Population Monitoring Work Group Meeting

March 25, 2020

Meeting Materials:

Agenda

Minutes

Draft MRGESCP PMWG 2020 Work Plan [read-ahead, draft]

Draft Assimilation and Synthesis of Information and Data Related to the RGSM [read-ahead, draft]

Draft 1 Consolidated Recommendations of Two Expert Science Panels on Monitoring of the RGSM [read-ahead, draft]

Next Steps in Modeling Process - Ideas From Dr. Yackulic Memo [read-ahead]

Follow-Up Questions on Integrated Model for RGSM [read-ahead]

Follow-Up Questions on Integrated Model for RGSM - Responses From Charles Yackulic [read-ahead]

Revised MRGESCP PMWG 2020 Work Plan [read-ahead]

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Population Monitoring Work Group (PMWG)
March 25, 2020
1:00 PM – 5:00 PM

Zoom Information:
https://west-inc.zoom.us/j/8983593120
Call-In: +1-669-900-6833
Meeting ID: 898-359-3120

Meeting Agenda

1:00 – 1:15	**Welcome, Introductions, Agenda Review, Meeting Notes** ➢ **Decision:** Approval of March 25, 2020 meeting agenda ➢ **Decision:** Approval of February 26, 2020 PMWG meeting minutes Read aheads: ☐ March 25, 2020 meeting agenda ☐ February 26, 2020 meeting minutes	*PMWG Co-chairs*
1:15 – 1:45	**Program Structure Planning** • Functions and tasks of the PMWG • Discussion how those functions and tasks will fit under new Program structure	*Facilitated discussion*
1:45 – 2:15	**Review of Executive Summary Template** Read ahead: ☐ Assimilation and Synthesis of Information and Data Related to the Rio Grande Silvery Minnow	*Kevin McDonald* *Catherine Murphy*
2:15 – 2:30	**Break**	
2:30 – 3:00	**Steps Forward with Integrated Model** • Follow-up Questions on Model Framework • Questions of Model Utility Read aheads: ☐ Follow-up Questions on Integrated Model for Rio Grande Silvery Minnow ☐ Memo: Next Steps in Modeling Process – Ideas from Dr. Yackulic	*Rich Valdez*

3:00 – 4:15	**Consolidation of Science Panel Recommendations** • Concurrence on Research Topics • Prioritization Process • Assignments to Address Research Topics Read ahead: ☐ Consolidated Recommendations of Two Expert Science Panels on Monitoring of the Rio Grande Silvery Minnow	*Rich Valdez, Mike Marcus* *Catherine Murphy*
4:15 – 4:45	**2020 Work Plan** Read aheads: ☐ Population Monitoring Work Group 2020 Work Plan ☐ Revised Population Monitoring Work Group 2020 Work Plan	*Joel Lusk*
4:45 – 5:00	**Wrap-Up** • Announcement • Action Items • Next Meeting	*PMWG Co-chairs*
5:00	**Adjourn**	

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Population Monitoring Work Group (PMWG)
Meeting Minutes

March 25, 2020 1:00 – 4:00 PM
Location: Zoom Meeting

Decisions:

- ✓ Approval of the March 25, 2020 meeting agenda, with the following amendment:
  - Move the Steps Forward with Integrated Model discussion to first on the agenda
- ✓ Approval of the February 26, 2020 meeting minutes

Action Items:

