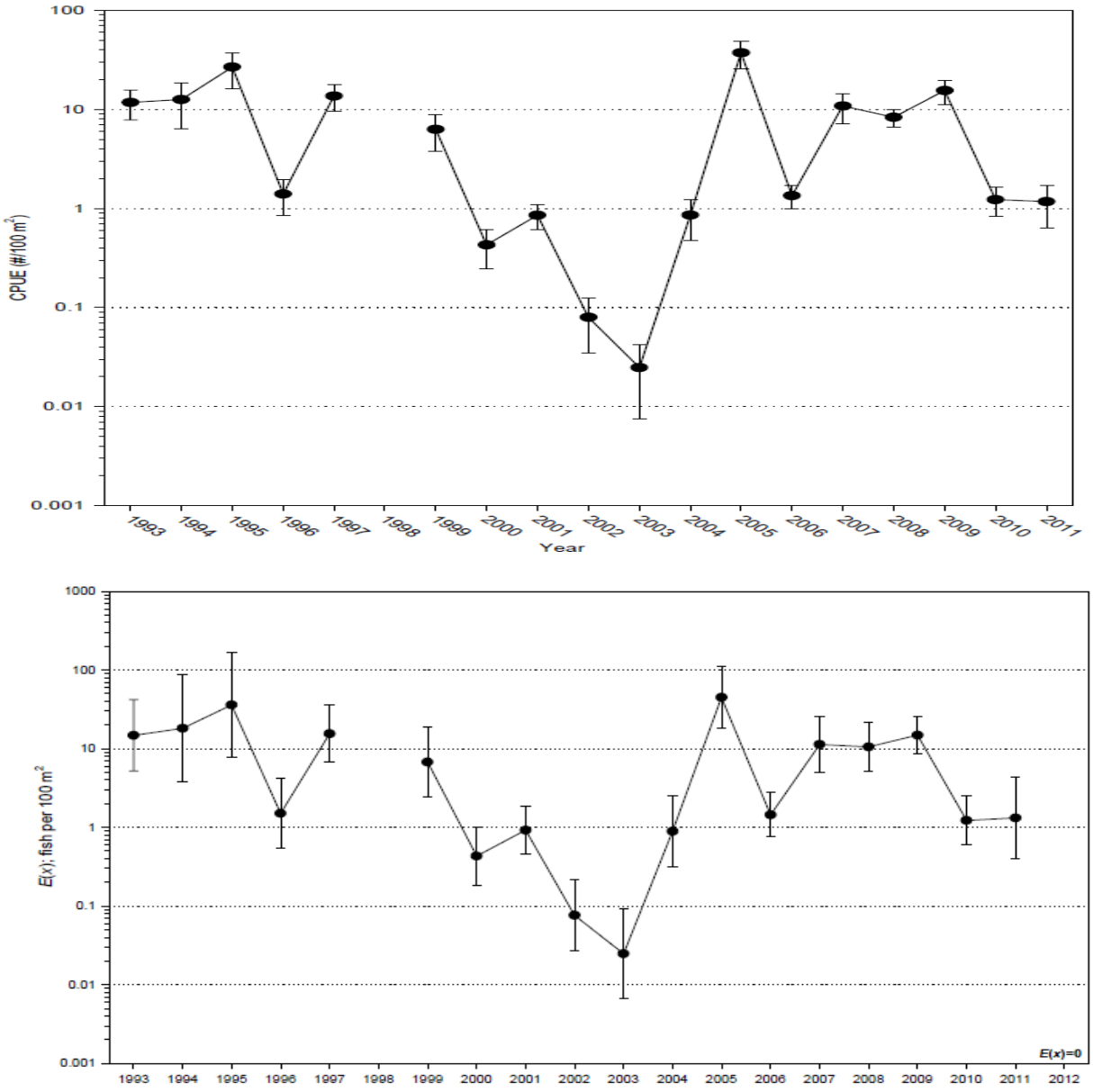


Figure S-1. Rio Grande silvery minnow densities (CPUE) for 1993-2011 as arithmetic means and standard errors (top) and as mixed model estimates of mean and 95% confidence intervals (bottom). Top figure is from Dudley and Platania (2012) and bottom figure is from Dudley et al. (2013).

Note:

This overview was developed by Rich Valdez for the purpose of characterizing the population monitoring program and data at Working Meeting #1 of the Population Monitoring Workshop Planning Committee; September 9, 2014.

Attachment 3

Approval of the 1st Task for Review of the Collaborative Program Fish Monitoring Program for the Rio Grande Silvery Minnow

A Proposal for a CPUE Metrics and Methodologies Workshop

Submitted to
The Executive Committee of the
Middle Rio Grande Endangered Species Collaborative Program

July 13, 2012

Executive Committee Action Requested:

- Approval to Conduct a Workshop on Catch-per-Unit-Effort (CPUE) Methodology used by the Current Rio Grande Silvery Minnow Population Monitoring Program (i.e., Task 1, see Appendix A).

Contents

Introduction

Background

This document was developed by the RGSM Population Monitoring workshop organizers at the request of the Executive Committee (EC) of the Middle Rio Grande Endangered Species Collaborative Program. The document outlines a proposed approach for evaluating and updating the fish monitoring plan for the Middle Rio Grande, New Mexico. This proposed approach helps to address issues identified in a scientific review of the Rio Grande silvery minnow (RGSM) population monitoring program and by the U.S. Fish and Wildlife Service (Service) in a letter dated March 23, 2012. The Service's letter recommended, as a step toward resolution, that the EC host a facilitated science workshop to discuss outstanding issues over the use of catch-per-unit-effort (CPUE) for monitoring the RGSM. Task 1 of this proposed approach addresses the Service's recommendation as part of a broader effort to develop a fish monitoring plan.

Primary Goal

The primary goal of this proposed approach is to evaluate and update the fish monitoring plan for the Middle Rio Grande. The focus of this plan shall be on the endangered Rio Grande silvery minnow, along with the identification and development of population demographic parameters that will best meet the needs of the Collaborative Program and the Recovery Implementation Program (RIP). The EC of the Collaborative Program has expressed the need to reliably measure the effects of Middle Rio Grande water management actions and conservation measures on the RGSM, and the Service seeks to determine the best population demographic parameter(s) for gauging species recovery and for measuring sufficient progress for the RIP. The proposed approach is intended to resolve how the RGSM population monitoring program can provide a reliable, precise, and accurate measure of the status and trend of the species for these purposes and that is also reasonably attainable (i.e., reasonable expenditure).

Proposed Approach

The workshop organizers believe that three major steps are needed to achieve the stated goal:

- Task 1 focuses on addressing technical questions concerning use of CPUE in the current RGSM monitoring program (see detailed write-up of Task 1 in Appendix A). This task should be approved and implemented as soon as possible to provide sufficient time to identify and invite qualified scientists to participate in the workshop process and to plan and organize the workshop.
- Task 2 is a review of the current monitoring program including temporal and spatial aspects of sampling design, data collection protocols, and data analyses.
- Task 3 is the development of a formal Fish Monitoring Plan with details of sampling design (e.g., number and location of samples, frequency of sampling, gear types, etc.), data collection protocols (e.g., data to be collected, manner of storage, etc.), and analytical methods (e.g., CPUE computation, relationship of CPUE to population estimates, use in PVA models, etc.).

Overview of current fish population monitoring

The fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and their habitat associations were first reported in 1987 (Platania 1993). Monitoring of the fish population with catch-per-unit-effort (CPUE) and specifically the endangered Rio Grande silvery minnow began in 1993 and has been carried out annually except for 1989 (e.g., Dudley and Platania 2011). The current monitoring program continues to provide annual, as well as more or less monthly, CPUE estimates for each of three reaches of the Middle Rio Grande:the Angostura, Isleta, and San Acacia reaches. Sampling has generally been conducted at 15-20 sites for up to 10 months in a year. Fish are taken with multiple seine hauls at a given sample site, and CPUE is computed for each species at each sample site as the pool of seine hauls expressed as the number of individuals per 100 m^2 (surface area) of water seined.

Outline of Actions by Task

The following is an outline of the three major tasks of this proposed approach with objectives and actions identified for each.

1. **Task 1. Conduct a Workshop on Catch-per-Unit-Effort (CPUE) Methodology used by the Current Rio Grande Silvery Minnow (RGSM) Population Monitoring Program (see Appendix A for details)**

Objectives:

- Evaluate statistical properties and interpretations of the current RGSM monitoring program, including precision and accuracy of CPUE.
- Discuss, evaluate, and reconcile areas of concern/disagreement over CPUE.
- Discuss and evaluate population estimation for RGSM and compare and correlate with CPUE,
- Identify and evaluate other methods for monitoring the RGSM, including methods used in other river systems.
- Identify, discuss, and reconcile uses of CPUE for RGSM, including demographic recovery criteria, sufficient progress metrics, and inputs and parameter estimates for Population Viability Analysis.

Actions:

- Retain two or three external scientists with expertise in CPUE, fish sampling design for small-bodied fishes, and other methodologies to participate in data examination, workshop presentation/interaction, and assist in preparing workshop report.
- Distribute and provide for independent examination, the existing monitoring data (and available population estimation data) to evaluate existing and potential precision and levels of detectable change in abundance of RGSM.
- Conduct a 3-day workshop that includes an introduction session with EC members (2-3 hr) followed by technical presentations, discussion, and draft report preparation.
- Prepare and present a report of the CPUE Workshop to the EC (report to be prepared jointly by workshop organizers and external scientists).

2. Task 2. Review Middle Rio Grande Fish Population Monitoring Plan

Objectives:

- Evaluate and refine sampling design, including statistical properties of spatial aspects (longitudinal locations of sample sites, habitats in which samples are taken) and temporal aspects (frequency of sampling, times of year when samples are taken).
- Evaluate and refine sampling methods, including gear types, sampling strategies, etc.
- Evaluate and refine data collection protocols, including types of data collected, recording methods, quality control, electronic storage, and data custody.
- Evaluate and refine data analyses.
- Identify other data needs for concurrent sampling during fish monitoring to support other studies (e.g., augmentation, fish movement, drying, genetics, adaptive management) as part of a programmatic monitoring program
- Evaluate how PVA may assist in refining monitoring.

Actions:

- Retain two or three external scientists with expertise in sampling design to participate in the workshop, evaluate and revise the fish monitoring plan, and prepare the workshop report.
- Conduct workshops and work sessions that address elements necessary for long-term fish population monitoring program development, including what other monitoring is needed that can be performed in conjunction with fish monitoring. Prepare and present a report to the EC as guidance to update the Fish Monitoring Plan for the Middle Rio Grande.

3. Task 3. Update the Collaborative Program Middle Rio Grande Fish Monitoring Plan

Objectives:

- Update the current Fish Monitoring Plan with revisions that may include sampling design, data collection, quality control, storage, and custody; cost estimates; and responsibilities.
- Define the metrics of interest for the initial phase of the Monitoring Plan (3 yrs), define how they will be calculated from the monitoring data, and document data precision and accuracy for the desired performance (such as precision and correlation with some "ground truth").
- Implement the updated Fish Monitoring Plan for a 3-year period for evaluation and refinement.
- Ensure that the needs of the Collaborative Program and the RIP are met with a monitoring program for RGSM sufficiently sensitive to:
  a. Detect changes in RGSM abundance with management actions;
  b. Provide reliable demographic recovery criteria for RGSM; and
  c. Provide reliable metrics for sufficient progress for the RIP.
  d. Utilize past data and analyses to be comparable to any proposed changes

Actions:

- Integrate the findings of Tasks 1 and 2 and update the Fish Monitoring Plan with emphasis on the RGSM.

  Implement and evaluate the Fish Monitoring Plan for meeting needs of the EC and the Service for monitoring species response(s) to management actions; demographic recovery criteria; and sufficient progress metrics.

Anticipated Time Schedule

An anticipated time schedule for this proposed approach is provided in Table 1. The following summarizes the schedule for each task and action.

Task 1: CPUE Workshop

- EC approval of Task 1 in July, 2012.
- Contract 2 or 3 external scientists that have the ability and time to participate in CPUE workshop.
- Independent data examination by external scientists and by Collaborative Program scientists to start as soon as data can be provided (the Program does not have the Population Estimation data at present, and some details are still missing from the Population Monitoring data). A reasonable period of time for this analysis is 3 months (Aug-Oct; given possible time conflicts of scientists and actual data analysis).
- Distribute pertinent existing reports concerning the population monitoring to all anticipated workshop participants at the same time that the data are made available.
- 3-day workshop by end of October 2012.
- Report to EC by December 2012.

Task 2: Review Monitoring Program

- Evaluate and refine aspects of fish monitoring program; workshops may be scheduled in January and February of 2013.

Task 3: Update the current Fish Monitoring Plan

- An updated draft RGSM Population Monitoring Plan will be vetted through the federal agencies and RIP so that it can be funded and implemented in FY2014.
- It is assumed that the current monitoring program will continue until a new or revised program is implemented, evaluated, and refined.

Table 1. Proposed time schedule for revision of the Fish Monitoring Plan.

Tasks	2012						2013					
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1. CPUE Workshop												
• EC Approval	X											
• Contract Scientists		X										
• Data Examination		X	X	X								
• 3-Day Workshop				X								
• Report to EC					X	X						
2. Evaluate Monitoring						X	X	X				
3.Update Plan								X	X	X	X	X

Estimated Costs

- The costs for Task 1 are estimated at $30,000 of federal funding (USFWS and Reclamation/CP) with cost share contributions from nonfederal signatories anticipated. The majority of this cost ($20-25,000) is for contracting external scientists' time and per diem. The costs for participation by the Collaborative Program participants or their contractors are not factored into this estimate.
- The costs of Tasks 2 and 3 are undetermined at this time. Each workshop for Task 2 is estimated to cost about the same as for Task 1 ($30,000).

Workshop Organizers

The CPUE Metrics and Methodologies workshop planners include:

- Rick Billings, Albuquerque-Bernalillo County Water Utility Authority
- Jim Brooks, U.S. Fish and Wildlife Service
- Michael Porter, U.S. Army Corps of Engineers
- Grace Haggerty, New Mexico Interstate Stream Commission
- Daniel Goodman, Montana State University
- Richard Valdez, SWCA
- Jason Remshardt, U.S. Fish and Wildlife Service

Literature Cited

Dudley, R.K. and S.P. Platania. 2011. Rio Grande silvery minnow population monitoring program results from September 2009 to October 2010. Report to the Middle Rio Grande Endangered Species Act Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, NM.

Platania, S.P. 1993. The fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and their habitat associations. Report to the New Mexico Department of Game and Fish, Santa Fe, and U.S. Bureau of Reclamation (Albuquerque Projects Office), Albuquerque, NM.

U.S. Fish and Wildlife Service. 2010. Rio Grande Silvery Minnow (*Hybognathus amarus*) Recovery Plan, First Revision. Albuquerque, NM.

Appendix A: Task 1 Description.

Task 1. Conduct a Workshop on Catch-per-Unit-Effort (CPUE) Methodology used in the Current Rio Grande Silvery Minnow (RGSM) Population Monitoring Program

This task is intended to explore and reconcile issues and concerns with using CPUE to monitor the RGSM. This task will accomplish the first necessary step in developing a better understanding of the current methodologies used to monitor the species and ways to improve and refine the monitoring program. This task will also begin to establish better communications among the scientists, managers, and the EC over the meaning and use of monitoring information. The workshop will also review methodologies for monitoring used in other river systems, as well as analytical methods that may help to improve a fish monitoring program for the Middle Rio Grande.

Objectives:

- Evaluate statistical properties and interpretations of the current RGSM monitoring program, including precision and accuracy of CPUE.
- Discuss, evaluate, and reconcile areas of concern/disagreement over CPUE.
- Discuss and evaluate population estimation for RGSM and compare and correlate with CPUE, with available population estimation data.
- Identify and evaluate other methods for monitoring the RGSM, including methods used in other river systems.
- Identify, discuss, and reconcile uses for CPUE, including recovery demographic criteria, sufficient progress metrics, and inputs and parameter estimates for Population Viability Analysis.

Actions:

- Retain 2-3 external scientists with expertise in CPUE, fish sampling design for small-bodied fishes, and other methodologies to participate in data examination, workshop presentation/interaction, and assist in preparing workshop report.
- Distribute and provide for independent examination, existing pertinent reports and the existing monitoring data (and available population estimation data_) to evaluate existing and potential precision and levels of detectable change in abundance of RGSM.
- Conduct a 3-day workshop, with EC members participating in a 2-hour introduction followed by technical presentations, discussion, and report preparation.
- Prepare and present a report of the CPUE Workshop to the EC (report to be prepared jointly by workshop organizers and external scientists).

Proposed Structure and Process:

- Workshop tentatively scheduled for 3 days in the last week of October, 2012. Draft agenda for the workshop (to be refined with the assistance of the external scientists) is:
    - Day 1—Morning: Presentation to EC of background, workshop objectives and EC/scientists dialogue/questions/comments.

- Day 1—Afternoon: Technical presentations and discussions on RGSM current monitoring.
- Day 2—Morning: Continuation of presentations and discussion of other methods used, data analyses, etc (to be further defined).
- Day 2—Afternoon: Discussion session (facilitated).
- Day 3—Morning: Technical presentations and discussion on demographic metrics for sufficient progress and recovery milestones (facilitated).
- Day 3—Afternoon: Report preparation by Participating Scientists.

- This workshop will involve a detailed evaluation of CPUE collection and analysis methodologies. It is recommended that primary attendees are scientists familiar with fish population monitoring in the MRG and that participating scientists are well prepared. A list of scientists will be developed jointly by the workshop organizers and the EC; that list will be used to form the discussion groups and to write the Workshop Report. A list of technical participants will be distributed to the EC for approval prior to the workshop. A cross section of knowledgeable scientists from the diverse agencies/entities is encouraged.
- Other attendees may participate as observers and be allowed to provide comments or questions only during specified comment/question periods, most likely at the end of each presentation and discussion session. This is done to ensure that the workshop stays on schedule with technical issues. However, this is a public meeting.
- Two to three scientists not currently involved in the Collaborative Program and with expertise in sampling methodologies/statistical analysis/CPUE monitoring for small-bodied river fishes will be contracted to participate in data examination, workshop participation, and report preparation. Availability will most likely be a determining factor in who is contracted. Prior to contracting with these individuals, their names and CVs will be provided to the EC members for approval.
- The contracted external scientists are not considered to be a science panel or peer reviewers but will participate as other scientists do in the workshop and will assist in drafting the Workshop Report on the last day of the meeting and following the workshop.
- A facilitator will be used to lead the workshop. The facilitator shall be experienced at leading technical workshops. One or two additional assistants may be requested to help with workshop materials, monitor and record discussion sessions, etc. The facilitator's contract may be with any of the EC members and the facilitator's name and CV will be provided to the EC for approval at the same time the information is provided to external scientists.
- The workshop organizers will remain in place to assist in selection and contracting the external scientists, setting up the workshop, and finalizing the Workshop Report. Technical editing and technical and administrative assistance will be provided by the Collaborative Program PMT and EC contributions.

Products/Outcomes:

- Workshop Report written by the workshop organizers and the external scientists to include:
  - Summary of CPUE issues as used in the MRG.

  - Effectiveness of current program and CPUE to address Collaborative Program and RIP needs.
  - Recommendation to the EC on continued use and refinement of CPUE.
  - Other uses for CPUE (e.g., survival, recruitment).
  - Recommendation to the EC for additional sampling methods for monitoring the RGSM.
  - Provision for minority reports to document alternative views or opinions on content of report.
- Electronic and hard copies of workshop proceedings and presentations.
- Summary of discussion group dialogue.
- Proposed outline to help guide Tasks 2 and 3.

Appendix B: Suggested External Scientists (Preliminary)

The following are recommended scientists and a list of their qualifications who are not directly involved with the Collaborative Program and who could provide an objective evaluation of the RGSM monitoring program and data:

- Dr. Wayne Hubert (retired)
  - Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, WY
  - Lead author: Relative Abundance and Catch-per-Unit-Effort, Chapter 7 *in* Analysis and Interpretation of Freshwater Fisheries Data
- Dr. Ron Ryel
  - Department of Forest, Range, and Wildlife Sciences, Utah State University, Logan, UT
  - Teaches classes in Inventory, Monitoring and Assessment
- Dr. Brett Johnson
  - Associate Professor, Colorado State University, Ft. Collins, CO
  - Co-author: Predator-Prey Interactions, Chapter 16 *in* Analysis and Interpretation of Freshwater Fisheries Data
- Dr. Carl Walters
  - University of British Columbia, Vancouver, BC
- Dr. Josh Korman
  - Ecometrics, Vancouver, BC
- Dr. William Pine
  - University of Florida, Gainesville, FL
- Dr. Lewis Coggins
  - NOAA's Southeast Fisheries Science Center, National Marine Fisheries Service, Beaufort, NC
- Dr. Ray Hilborn
  - School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA
- Dr. Mike C. Runge
  - US Geological Survey Patuxent Wildlife Research Center, Laurel, MD

Scientists will provide curriculum vitae to the Collaborative Program and the EC as part of the selection process for participating in the CPUE workshop.

Mary Fabrizio
Phaedra Budy
David Gale

Survey of the Executive Committee on Fish Population Monitoring Needs Summary Report

Middle Rio Grande Endangered Species Collaborative Program

March 2015

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

Survey of the Executive Committee on Fish Population Monitoring Needs, Summary Report Middle Rio Grande Endangered Species Collaborative Program March 2015

Introduction and Background

The Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program) Executive Committee (EC) consists of designated representatives from each of the 16 Signatories. In May 2014, the Collaborative Program Population Monitoring Workshop Planning Workgroup (Planning Workgroup) requested that the EC complete a survey entitled "Executive Committee Survey of Collaborative Program Fish Population Monitoring Needs." The Rio Grande silvery minnow (silvery minnow) is a federal and state listed endangered species, and is the primary concern for the Collaborative Program in the Middle Rio Grande. The purposes of the survey were primarily to (1) assess the level of understanding by EC members of the monitoring program's metrics and methodologies, (2) obtain EC member's perspectives on the effectiveness of the current Rio Grande silvery minnow (RGSM) monitoring program in meeting the needs of the Collaborative Program, and (3) obtain information on what EC members believe are important in a species monitoring program that is designed for a recovery focused program (Recovery Implementation Program [RIP]).

The Planning Workgroup will use this survey to help guide the agenda and assemble questions for a Fish Population Monitoring Workshop that will assess the current fish monitoring methodologies and CPUE indices through discussions in a forum that includes scientists external to the Collaborative Program who are subject experts. The workshop is intended to provide the EC with recommendations that will help to build the direction and rationale for the Collaborative Program's RIP fish monitoring program.