WHO	WHAT	BY WHEN
Program Support Team (PST)	Re-send invitations to the Zotero library	March 27, 2020
PST	Send the 2003 Remshart and Tashjian report to Charles Yackulic	March 27, 2020
Charles Y.	Share results of evaluating capture probability based on seine type	March 27, 2020
PST	Convert the table of topics into a spreadsheet with additional columns for tracking	March 27, 2020
Mike Marcus	Draft language on how priority numbers have evolved for the panel recommendations	April 1, 2020
Eric Gonzales & Michael Porter & PMWG	Send Mike M. the scopes of work for the ASIR/Utah State University mesohabitat study, the U.S. Geological Survey evaluation of mesohabitat data, and any other data or literature to be included in the mesohabitat executive summary	April 1, 2020
Charles Y. & Shay Howlin	Determine if the 1996 FLO data should be digitized	April 1, 2020
PMWG	Send any comments on Charles Y.'s proposed next steps on the integrated model to Rich Valdez (cc Debbie Lee and Charles Y.)	April 3, 2020
PMWG	Send any additional questions or comments for the integrated model to Rich V. (cc Debbie L. and Charles Y.)	April 3, 2020
PST	Revise past PMWG meeting minutes to identify the notetaker	April 3, 2020
PST	Populate table of topics with citations from existing literature reviews and bibliographies	April 3, 2020
PMWG	Sign up on table of topic areas to be the initiating author for a topic, provide literature on the topic, or review the draft executive summary	April 3, 2020

PST	Coordinate with co-chairs of Genetics group on if/when the group should reconvene	April 7, 2020
Mike M.	Complete an executive summary for consolidation of mesohabitats for monitoring Rio Grande silvery minnow using the template	April 20, 2020
Joel Lusk, Rich V., & PST	Revise PMWG work plan to have more details on subtasks and deadlines	April 20, 2020

- Next Meeting: April 28, 2020, 1:00 – 4:00 PM

Welcome, Introductions, Agenda Review, and Meeting Notes

The PMWG co-chairs, Rich Valdez, SWCA, and Joel Lusk, U.S. Bureau of Reclamation, opened the meeting and led introductions. They reviewed the agenda and the minutes from the February 2020 meeting.

- **Decision**: Approval of March 25, 2020 PMWG meeting agenda with amendments
- **Decision**: Approval of February 26, 2020 PMWG meeting minutes
- **Action Item**: The PST will re-send invitations to the Zotero library
- **Action Item**: The PST will revise past PMWG meeting minutes to identify the notetaker

Steps Forward with Integrated Model

Rich V. noted that since the last PMWG meeting, Charles Yackulic, U.S. Geological Survey, provided some thoughts on next steps for the integrated stock assessment model, which are shared in a memo. Charles Y. proposed two next steps: (1) consider revisions to the model inputs, and (2) develop future modeling scenarios.

The group discussed the proposed next steps. During the discussion, the following points were made:

RGSM Physical Characteristics

- Caldwell et al. found a significant relationship between the size of RGSM and the average temperature across a two year study.

- **Action Item**: PST share the Caldwell et al. study with Charles Y.

Data Availability

- The FLO 1996 data are in hardcopy data sheets. These include depth, velocity, and mesohabitat type from two sets of studies: eight transects during the winter of 1996 release, and twenty-six transects during spawning releases in 1996. Shay Howlin, PST, estimated it would take approximately fifteen hours to enter the data.
- Remshardt and Tashjian (2003) did deliberately biased sampling and randomized sampling of habitats, and recorded depth, velocity, and mesohabitat type.
- One PMWG member suggested that Charles Y. be cautious at using salvage data prior to 2003 because those numbers were not as accurate. Another member noted that the data from the years Mike Hatch was doing salvage, 2004-2006, were pretty accurate.
- Thomas Archdeacon, U.S. Fish and Wildlife Service, had provided Charles Y. with salvage data, but the data needs to be converted into a consistent format.

- **Action Item**: Shay H. and Charles Y. determine if the 1996 FLO data should be digitized

- **Action Item**: PST send Charles Y. the Remshart and Tashjian (2003) report

RGSM Population and Survival

- By looking at salvage data, Charles Y. is hoping to get a better estimate on how much habitat is available by reach. Salvage data can give a minimum population estimate for that river section.
- Salvaged fish have a different survival rate from regular fish, and should be temporarily treated differently in the model. There is a paper from Caldwell looking on RGSM survival and stress.

Future Scenarios

The group discussed how to best develop future scenarios which can be inputted into the model. Charles Y. noted that the PMWG may not be the appropriate group to come up with those scenarios, or suggested additional people may need to be brought into the process. One member cautioned against moving too fast on scenarios until there is a better understanding of the model's capabilities. Charles Y. noted that this may be a parallel process, as knowing what the questions the model would be expected to answer would be useful.

The following individuals volunteered to be part of a small group to work on developing scenarios, when the timing is appropriate: Rich V., Michael Porter, Grace Haggerty, Catherine Murphy, Joel L., and Kevin McDonnell.

There is also another effort going on with Tim Walsworth and Phaedra Budy's, Utah State University (USU), reanalysis of the Hydrobiological Objective (HBO). In the HBO, the U.S. Fish & Wildlife Service put forth eight hydrographs that USU is currently analyzing. NM Interstate Stream Commission and Reclamation are working on convening a small group of the modelers together to coordinate efforts. This small technical group would include Tim Walsworth, Phaedra Budy, Charles Y., Kevin M., Shay H., Rich V., and Joel L.

- **Action Item**: PMWG members send any comments on Charles Y.'s proposed next steps on the integrated model to Rich Valdez (cc Debbie Lee and Charles Y.)

Questions on Model Development

Rich V. had provided Charles Y. with a series of questions related to the model development. Both the questions and the responses were sent out as read-aheads for the meeting. One PMWG member asked about developing a capture-probability based on seine type.

- **Action Item**: Charles Y. will share the results of evaluating capture probability based on seine type
- **Action Item**: PMWG members send any additional questions or comments for the integrated model to Rich V. (cc Debbie L. and Charles Y.)

Program Structure Planning

Debbie L. noted that the Executive Committee had asked each work group to note their functions and think about how those functions could be integrated into the new adaptive management framework being developed. She observed that much of that has been already been laid out in the introduction to the executive summary template.

Catherine M. and Kevin M., Program Support Team, had been tasked at the previous meeting with developing a template for topical executive summaries. The draft template was included with the

meeting read-aheads. The assimilation and synthesis of information was directly applicable to the Program's adaptive management process.

The panel recommendations used to develop the topic areas fell into the following categories: scientific uncertainties, data analysis actions, and modifications to sampling design. In addition to the panel recommendations, uncertainties and testable hypotheses will also be coming from the conceptual ecological models and other processes. The executive summaries were designed to take the recommendations that the PMWG thought were most important and develop a formal internal review process in order to move those forward. Through this process, testable hypotheses will be developed, and will be integrated into the larger Program planning.

One participant noted that the PMWG efforts were unique from others in the Program as it includes monitoring and species status, and that at some point, the different efforts will need to integrate. Catherine M. responded that there will be a hierarchy of models, such as an ecosystem model with life history models underneath that feed into population models. The ultimate goal is to have all the different models inform one another and work together.

Review of Executive Summary Template

The PMWG discussed the draft executive summary template. During the discussion, the following points were made:

- One of the functions of these templates is to be a communication tool. The executive summaries are meant to be in narrative form, with tables as the last resort. That way, the technical experts are translating data and information with minimal technical jargon. The Science and Adaptive Management Committee (SAMC) is the audience for these summaries, and the more the summary authors and contributors can make conclusions, the easier it will be for the SAMC to use the summaries. Tables and figures need to be interpreted.
- The reasoning behind including both uncertainties and hypotheses is because they are not necessarily the same. Uncertainties do not necessarily lead to hypotheses; they could be addressed with data analyses.