Of the 16 signatory representatives, 11 EC members responded to the survey, as follows:

- Albuquerque Bernalillo County Water Utility Authority (ABCWUA)
- Assessment Payers Association of the MRGCD (APA)
- Bureau of Reclamation (Reclamation)
- City of Albuquerque (CoA)

- Fish and Wildlife Service (FWS)
- New Mexico Interstate Stream Commission (NMISC)
- New Mexico Department of Game and Fish (NMDGF)
- Pueblo of Isleta
- Pueblo of Santa Ana
- U.S. Army Corps of Engineers (USACE)
- University of New Mexico (UNM)

The survey (Attachment 1) consisted of 10 questions (with 1 question containing 3 parts). Each question asked the respondent to (A) assess the level of importance of each identified need and (B) assess how well the current monitoring program addresses each identified need. Each respondent rated the need using a scale of 1 to 6, with 1 being "not needed," 5 being "a critical need," and 6 being "unsure/don't know." Comments were encouraged, and were included by some of the respondents. Table 1 shows the numerical responses from each responding member of the EC. The figures graphically depict the responses to each question.

Funding for this report was provided by the ABCWUA and the NMISC as part of their contribution to the nonfederal cost share for the Collaborative Program.

Table 1. Responses to the Executive Committee Survey of Collaborative Program Fish Population Monitoring Needs

	A. Level of Importance for Each Need																	B. How Well Current Monitoring Program Addresses Need															
	Albuquerque-Bernalillo County Water Utility Authority	Assessment Payers Association of the MRGCD	Bureau of Reclamation	City of Albuquerque	Fish and Wildlife Service	Interstate Stream Commission	Middle Rio Grande Conservancy District	New Mexico Attorney General's Office	New Mexico Department of Agriculture	New Mexico Department of Game and Fish	Pueblo of Isleta	Pueblo of Sandia	Pueblo of Santa Ana	Pueblo of Santo Domingo	U.S. Army Corps of Engineers	University of New Mexico	AVERAGE	MEDIAN	Albuquerque-Bernalillo County Water Utility Authority	Assessment Payers Association of the MRGCD	Bureau of Reclamation	City of Albuquerque	Fish and Wildlife Service	Interstate Stream Commission	Middle Rio Grande Conservancy District	New Mexico Attorney General's Office	New Mexico Department of Agriculture	New Mexico Department of Game and Fish	Pueblo of Isleta	Pueblo of Sandia	Pueblo of Santa Ana	Pueblo of Santo Domingo	U.S. Army Corps of Engineers	University of New Mexico	AVERAGE	MEDIAN
1. Provides estimates of long-term population trends (increase/decrease).	5	1	5	5	5	2	--	--	--	4	5	--	5	--	5	5	*4.3*	*5*	2	1	4	2.5	4	2	--	--	--	6	2	--	4	--	3	5	*3.2*	*3*
2. Provides estimates of population abundance over time and area.	5	1	5	5	3	5	--	--	--	5	5	--	4	--	5	4	*4.3*	*5*	2	1	4	2.5	2	1	--	--	--	6	4	--	3	--	2	3	*2.8*	*2.5*
3. Evaluates species response to variations in natural conditions.	4	3	5	5	2	4	--	--	--	5	5	--	4	--	4	3	*4.0*	*4*	3	1	3	2	1	1	--	--	--	6	4	--	3	--	2	4	*2.7*	*3*
4. Evaluates species response to management actions, such as:	5	--	5	--	2	5	--	--	--	5		--		--	3		*4.2*	*5*	1	--	--	--	1	1	--	--	--	--	--	--	--	--	1	--	*1.0*	*1*
Habitat restoration	5	3	4	4		5	--	--	--	5	5	--	4	--	2	4	*4.1*	*4*	1	2	1	2		1	--	--	--	6	4	--	1	--	1	3	*2.2*	*1.5*
Modified spawning flows		3	5	4	2	5	--	--	--	5	5	--	3	--	4	5	*4.1*	*4.5*		2	5	3	1	1	--	--	--	6	4	--	3	--	2	4	*3.1*	*3*
Summer/fall/winter operations	5	3	5	4	3	4	--	--	--	5	4	--	3	--	2	5	*3.9*	*4*	1	2	4	3	1	1	--	--	--	6	2	--	3	--	1	5	*2.6*	*2*
Other	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5. Refines understanding of species development and behavior.	4	4	4	4	3	3	--	--	--	3	3	--	3	--	3	2	*3.3*	*3*	2	2	1	2.5	1	1	--	--	--	6	2	--	2	--	1	6	*2.4*	*2*
6. Evaluates progress toward species recovery.	5	3	5	5	5	4	--	--	--	4	3	--	4	--	5	5	*4.4*	*5*	1	1	6	2	4	2	--	--	--	2	2	--	4	--	2	5	*2.8*	*2*
7. Evaluates sufficient progress.	5	2	5	4	4	4	--	--	--	3	3	--	3	--	5	6	*4.0*	*4*	1		6	2	4	6	--	--	--	2	2	--	3	--	2	6	*3.4*	*2.5*
8. Assesses population viability and self-sustainability.	5	3	5	5	3	3	--	--	--	5	3	--	3	--	4	5	*4.0*	*4*	3	1	3	2	2	6	--	--	--	1	2	--	6	--	2	5	*3.0*	*2*
9. Tracks trends and abundances of other fish species.	3	2	3	3	2	2	--	--	--	2	3	--	3	--	3	4	*2.7*	*3*	3	2	4	2	3	6	--	--	--	6	3	--	4	--	3	5	*3.7*	*3*
10. Provides high level of precision and accuracy for the cost.	5	4	3	4	5	4	--	--	--	5	3	--	3	--	2	3	*3.7*	*4*	1	1	3	2	5	1	--	--	--	2	1	--	3	--	1	5	*2.3*	*2*

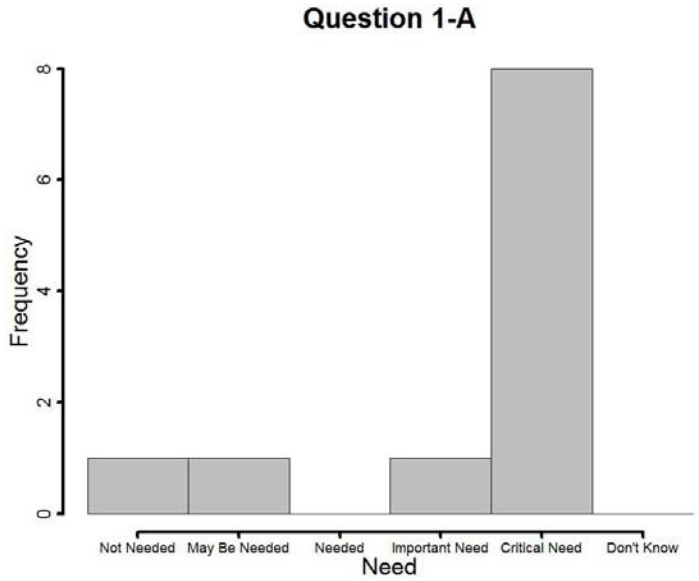
Notes:

A. Level of Importance for Each Need
1. Not needed
2. May be needed
3. Needed
4. Important need
5. Critical need
6. Don't know

B. How Well Current Monitoring Program Addresses Need
1. Poor
2. Fair
3. Well
4. Very well
5. Exellent
6. Don't know

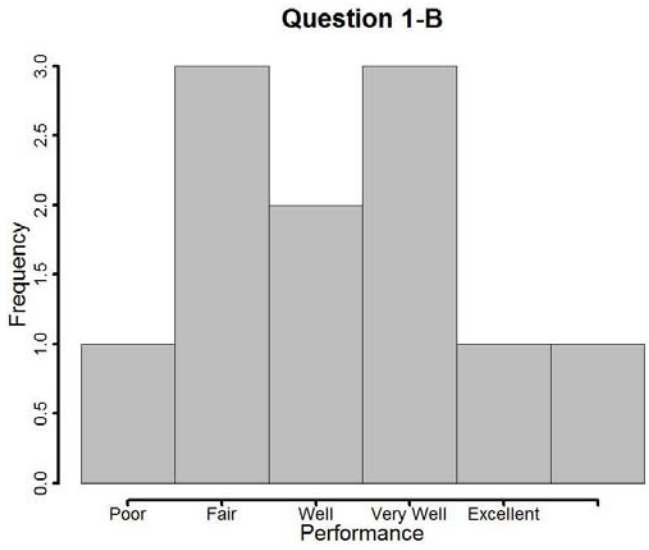
1. Provides estimates of long-term population trends (increase/decrease)

A) Level of importance



This is seen as a critical need by the majority of signatories.

B) How well current monitoring program addresses this need



Range of responses indicates uncertainty by the EC.

Question 1 Comments provided as written (anonymous):

- *Long term is very relative. RGSM seem to have large population fluctuations possible year to year, which makes sense for a fairly short lived species. Population estimate trends seem to depend greatly on assumptions and may in fact compound errors and not be useful as an accurate reflection of actual population.*

- *The PVA process identified the population monitoring, long-term trend data as some of the most valuable robust data on the species that the Program currently has. However, it is always valuable to re-examine and ensure that it meets the Program's needs and is being used appropriately. Maintaining the long-term trend dataset is a critical need; if adjustments are made those will require overlap for a period of time with the current monitoring protocol so that we can still translate from past data to any new effort and maintain the long-term trend information. For example, a biometrician could build in a random aspect to our current program and could reduce the number of sampling events we do at our current 20 sites. An overlapping adjustment was done for several years with the RGSM Population Estimate Program which was discontinued recently.*

- *CP should consider using traps to supplement seine data.*

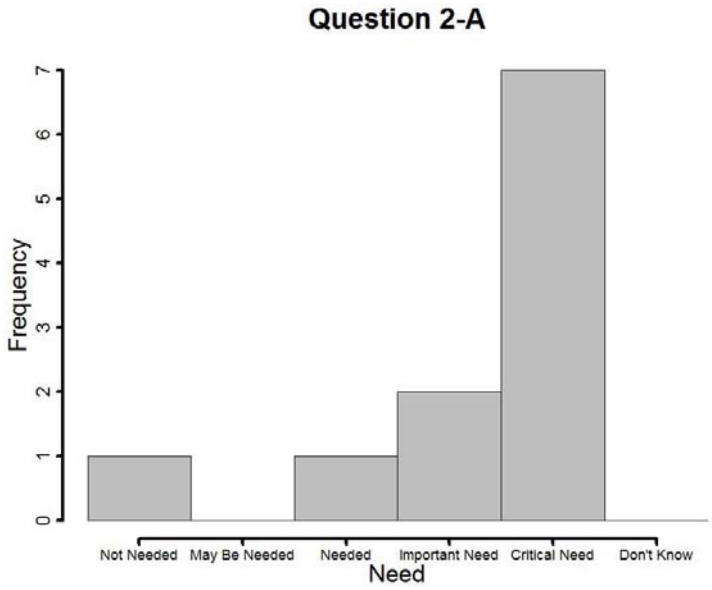
- *Despite alternative sampling methods, the current protocol provides consistant, long-term trend data.*

- *Monitoring is robust at detecting major increasing population trends of smaller silvery minnows, but limited for enumerating decreasing densities of larger silvery minnows. There appears to be differential overdispersion by size and age.*

- *This may be one of the most thoroughly evaluated catch-per-unit-effort studies ever done, especially on a warm-water and small-bodied fish. A 20-year time series conducted with the same efficiency and consistency simply does not exist elsewhere in the scientific literature.*

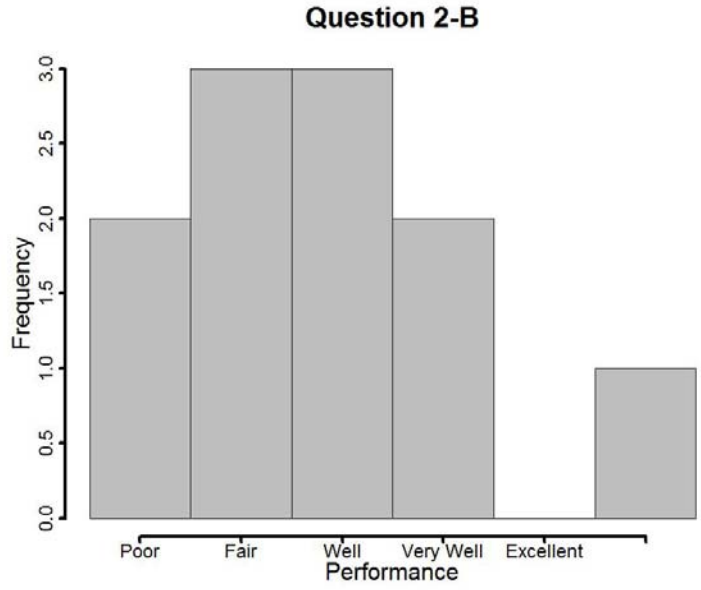
2. Provides estimates of population abundance over time and area.