➢ **Action Item**: PMWG members send additional comments on the executive summary template to Catherine M. and Kevin M. (cc Rich V. and Debbie L.)
➢ **Action Item**: Mike Marcus will complete an executive summary for consolidation of mesohabitats for monitoring Rio Grande silvery minnow using the template
➢ **Action Item**: Eric Gonzales and Michael Porter send Mike M. the scopes of work for the ASIR/Utah State University mesohabitat study, the U.S. Geological Survey evaluation of mesohabitat data, and any other data or literature to be included in the mesohabitat executive summary

Consolidation of Science Panel Recommendations

Rich V. and Mike M. reviewed the revised document noting the different topic areas, and how those topic areas were developed. In response to a question, Mike M. noted that the priority numbers have changed over time.

➢ **Action Item**: Mike M. will draft language on how priority rankings have evolved for the panel recommendations

The group discussed the table of topics, and the following suggestions were made:

- Revise the header of the first column to "Science Topic"
- Include an identifier for each topic (e.g., numbering)

- Put the table in a spreadsheet with tracking columns

- **Action Item**: The PST will convert the table of topics into a spreadsheet with additional columns for tracking
- **Action Item**: PMWG members will sign up on the table of topic areas to be the initiating author for a topic, provide literature on the topic, or review the draft executive summary
- **Action Item:** The PST will populate the table of topics with citations from existing literature reviews and bibliographies

2020 Work Plan
Joel L. reminded the group that at the last Executive Committee meeting there were questions raised around the PMWG's work plan and the progress of the group. To address those concerns, Joel had rewritten the work plan to incorporate measurable and assignable tasks. During the discussion, members voiced the desire for more detail, noting subtasks and deadlines for each subtask. The following specific suggestions were made:

- Include progress reports to the Executive Committee
- Include a task of developing a synthesis report
- Target two executive summaries to be completed by December 2020, with two others in progress
- Restructure the work plan so that the first task is the integrated stock assessment model, with subtasks to support that

- **Action Item**: The PMWG co-chairs and the PST revise the work plan to have more detail on subtasks and deadlines

Wrap-Up and Adjourn
It was suggested that the Genetics work group may need to reconvene soon.

- **Action Item**: The PMWG will Coordinate with co-chairs of Genetics group on if/when the group should reconvene

The next PMWG meeting will be a virtual meeting on April 28, 2020 from 1-4 PM. The following topics will be on the agenda:

- Revisit the PMWG work plan
- Review of the executive summary example(s) using the template
- Advancing the consolidation of science panel recommendations document
- Updates on integrated stock assessment model

Meeting Participants
Trevor Birt, N.M. Interstate Stream Commission
Lynette Giesen, U.S. Army Corps of Engineers
Eric Gonzales, U.S. Bureau of Reclamation
Grace Haggerty, N.M. Interstate Stream Commission
Mo Hobbs, Albuquerque-Bernalillo County Water Utility Authority
Shay Howlin, Program Support Team
Debbie Lee, Program Support Team
Joel Lusk, U.S. Bureau of Reclamation
Mike Marcus, Assessment Payers Association of the Middle Rio Grande Conservancy District

Anne Marken, Middle Rio Grande Conservancy District
Kevin McDonnell, Program Support Team
Catherine Murphy, Program Support Team
Michael Porter, U.S. Army Corps of Engineers
Rich Valdez, SWCA
Charles Yackulic, U.S. Geological Survey

Notetaker: Debbie Lee, PST

Middle Rio Grande Endangered Species Collaborative Program
Population Monitoring Work Group
2020 Work Plan

The Population Monitoring Work Group (PMWG) was tasked with providing technical review, focused assessment, and recommendations related to monitoring of fish populations in the Middle Rio Grande (MRG), as impacted by water management and river dynamics.

The PMWG plans to complete the following tasks in 2020:

Task	Subtasks	Target Completion Date
1. Integrate and prioritize recommendations from the science panels	a) Evaluate recent modifications to RGSM population monitoring program	Currently on hold with development of the RGSM Integrated Stock Assessment model
	b) Gear selectivity study	December 2020
	c) Track progress in addressing panel recommendations	Ongoing in 2020
2. Analyze RGSM data to support modeling efforts	a) Survival, age composition, recruitment, and other analyses as identified	December 2020
3. Develop and review a RGSM Integrated Stock Assessment Model		December 2020
4. Development of PMWG report(s)	a) Scientific report documenting the data and methods of the RGSM Integrated Stock Assessment Model	December 2020
	b) USGS Open File Report	Ongoing in 2020
5. Give a progress update to EC		December 2020/January 2021

These tasks support the completion of Task 2 under the original PMWG charge approved by the EC in May 2016.