A) Level of importance



Majority see this as a critical need for the Program.

B) How well current monitoring program addresses this need



Range of responses indicates uncertainty by the EC.

Question 2 Comments provided as written (anonymous):

- *The population monitoring program assesses relative species abundance in terms of density; it does not provide a population estimate (i.e., number of individuals in the population - that was provided through the RGSM Population Estimation Program that was discontinued recently). The sampling sites for population monitoring are distributed over the overall area of the MRG where minnows are found; sampling 9 months during the year covers the fluctuations over time in terms of monthly and yearly changes. Our answers to this question assume it is referring to the need for abundance information over time and area (rather than the need for a specific estimate or population number). Also, our answers assume the level of resolution of time and area under consideration is consistent with the scope of the population monitoring as noted above. See Response 3 below for some population monitoring limits.*

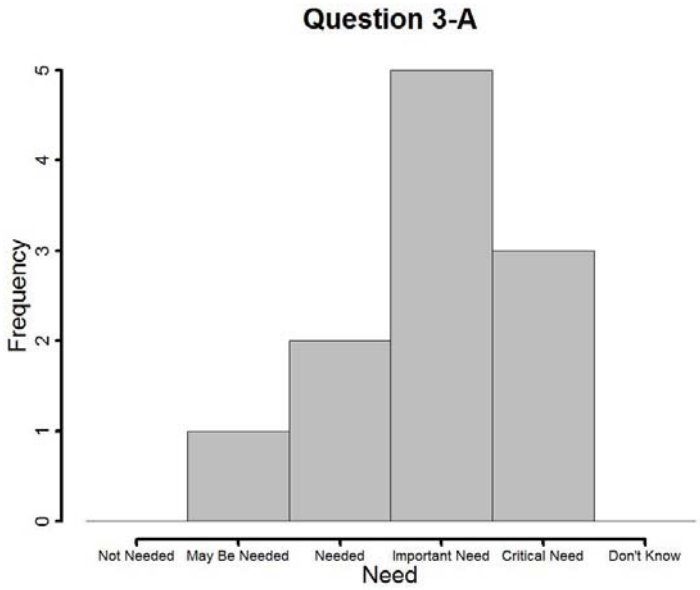
- *Current methods do an acceptable job of providing population estimates.*

- *The monitoring program provides a relative abundance (CPUE), which makes comparisons between reaches and years less definitive. Attempts to estimate abundance from CPUE have not been productive. Progress criteria should reflect the uncertain nature of the CPUE data.*

- *The relationship between CPUE and census size is difficult to ascertain even in relatively closed systems. However, there is a strong correlation of CPUE and census size.*

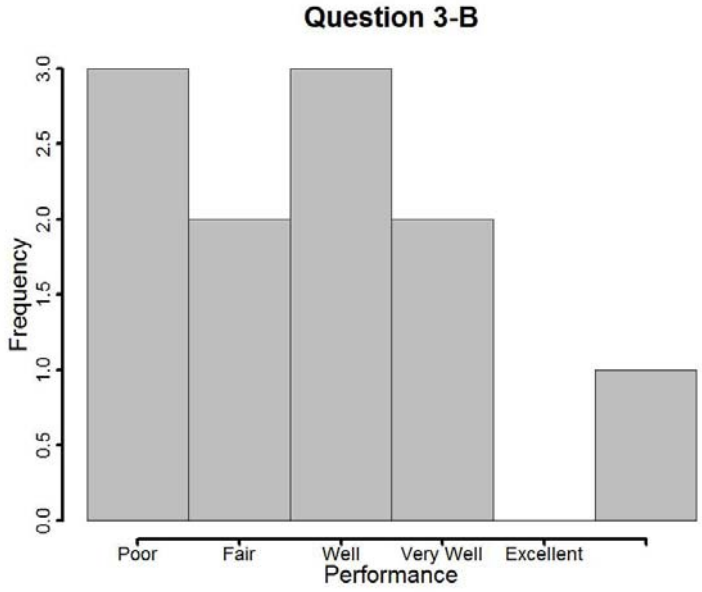
3. Evaluates species response to variations in natural conditions.

A) Level of importance



Majority indicates needed to critical need for species response to natural variability.

B) How well current monitoring program addresses this need



Range of responses indicates uncertainty.

Question 3 Comments provided as written (anonymous):

- *This is a broad question and depends on which conditions are referenced. For species response to spring peak and summer intermittency, the PVA process has identified the value of the population monitoring data for assessing correlations with those river conditions. However, there is a limit, because population monitoring is at the population level (broad scale), it does not allow an evaluation of site-specific project contributions or site-specific conditions to the overall species status. In addition, as the MRG is highly regulated, the current monitoring reflects species response under regulated conditions, such as the response to the current severe drought.*

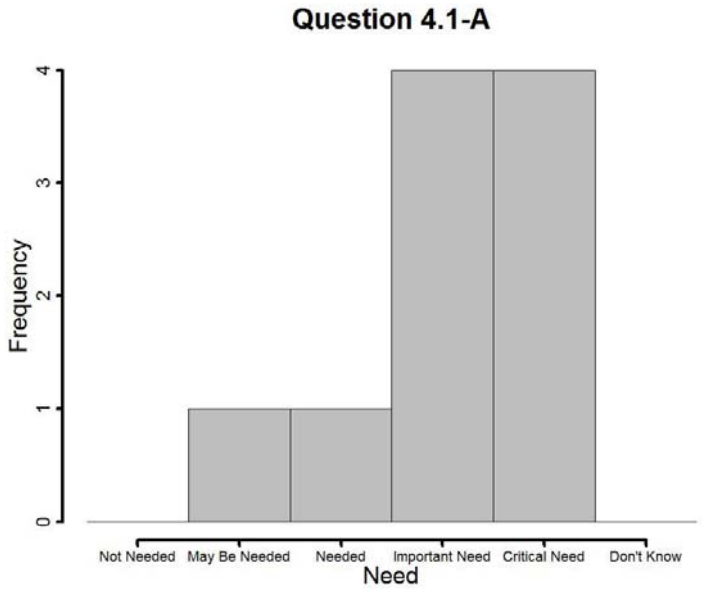
- *Monitoring is robust at detecting major increasing population trends of smaller silvery minnows, but limited for enumerating decreasing densities of larger silvery minnows. There appears to be differential overdispersion by size and age.*

- *Species sampling is sufficiently temporally and spatially dense to assess fish response to varying conditions, including river drying and intermittency. High flow conditions impede sampling.*

4. Evaluates species response to management actions, such as:

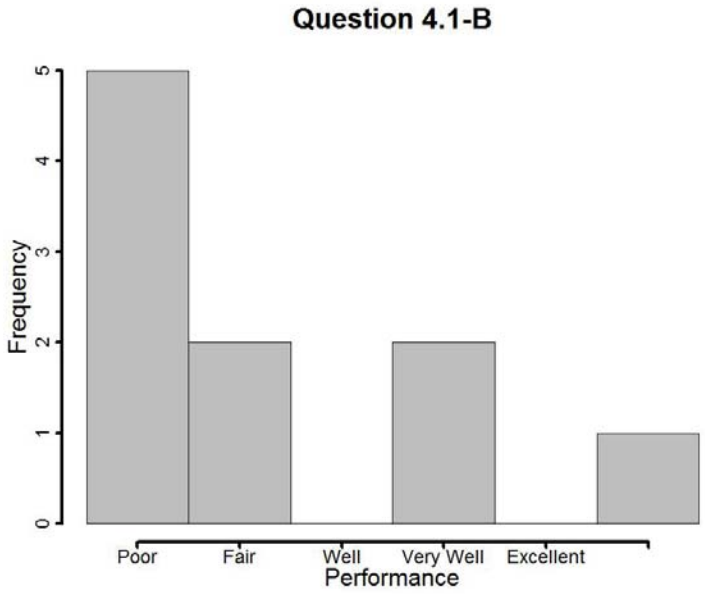
4.1. Habitat restoration

A) Level of importance



Majority believes this is an important or critical need.

B) How well current monitoring program addresses this need



Majority believes need is addressed poor to fair.

Question 4.1 Comments provided as written (anonymous):

- *See comments above; because the current population monitoring was designed to provide population-wide (broad scale) information on species trends in abundance, it does not necessarily allow for site-specific conclusions on the contributions of individual projects such as HR to the overall species status. To better focus on specific habitat restoration sites or other operational changes, additional monitoring could be done at a site-specific level. At habitat restoration sites, monitoring could be conducted to determine if the improvements have attracted more RGSM and other fish species, determine if the project has created desirable habitat for the minnow, determine how the restoration functions with the various water operations, etc. This would then, in turn, better focus the design of future restoration projects. This type of site-specific monitoring for HR projects is currently addressed in the Effectiveness Monitoring Plan (EMP) developed by the Program and specifically addresses this need to evaluate the effectiveness of Habitat Restoration projects for the minnow and flycatcher. The EMP is comprised of a Low Intensity and High Intensity level of effort for monitoring representative HR sites and should be implemented, and then evaluated, for its ability to address this need for evaluating species' responses to HR.*

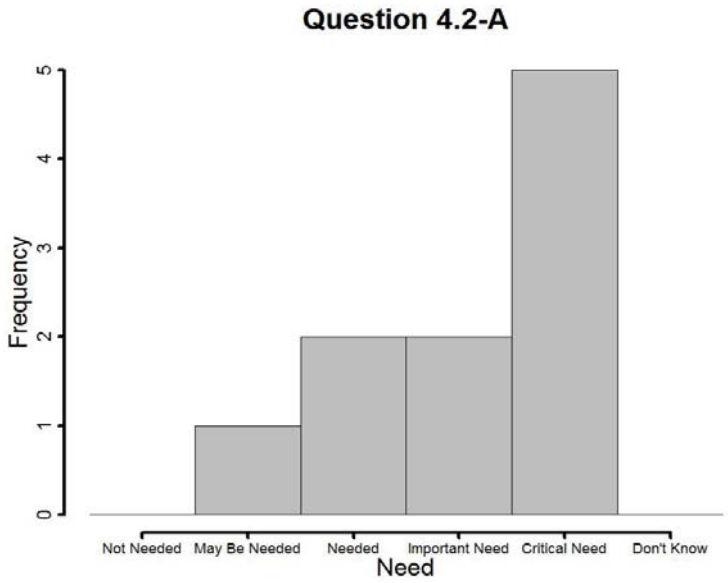
- *Current monitoring program is not designed to evaluate habitat restoration projects. Population response may result from overall habitat restoration, but may be influenced by other management actions.*