Assimilation and Synthesis of Information and Data Related to the Rio Grande Silvery Minnow

Introduction

Members of the Population Monitoring Work Group (PMWG) identified 22 topic areas for review, and will complete an Executive Summary for each. The 22 topic areas were consolidated from the existing independent science panel recommendations (Hubert et al. 2016; Noon et al. 2016). The Executive Summaries will help assimilate and synthesize relevant information about the Rio Grande silvery minnow (RGSM) for each topic area so that uncertainties and research questions can be identified and addressed.

Topic Areas

A consolidated review of the aforementioned Hubert et al. and Noon et al. science panels' recommendations was completed by the Population Monitoring Work Group. These recommendations were subsequently organized by category, according to subject matter and work group priority. The following steps were taken to consolidate the science panel recommendations:

1. Recommendations were copied verbatim and listed in separate tables for each of the science panel reports; recommendation number and report page number were added to facilitate referencing each in its respective report.
2. The prioritizations for the recommendations within each science panel report were added as the last two columns of in each table. Prioritizations included those assigned by the work group and by the Noon et al. panel, as the Hubert et al. panel did not assign priority.
3. The recommendations were consolidated and categorized by subject matter.
4. Science topics were extracted from the consolidated recommendations and presented as a list to the work group.

Executive Summaries

Assembling Executive Summaries serves the following purposes:

1. Provides a reference list of relevant literature on each topic to identify and document knowledge gaps and non-consensus areas on available RGSM population information.
2. Helps inform the Collaborative Program's recommendation of studies and projects designed to resolve key scientific uncertainties related to the RGSM.
3. Documents the PMWG's progress in addressing the panel recommendations and provides a brief synopsis by topic to the Science and Adaptive Management Committee (SAMC) and Collaborative Program signatories.

Each Executive Summary will highlight current, relevant literature that provides evidence in support of the summarized statements. This exercise will identify consensus, alternative hypotheses, and uncertainties by topic. Understanding what is currently known and what

remains unknown is crucial to prioritizing key scientific uncertainties and developing effective management alternatives.

The SAMC will use the Executive Summaries to direct activities that reduce key scientifice uncertainties. These may include additional literature reviews, modeling exercises, monitoring activities, or field studies. Documenting progress on addressing the science panel recommendations will support the larger Science and Adaptive Management Strategy effort the Collaborative Program is currently undertaking.

Executive Summary Development & Review Process

The following outlines the Executive Summary development and review process and timeline:

1. Choose a work group member volunteer to develop an Executive Summary for one topic area
    - Choose a topic area
    - Assign an initiating author
    - Assign a deadline for submitting the initial draft to the PST (up to 45 days, with extension to 60 days if necessary)
2. The Program Support Team (PST) will ensure the initial draft Summary is on topic, clear, and complete, and if necessary, will work with the author to finalize the draft
    - Assign deadline for distribution of initial draft to subject matter experts (up to 15 days)
3. Choose 1-2 subject matter experts (SMEs) to review the Summary and return it to the PST
    - Assign subject matter expert reviewer(s) (up to 2)
    - Assign deadline for submitting the SME reviews to the PST (up to 15 days)
4. The PST incorporates SME comments into the Summary and distributes the document to all interested parties
    - Create a distribution list of all interested parties
    - Assign deadline for distribution to interested parties (up to 15 days)
    - Assign deadline for submitting these comments to the PST (up to 10 days)
5. The PST incorporates remaining comments into the Summary
    - Assign deadline for re-distribution of the final product to the work group (up to 15 days)
    - Set a work group meeting date (one week after re-distribution)
6. Hold a work group meeting to develop recommendations, if appropriate, for the SAMC based on the Executive Summary.