- *Depends on the expected scope of restoration. For example, if restoration efforts are expected to increase reach-wide abundances, then population monitoring as currently constituted provides reach-wide estimates of abundance. If a specific restoration site is expected to increase abundance only at the site, then sampling should occur at that site.*

4. Evaluates species response to management actions, such as:

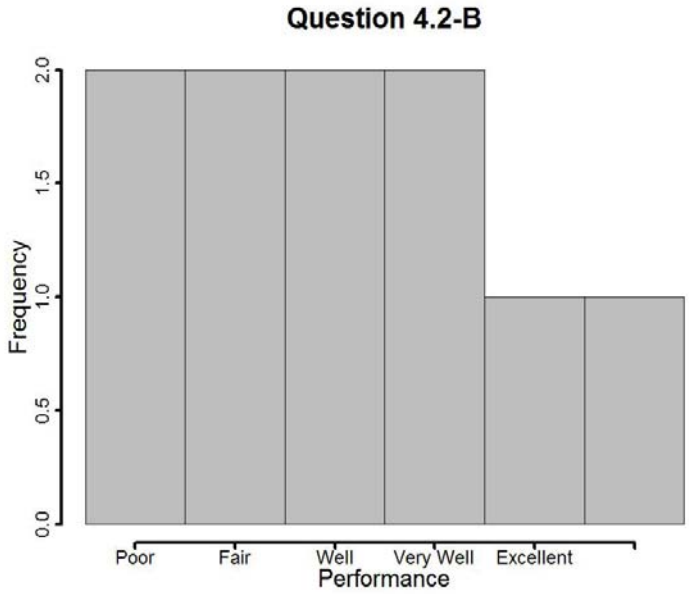
4.2. Modified spawning flows

A) Level of importance



Majority indicates important to critical need.

B) How well current monitoring program addresses this need



Range of responses shows uncertainty or unknown.

Question 4.2 Comments provided as written (anonymous):

- *One of the strongest correlations identified through the PVA process was between population monitoring data for the October census and the correlation with spring spawning flows.*

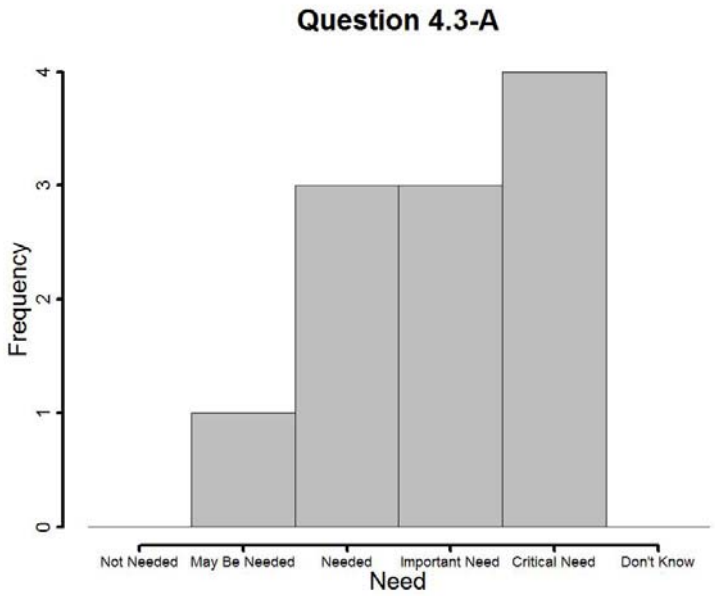
- *The CPUE data are one consideration for the development of recruitment flow management actions. Focused studies on silvery minnow spawning and nursery areas provides finer resolution data for spawning flow criteria.*

- *Addresses post-modified flow abundance and provides insight into recruitment.*

4. Evaluates species response to management actions, such as:

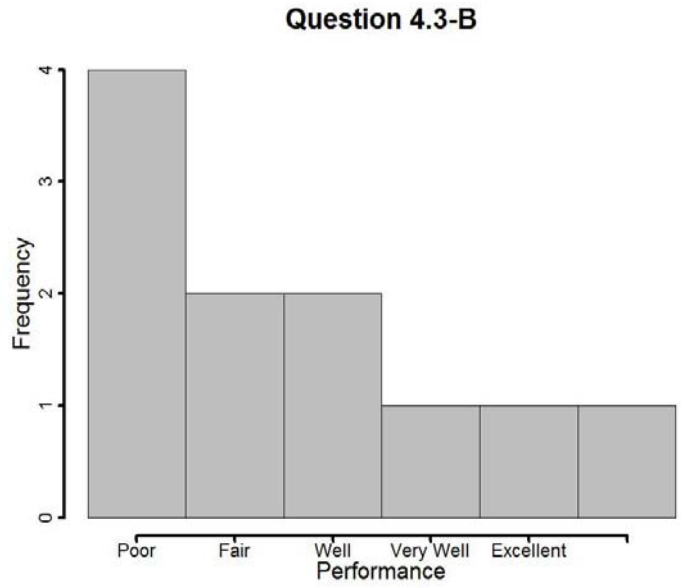
4.3. Summer/fall/winter operations

A) Level of importance



Majority believes this is a need to critical need.

B) How well current monitoring program addresses this need



Range of responses indicates uncertainty or unknown.

Question 4.3 Comments provided as written (anonymous):

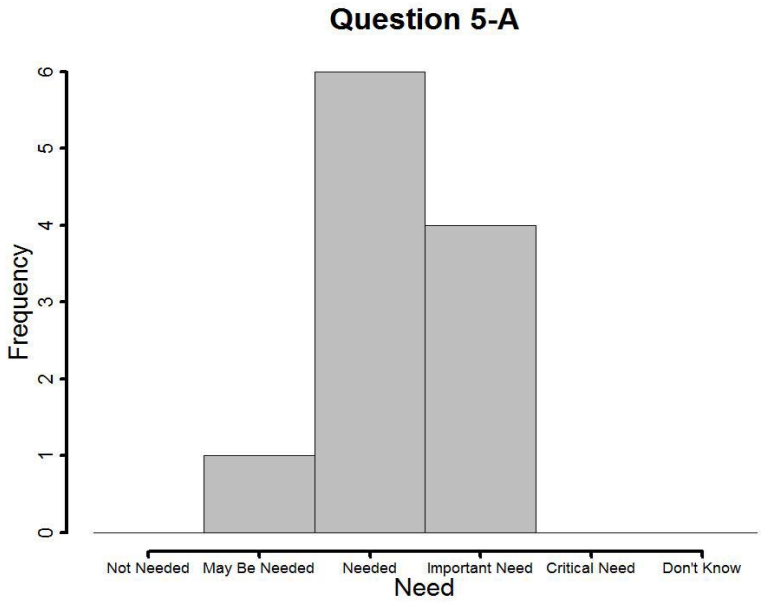
- *Another correlation informed by the population data is between summer and fall operations and October census data for the population. The population monitoring program also allows for assessment of trends during winter months (both within a given year and across years).*

- *CP should consider allowing habitat restoration projects to be constructed during the low to no flow periods in the summer to reduce costs, reduce construction time frame, and better construct features in the dry.*

- *Not applicable to USACE water operations. There is currently no standardized fish population monitoring on the Rio Chama, or the Cochiti Reach on the Rio Grande.*

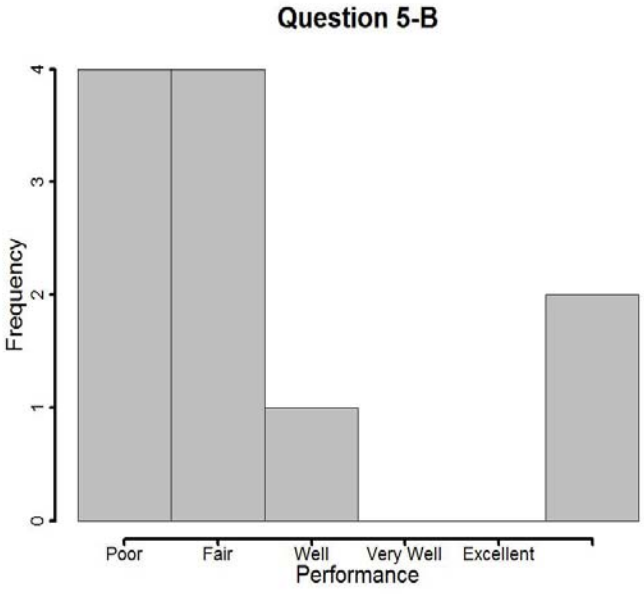
5. Refines understanding of species development and behavior.

A) Level of importance



Majority indicates needed (perhaps not through this monitoring program?).

B) How well current monitoring program addresses this need



Majority indicates poor to fair or unknown.

Question 5 Comments provided as written (anonymous):

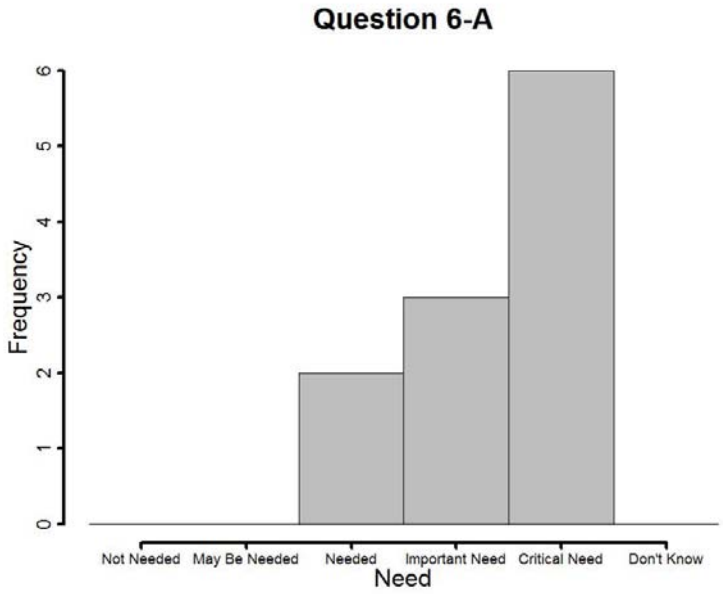
- *To refine our understanding of species development, specific scientific studies are needed rather than expecting a broad-scale population monitoring program to fulfill this need. This information is not normally obtained through population-level monitoring; research and monitoring are two separate objectives. Our baseline monitoring program should be geared toward long term population trends only and more specific information needs should be met through short term adaptive management assessments. The fish length data obtained from monthly population monitoring does contribute, however, to our understanding of minnow development during the summer and fall (for Age-0, young of year), as well as the overall composition of age-classes in the population. However, a population monitoring program is not a behavioral study, nor a specific species development study. To do address those needs correctly, specific scientific research studies are required. Many of those studies have been conducted and some were funded by the Program (e.g., age and growth, minnow egg and larval development, fecundity, spawning behavior studies).*

- *This requires a different study design from population monitoring.*

- *This is not a stated goal of population monitoring.*

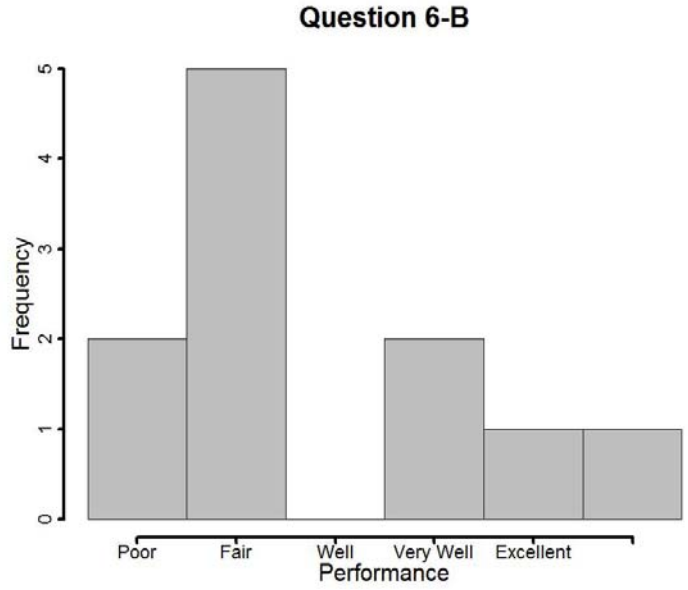
6. Evaluates progress toward species recovery.

A) Level of importance



Majority sees this as an important to critical need.

B) How well current monitoring program addresses this need



Majority indicates poor to fair.

Question 6 Comments provided as written (anonymous):

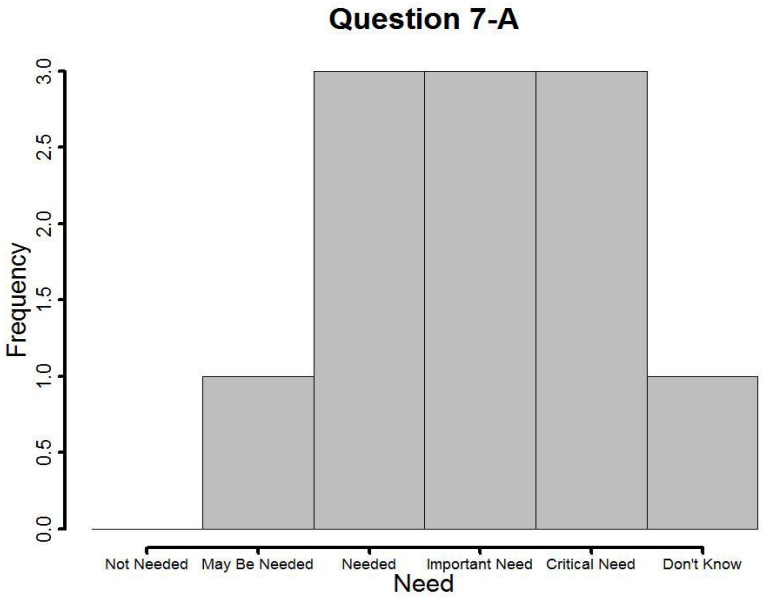
- *This is a critical need; however, the Program or RIP would need to identify how progress toward recovery will be evaluated. Then the use of data from the population monitoring program can be assessed for how well it meets that evaluation need. The current monitoring does track the silvery minnow with a common, scientifically accepted measure for fish population assessment (CPUE). If the Program or RIP determines that additional monitoring is needed to evaluate progress toward recovery, all agencies should agree to this within the Program, including the USFWS, which has the responsibility for determining recovery criteria.*

- *Current recovery criteria have little documentation for the target values. This may be addressed by revisions to the monitoring program or the recovery criteria.*

- *Disagreement about recovery criteria precludes answering this question; however, population monitoring is a critical piece of information to assess species status.*

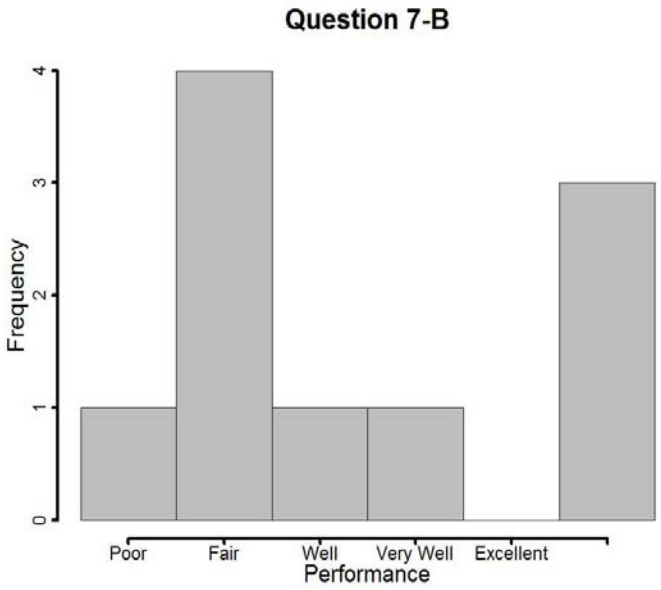
7. Evaluates sufficient progress.

A) Level of importance



Range of responses indicates uncertainty but needed.

B) How well current monitoring program addresses this need



Wide range of responses indicates uncertainty and unknowns.

Question 7 Comments provided as written (anonymous):

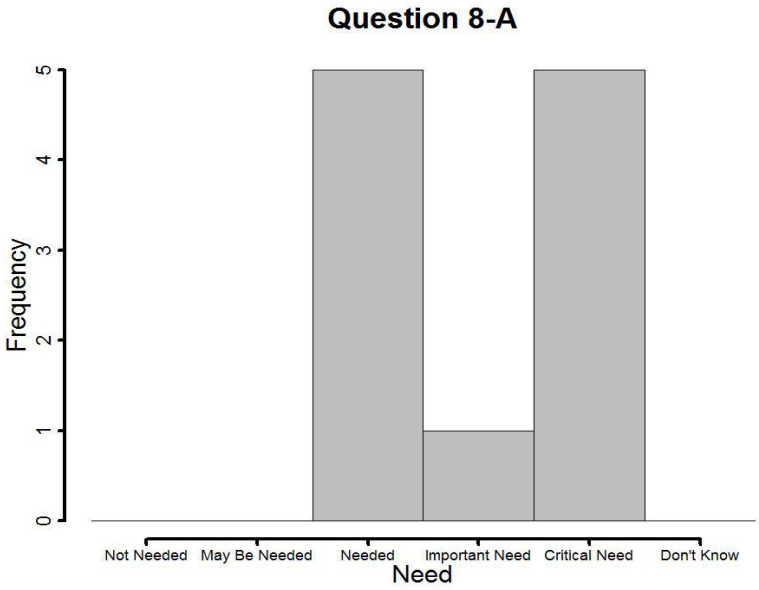
- *This is a critical need; however, the Program or RIP would need to identify how progress toward recovery will be evaluated. Then the use of data from the population monitoring program can be assessed for how well it meets that evaluation need. The current monitoring does track the silvery minnow with a common, scientifically accepted measure for fish population assessment (CPUE). If the Program or RIP determines that additional monitoring is needed to evaluate progress toward recovery, all agencies should agree to this within the Program, including the USFWS, which has the responsibility for determining recovery criteria.*

- *Progress criteria have little documentation for the target values. This may be addressed by revisions to the monitoring program or the progress criteria. See response below (8).*

- *I don't understand this question.*

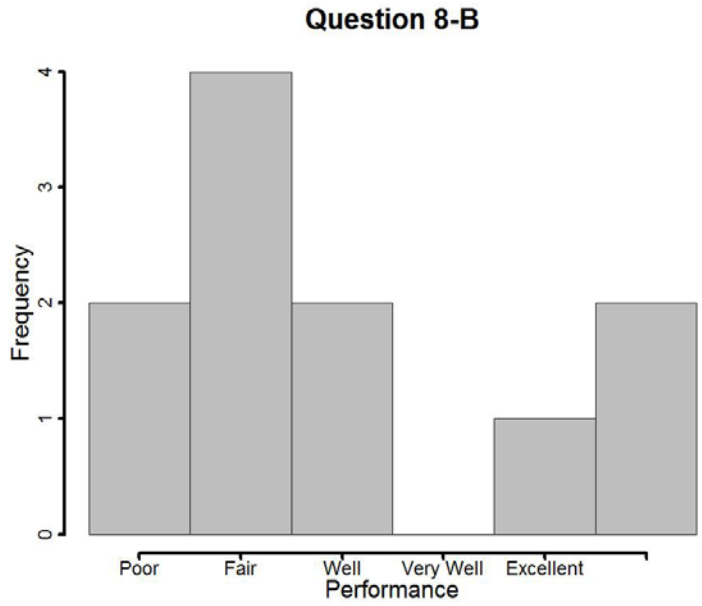
8. Assesses population viability and self-sustainability.

A) Level of importance



Needed to critical need.

B) How well current monitoring program addresses this need



Wide range of responses indicates uncertainty and unknowns.

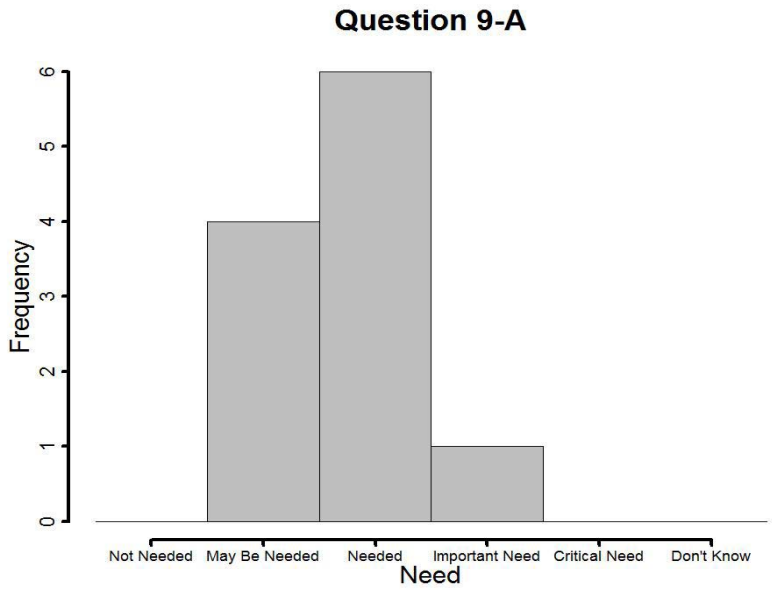
Question 8 Comments provided as written (anonymous):

- *This is a long-term need. The life history of this species (short-lived and fluctuating abundance, or "r-selected") makes determinations of population viability difficult, as was brought forward during the PVA process. Long-term trend data that are provided through the population monitoring program do provide the big picture of overall trends in abundance over time, which can provide insight into the viability and self-sustainability of the population. Specifically how that viability is evaluated requires more definition and discussion - e.g., is it a multi-year average that needs to be above a certain threshold, is it the lambda value (i.e., positive increase in abundance yearly), etc.? There is current guidance in the USFWS' recovery plan, and we expect this will be revised over time with improved understanding of the species and through adaptive management.*

- *The population data appear to be over-dispersed (lots of zeros). The CPUE data have been used in population viability analyses (PVA). PVA modeling may be useful for developing useful progress criteria.*

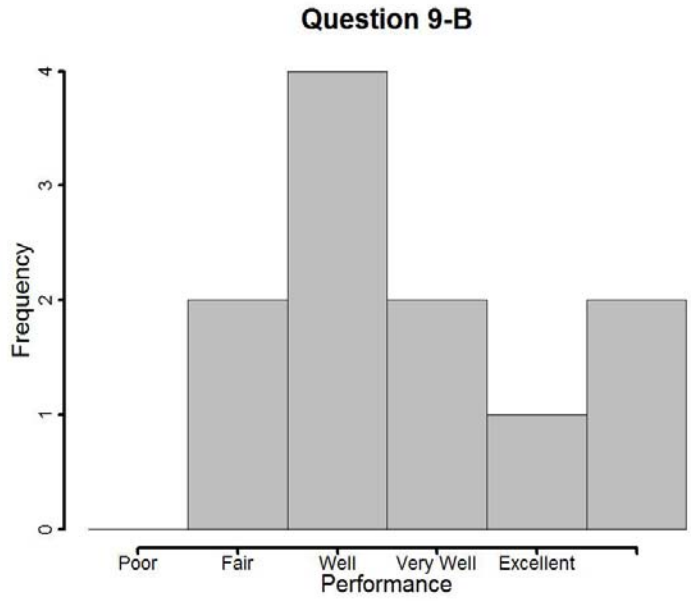
9. Tracks trends and abundances of other fish species.