Executive Summary Development Guidelines

The following guidelines are intended to standardize the information provided in each Executive Summary:

- Executive Summaries briefly present the topic in 2 to 5 pages (not including citations)
- Follow a concise and standardized format; Executive Summaries are not meant to provide an exhaustive literature review
- Back up all statements with references and provide full citations
- Use the most current and relevant sources for information, noting peer reviewed literature
- Rather than using figures and tables, summarize the messages conveyed by a figure or table in the form of a statement and include citations
- The SAMC is the audience for these summaries; limit use of technical statements and jargon, unless they have direct relevance to management implications

Executive Summary Template

Topic Area Title:

Program Goal Relevance:

Brief Summary of Available Literature:

List the Uncertainties:

List the Hypotheses Identified from Literature:

Management Implication(s) of Hypotheses (if any):

Potential Approaches to Test Hypotheses:

Literature Cited:

Contributors:

Reviewers:

Consolidated Recommendations of Two Expert Science Panels on Monitoring of the Rio Grande Silvery Minnow

Richard A. Valdez and Mike Marcus
Population Monitoring Workgroup
Draft 1, March 16, 2020

Overview

The Population Monitoring Workgroup (PMWG) is charged by the Executive Committee (EC) of the MRGESCP with evaluating the monitoring program for the Rio Grande Silvery Minnow (RGSM) in the Middle Rio Grande, NM. In July 2012, the EC approved the first of three tasks—that the PMWG convene a science panel and conduct a workshop to evaluate the monitoring program. The following is a summary of actions taken by the PMWG pursuant to Task 1 (workshop) and the transition to Task 2 (review monitoring plan):

- July 13, 2012: EC approves charge for Task 1 (CPUE Workshop; PMWG 2012).
- May 2014: PMWG sends survey to EC on fish population monitoring needs (DBSA 2015).
- Dec 8-10, 2015: PMWG holds Independent Science Panel Workshop on Population Monitoring, Isleta Casino and Resort, Albuquerque, NM (Hubert et al. 2016).
- Apr 13, 2016: Final Report of Science Panel to PMWG on RGSM Population Monitoring (Hubert et al. 2016).
- July 12, 2016: PMWG forwards request to EC to initiate Task 2 (Review Population Monitoring Plan), and initiates evaluation and prioritization of Hubert recommendations.
- Mar 23, 2017: PMWG requests that Bureau of Reclamation incorporate eight Hubert recommendations into Population Monitoring Contract.
- Jun 2017: Final Report on RGSM Scientific Uncertainties (Noon et al. 2017[1]).

[1] The Noon science panel was convened as part of the development of an adaptive management framework for the Middle Rio Grande—unrelated to the PMWG—and contains substantive information relative to the Rio Grande silvery minnow monitoring program.

- Nov 29, 2017: PMWG initiates consolidated review and prioritization of panel recommendations from Hubert (22, Table A-1) and Noon (19, Table A-2).
- Jun 15, 2018: Members of PMWG begin analyses of specific panel recommendations (e.g., Valdez 2018).
- Nov 11, 2018: Contracted biometrician initiates Integrated RGSM Population Model to assist evaluation of panel recommendations (Yackulic 2018).
- Feb 18, 2020: Consolidated review of Hubert and Noon panel recommendations completed and organized by category, according to subject matter and priority (Table A-3).
- Feb 26, 2020: PMWG agrees to write short summaries of scientific topics identified from prioritized consolidated recommendations (Table 1).