A) Level of importance



Needed, maybe?

B) How well current monitoring program addresses this need



Range of responses indicates uncertainty and unknowns.

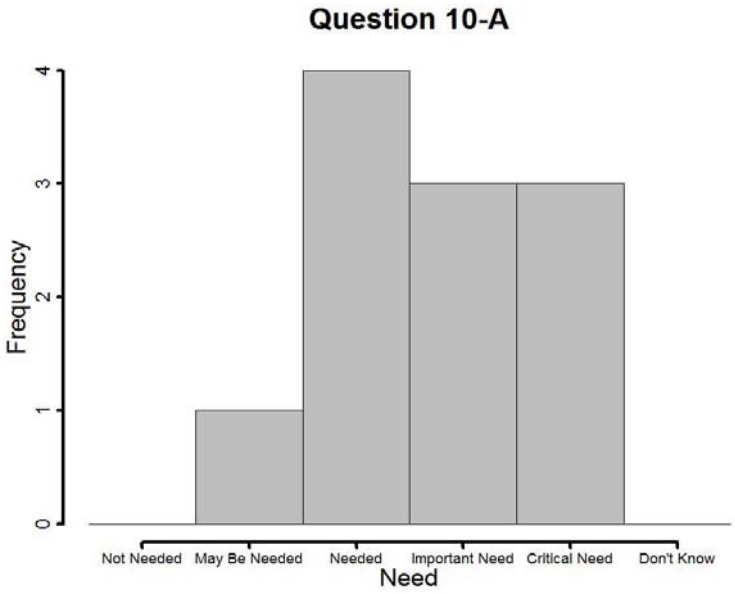
Question 9 Comments provided as written (anonymous):

- *The current population monitoring program does collect concurrent data on the broader fish community - i.e., what other fish species are also found and their abundance at each monitoring site. The annual report for population monitoring devotes an entire section to the MRG fish community. These data are useful for examining trends of competitor and predator fish species that may impact the minnow population, as well as evaluating the risk of upstream expansion of those species (e.g., fish passage).*

- *Tracking multiple fish species may inform the program about important ecological relationships.*

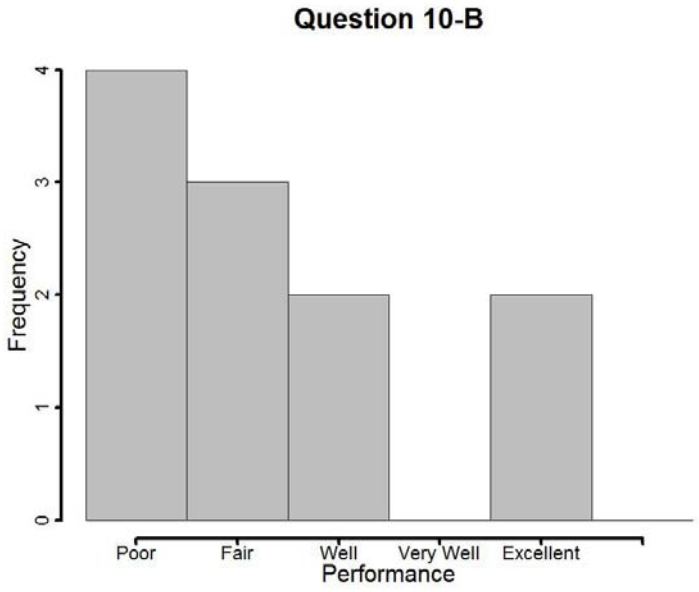
10. Provides high level of precision and accuracy for the cost.

A) Level of importance



Needed to critical need.

B) How well current monitoring program addresses this need



Range of responses indicates uncertainty, mostly poor to well.

Question 10 Comments provided as written (anonymous):

- *The current population monitoring program is conducted at fairly low cost for the type of data that are provided and the importance of those data. The current population monitoring program provides a reasonable level of precision and accuracy for the scope and cost. More thorough monitoring efforts could be examined, however many suggestions in the past have been at high cost with little anticipated benefit over the current program. Nonetheless, it is always valuable to re-examine and ensure the population monitoring effort is meeting the Program's needs.*

- *Not sure how to answer this question because my answer depends on the metric being measured. Assume you are asking about metric 2.*

- *Recognize the trade-off between precision & accuracy with cost. This is an important concept that limits the sufficient progress and recovery criteria. Detecting a 10% population change is considerably more expensive than detecting a 50-100% change. Successful recovery will depend on management actions that have large positive effects on silvery minnow populations.*

Summary and Conclusion

In general, the results of the questionnaire indicate that the EC has a number of expectations for the Collaborative Program's fish monitoring program. Whether these are obtainable expectations was not explored in this questionnaire, but could be an important topic of discussion during the first Population Monitoring Workshop. The results of the survey also indicated that, in many cases, the EC provided a wide range of responses on whether the current monitoring program addresses those needs. These responses seem to indicate that the EC as a whole was much less certain about the current monitoring program and what it does than what they believe is important for a monitoring program to provide. These issues also should be explored during the Workshop. Some attention should be given to this report during the Workshop to ensure that scientists engaged are aware of the ultimate purpose for monitoring the Rio Grande silvery minnow for the Collaborative Program.

Additional comments were made at the end of the survey. The majority of these comments indicated that (1) the current Program needs to be evaluated from a technical, cost, and managerial viewpoint to look at any improvements that could be made, (2) additional monitoring conducted concurrently with the existing monitoring program could be beneficial, and (3) a workshop is needed and can be used to address the stated needs.

Final Comments provided as written (anonymous):

- *The program must evaluate current monitoring from a technical, cost and managerial viewpoint. Almost two decades of the current process should be investigated from a technical and managerial viewpoint. This is representative of good science and management. It should not take multiple years to do this. How the fish are monitored is the backbone of successful recovery and if this can be improved, needs additional sampling, needs a different sampling design, more locations or different analytical methods should be determined. Workshops are common and effective ways to do this. A beginning workshop to start addressing the monitoring program is an important step and the EC should step up.*

- *Recommend input from independent biometrician(s) with expertise on small-bodied, short-lived fish species in ephemeral western river systems, in conjunction with the establishment of an Independent Science Panel, to examine the appropriateness of*

randomizing aspects of monitoring and/or evaluating the number of sampling events we do at our current 20 sites. As mentioned above, the PVA process identified the population monitoring, long-term trend data as some of the most valuable robust data on the species that the Program currently has. However, it is always valuable to re-examine and ensure that it meets the Program's needs and is being used appropriately. To maintain the comparability of the long-term dataset with any future adjustments, any changes that are considered (e.g., additional sites, new methods) would need to be conducted concurrently with the existing monitoring protocol to preserve the long-term dataset and allow us to translate between the current and the new approach. For example, this was done for several years with the RGSM Population Estimation Program. The current population monitoring program provides a long term data set for estimates on the RGSM population and the fish community in the MRG. This program should be continued; adding additional monitoring sites to the current 20 sites would be beneficial and would help address concerns regarding site selection for the population monitoring program. It would also provide additional data and geographic coverage. The population monitoring program (or any monitoring) needs to be cost-effective and designed to provide the information needed for management decisions. That requires awareness (and documentation) of what questions management needs answered. Implementing the RGSM Population Estimation Program again would provide more robust information on species status and specific mesohabitat use information.

- *This workshop is badly needed and has been in planning for too long. The lack of sufficient progress in getting a reasonably simple workshop organized does not reflect well on agencies trying to monitor sufficient progress on the health of endangered species.*

- *The program is not designed to accomplish many of these tasks. And many of them are very costly.*

- *The population monitoring is crucial to recovery planning but the tension associated with providing accurate estimates that could indicate declining numbers/viability make it hard for some Committee members to accept. Whatever approach is adopted will have to be very robust. It may require that several complimentary approaches may be needed.*

Attachment 1

Blank Survey

Executive Committee Survey of MRGESCP Fish Population Monitoring Needs

May 15, 2014

To: Middle Rio Grande Endangered Species Collaborative Program Executive Committee
From: Population Monitoring Workshop Planning Committee

The Population Monitoring Workshop Planning Committee requests that you please take a few minutes to:
A) Indicate the level of importance (1-6) for each of the identified "needs" below of a RGSM monitoring program

B) Evaluate (to the best of your knowledge) how well the MRGESCP's current monitoring program addresses each identified need (1-6).

Please expand on your answers if you wish and indicate additional needs that you believe should be considered. The input you provide will help to guide the workshop to ensure we address EC needs.

Name: _____
Organization: _____

	A. Level of Importance for Each Need						B. How Well Current Monitoring Program Addresses Need					
	Not Needed	May Be Needed	Needed	Important Need	Critical Need	Don't Know	Poor	Fair	Well	Very Well	Excellent	Don't Know
	1	2	3	4	5	6	1	2	3	4	5	6
1. Provides estimates of long-term population trends (increase/decrease). Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Provides estimates of population abundance over time and area. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Evaluates species response to variations in natural conditions. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Evaluates species response to management actions, such as:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Habitat restoration Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Modified spawning flows Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Summer/fall/winter operations Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(continued)

Executive Committee Survey of MRGESCP Fish Population Monitoring Needs

	A. Level of Importance for Each Need						B. How Well Current Monitoring Program Addresses Need					
	Not Needed	May Be Needed	Needed	Important Need	Critical Need	Don't Know	Poor	Fair	Well	Very Well	Excellent	Don't Know
	1	2	3	4	5	6	1	2	3	4	5	6
5. Refines understanding of species development and behavior. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Evaluates progress toward species recovery. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Evaluates sufficient progress. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. Assesses population viability and self-sustainability. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
9. Tracks trends and abundances of other fish species. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. Provides high level of precision and accuracy for the cost. Comments:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Additional Comments/Suggestions:

Memorandum

October 6, 2018

To: Eric Gonzales, Bureau of Reclamation

From: Rich Valdez, SWCA

Subject: Review of Parameters for Hydrological Objectives (HBOs)

The Hydrological Objectives (HBOs) are numerical criteria for genetic diversity and population viability of the Rio Grande Silvery Minnow that are used in the 2016 Biological Opinion (BiOp) to help inform decisions about water management in the Middle Rio Grande.

The numerical criteria are 0.3 fish/100 m^2 for genetic diversity and 1.0 fish/100 m^2 for population self-sustainability. These criteria are used in the Incidental Take Statement (ITS) of the BiOp as criteria for incidental take (see page 107 of 2016 BiOp), and to determine predicted river flows necessary for maintaining equivalent levels of fish density.

Derivation of criteria for the HBOs is described on pages 18-20 of Appendix A of the BiOp. The methodology for deriving the criteria were adopted from the 2002 Colorado Pikeminnow Recovery Goals (Service 2002, as cited on page 19 of Appendix A), that I assisted the Service in developing. The Recovery Goals were developed using parameters specifically selected for the Colorado Pikeminnow in conference with several geneticists and conservation biologists, and may not apply to the Rio Grande Silvery Minnow.

I recommend that Reclamation evaluate the parameters used in the HBOs with the following considerations:

1. The Ne of 5,000 for silvery minnow is attributed to Alo and Turner (2016), who used an Nev. The genetic variable Ne describes genetic effective population size, or the minimum number of individuals in a population necessary to minimize genetic inbreeding. The variable Nev is the variance effective size that describes the variability of allele frequencies over time. The methodology described in the 2002 Recovery Goals uses Ne and not Nev. These two genetic variables should be evaluated to determine the most appropriate number for the silvery minnow.

2. An Ne/Ng of 0.30 is used for the HBOs, as the proportion of adults contributing genes to the next generation. This is the same Ne/Ng (0.30) as used for the Colorado Pikeminnow, which has a different life history than the silvery minnow. The Ne/Ng should be evaluated for the silvery minnow.

3. The derived Ng of 16,667 (actually, the adjusted Ne) is divided into an estimate of average area of the river, from Angostura Dam to the Elephant Butte inflow, from Bui (2016). This results in a CPUE of 0.3 fish/100 m^2. There are substantial assumptions

behind this step, including the accuracy of the total river area at various flow stages, as well as the assumed even distribution of silvery minnow in the river channel. These assumption probably contains substantial variability and perhaps error, given that flow variation of the MRG is considerable and that the silvery minnow is distributed in a clumped fashion. The variability of the criteria 0.3 should be included in the HBOs.

4. The computation of a buffered MVP (minimum viable population) uses the adjusted Ne (16,667) with the average annual mortality rate added to compensate for inter-annual loss of individuals. Appendix A uses an average annual mortality rate of 0.46, which I am not able to find in Goodman (2012). Goodman (2010) estimated survival from intra-cohort regression of Nt+1/Nt and derived an annual survival rate of 0.058 for 2007 and similar estimates for other years. The mortality rate (1 - 0.058 = 0.942) is quite different from 0.46 used to develop the buffered MVP. The mortality rate used to buffer the MVP should be evaluated for the silvery minnow.

5. When the buffered MVP is used to derive density of 1.0 fish/100 m^2, different numbers of fish are used in the calculation (24,404) than the stated average (24,334), and very different numbers of river area are used for the MVP (49,202,205 m^2) than for genetic viability Ne (25,561.1 m^2). The numbers of fish and the area of river need to be reconciled and further clarified.

The HBOs as used in the 2016 BiOp affect many stakeholders, and a scientifically sound and supported process for deriving the criteria is important. I recommend an external scientific peer review of the parameters used to derive the criteria of the HBOs by a panel of population ecologists and geneticists. These criteria are important for complying with the 2016 BiOp and for gauging genetic diversity and population viability used to evaluate results of flow-related modeling for the River Integrated Operations (RIO), an essential element of the BiOp for the Bureau of Reclamation.

Rich

DRAFT
Population Monitoring Work Group (PMW) Charge

Overall Purpose

The Population Monitoring Work Group was established by the Middle Rio Grande Endangered Species Collaborative Program (MRGESCP) Executive Committee (EC) to provide technical review, focused assessment and provides recommendations related to fish populations impacted by water management and river dynamics.

In the original charge to the PMW, the EC tasked the group with evaluating and recommending refinement of the Middle Rio Grande Fish Population Monitoring Plan following the completion of the CPUE Workshop.

The goal is to recommend and support a Rio Grande Silvery Minnow (RGSM) Monitoring Plan that integrates the historic methodologies and locations with additional refinements, as needed, to address the needs of the Biological Opinions (BOs) and the evolving Middle Rio Grande (MRG) Adaptive Management Program.

The recommended RGSM Monitoring Plan will detail the methods of fish monitoring for the mutual benefit of all stakeholders who may conduct fish monitoring. The MRGESCP Adaptive Management Committee will recommend a structured RGSM Monitoring Plan to the EC for consideration and adoption that meets the needs of the BOs, the agencies and stakeholders responsible for management of the water and resources in the MRG.

Fiscal Year 2018 and 2019 Proposed Focus

Overview: In 2018 and 2019 the PMW will initiate the process of moving their activities into the MRGESCP Adaptive Management program. The logic in implementing a phased integration program is to provide support to the PMW to continue its review and assessment work while migrating the program functions into the overall adaptive management program. Specific activities over the next two years will focus on continued refinement and assessment of the previous workshop recommendations while building on the technical and information needs of the BO(s).

In 2018, the PMW will evaluate the recommendations from the Noon et al. and Hubert et al. reports, review the BO needs, and provide recommendations to the EC regarding implementing a MRG Fish Monitoring Plan.

Tasks and Management/Science Implications

1) Finish integration and prioritizing of the Noon and Hubert peer review recommendation and will focus on the following key areas:
   - Progress to date on addressing the Hubert et al. recommendations
   - Identify any overlap with recommendations from the Noon et al. report
   - Priorities articulated by the EC

- Identification of overlap, inconsistencies, and gaps
- Prioritize the assessments with supporting logic

2) Evaluate the current RGSM Fish Monitoring Plan.

3) Recommend and direct prioritized data analyses based on the integrated Noon and Hubert peer review recommendations to inform and aid refinement and developments to the Fish Monitoring Plan

   This task has the following parts:
   a. Hiring external consultant(s) with experience with sampling design, statistics, and fish population modeling to assist with data analyses where necessary and supported.
   b. Agree on data analyses to conduct as a work group and assign tasks to individuals or small teams.
   c. Review analyses and refine analyses as needed

4) Identify, categorize and monitor additional datasets that could support the Fish Monitoring Plan

Additional data sources may be identified that could inform and support the RGSM Fish Monitoring Plan. These datasets should be identified and categorized with metadata details of:

- Who owns the data
- Over what time period was the data collected
- In what location(s)
- Using what collection methods
- Physical location of the data
- Data custodian

5) Identify additional data gaps and needs for concurrent sampling during fish monitoring to support other studies including but not limited to augmentation, fish movement, drying, genetics, adaptive management. These data will be used to support other studies and research issues associated with the MRGESCP Adaptive Management Program.

6) Develop a transition plan for work not completed by the Work Group in 2018 to be carried over into 2019. These work topics will be integrated into the initial Triennial Study Plan for the MRGESCP Adaptive Management Program.

The EC has tasked all work groups and committees to detail the aspects of its work that were not completed in 2018, and recommendations for further work in a transition plan, to present back to the EC at the end of 2018.

Deliverables

1. final list of the consolidated list of the Hubert and Noon peer review recommendations with the following supporting data:
    a. Priority ranking
    b. Status on actions related to each recommendation
    c. Point person(s) for action
    d. Proposed timeline for completion of task
    e. Relationship of the task to other tasks (is there a sequence to be followed)

The Population Monitoring Work Group will identify and address any overlap between the Hubert and Noon recommendations.

The Population Monitoring Work Group will provide a prioritized spreadsheet to the Adaptive Management Committee and the Science and Habitat Restoration Workgroup for consideration in the development of the Triennial and annual study plans.

2. The Population Monitoring Work Group will coordinate with statisticians at WEST to ensure that the work tasks associated with Charles Yackulic provide support to addressing RGSM population monitoring needs. Additional statistical support will be coordinated with the Adaptive Management Committee and where appropriate work will be assigned to either group members of science and statistical work staff at WEST.

3. Development of a spreadsheet which identifies RGSM datasets with the appropriate metadata to allow tracking, identification of support, and potential for use by other studies (ex. Physical habitat).

   The Population Monitoring Work Group will utilize the combined Hubert and Noon panel recommendations to guide prioritized proposals for fiscal year 2019. Studies should be nested and sequenced to build on collected data and analysis to support meeting the information needs of the Biological Opinions and resource management needs.

4. At a minimum quarterly meetings of the Population Monitoring Work Group

5. Assessment of the existing components of the RGSM Monitoring Programs in respect to:
    a. Objectives
    b. Support
    c. Products developed
    d. Location of data collection sites
    e. Physical location of the data

Timeline

	Task:	Delivery Date:
1.	Evaluate current RGSM Fish Monitoring Plan	Sept. 2018
2.	Finish Hubert et al. prioritization and integration with the Noon et al. recommendations. Provide descriptions of overlaps and a prioritized recommendation for sequencing of studies over the next three fiscal years. • Hubert recommendations • Integrated Noon and Hubert Recommendations • Three year prioritized study list to both the Adaptive Management Committee and Science Work Group	August 2018 September 2018 October 2018
3.	Provide Charles Yackulic background data a. Identify desired analyses b. Identify any additional statistical support c. Evaluate preliminary analyses d. Identify potential additional assessments	August 2018 September 2018 September 2018 November 2018 December 2018
4.	Create RGSM population dataset spreadsheet	December 2018
5.	Link Hubert, Noon and Yackulic work products to the Biological Opinion(s) and agency actions	December 2018

Additional Objectives

In addition to the tasks listed above, the following objectives for the Population Monitoring Work Group were approved and directed by the EC in 2015:

- Evaluate and refine sampling design, including statistical properties of spatial aspects (longitudinal locations of sample sites, habitats in which samples are taken) and temporal aspects (frequency of sampling, times of year when samples are taken).
- Evaluate and refine sampling methods, including gear types, sampling strategies, etc.
- Evaluate and refine data collection protocols, including types of data collected, recording methods, quality control, electronic storage, and data custody.
- Evaluate and refine data analyses.
- Evaluate how PVA may assist in refining monitoring.

Some of these objectives may be addressed in part or full in the listed tasks. Any that are not fully addressed by the end of the calendar year 2018 will be detailed in the transition plan to the EC as additional work that still needs to be completed and will be folded into the larger Adaptive Management program.

Population Monitoring Work Group Members

Name	Organization
Thomas Archdeacon	U.S. Fish & Wildlife Service
Jennifer Bachus	U.S. Bureau of Reclamation
Rick Billings	Albuquerque Bernalillo County Water Utility Authority
David Campbell	U.S. Fish & Wildlife Service
Jason Davis	U.S. Fish & Wildlife Service
Ann Demint	U.S. Bureau of Reclamation
Julie Dickey	Western Ecosystems Technology, Inc.
David Gensler	Middle Rio Grande Conservancy District
Lynette Giesen	U.S. Army Corps of Engineers
Eric Gonzales	U.S. Bureau of Reclamation
Grace Haggerty	New Mexico Interstate Stream Commission
Brian Hobbs	U.S. Bureau of Reclamation
Debbie Lee	Western Ecosystems Technology, Inc.
Mike Marcus	Assessment Payers Association of the MRGCD
Anne Marken	Middle Rio Grande Conservancy District
Michael Porter	U.S. Army Corps of Engineers
Ashlee Rudolph	U.S. Bureau of Reclamation
Dale Strickland	Western Ecosystems Technology, Inc.
Jared Studyvin	Western Ecosystems Technology, Inc.
Ashley Tanner	Western Ecosystems Technology, Inc.
Rich Valdez	SWCA Environmental Consultants
Dave Wegner	Western Ecosystems Technology, Inc.
Mathew Wunder	New Mexico Department of Game and Fish