Consolidation Process

The following steps were taken to consolidate the science panel recommendations:

1. Each recommendation was copied verbatim from the science panel report and listed in Table A-1 for the Hubert panel and A-2 for the Noon panel; recommendation number and report page number were added to facilitate locating each in the respective report.
2. The prioritizations for each recommendation within each science panel report were added as the last two columns of Tables A-1 and A-2. Prioritizations include those assigned by the PMWG and by the Noon panel; the Hubert panel did not assign priorities.
3. The recommendations were consolidated into a single table (Table A-3) and categorized by priority.
4. Science topics were extracted from the consolidated recommendations and listed in Table 1.

Summary Writeups

A short write-up will be provided by members of the PMWG for each of the science topics identified in Table 1. Each write-up will be formatted as follows:

<<Kevin and Catherine will provide format>>

Table 1. List of recommended science topics from the Hubert and Noon science panels.

Recommended Science Topic	Recommendation Number[1]		Responsible Person
	Hubert	Noon	
Relationship of CPUE and true population size of RGSM	--	A1	
Age-specific survival of RGSM	--	A2, A3	
Size and age-specific fecundity of RGSM	22	A4, B3	
Relationship of demographic rates and abiotic and biotic factors	10, 24	A5	
Evaluate existence and strength of density dependence to limit population	21	A6	
Effect of augmentation on RGSM Population	--	A7	
Contribution of salvaged RGSM to population dynamics	--	A8	
Develop and deploy "vertically-integrating" Moore egg collectors	--	B1, E2	
Effect of environmental cues on spawning onset and activity	--	B2, D2	
Age composition of RGSM population	--	C, E1	
Selectivity of gears used to sample RGSM	--	E1	
Spatial extent and historical availability of habitat and hydraulic quality used by RGSM	16	D1	
Roles and relative contributions to fish production by age in channel and floodplain habitats	--	D3	
Evaluate management potential for fish production by reach	--	D4	
Consolidation of mesohabitats for monitoring RGSM	--	E3	
Compute CPUE from larval and standard seines by age	1, 2, 3	--	
Evaluate effect of zero catches on CPUE and sample design	4, 5, 6	--	
Effect of environmental factors on seine capture probability	7, 8	--	
Mixture model and alternatives for computing RGSM CPUE	10, 11, 14, 17	--	
Use classification and regression trees, boosted regression trees, or random forests to examine relationships between hydrologic variables and CPUE	18	--	
Effect of increased sample size on RGSM monitoring	12, 13	--	
Implement studies using different sampling designs	19	--	

[1]see Tables A-1 and A-2 for Recommendation Numbers

Literature Cited

Daniel B. Stephens and Associates, Inc. (DBSA) 2015. Survey of the Executive Committee on fish population monitoring needs. Summary Report, Middle Rio Grande Endangered Species Collaborative Program. Albuquerque, NM.

Hubert, W.A., M.C. Fabrizio, and R. Hughes. 2016. Summary of findings by the External Expert Panelists: Rio Grande silvery minnow population monitoring workshop Isleta Casino and Resort, 8-10 December 2015. U.S. Bureau of Reclamation, Albuquerque, NM.

Noon, B., D. Hankin, T. Dunne, and G. Grossman. 2017. Independent Science Panel Findings Report: Rio Grande silvery minnow key scientific uncertainties and study recommendations. Prepared for the U.S. Army Corps of Engineers, Albuquerque District on Behalf of the Middle Rio Grande Endangered Species Collaborative Program. Prepared by GeoSystems Analysis, Inc. Albuquerque, NM. June 2017. Contract No. W912PP-15-C-0008.

Population Monitoring Workgroup (PMWG). 2012. 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, Albuquerque, NM.

Valdez, R.A. 2018. Age composition of Rio Grande silvery minnow: Application of distribution separation methods to estimate age composition. A data analysis done for and in collaboration with the Data Analysis Team of the Population Monitoring Workgroup, Albuquerque, NM.

Yackulic, C.B. 2018. Developing an integrated population model for Rio Grande silvery minnow in the Middle Rio Grande. U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ.

Appendix A: Tables of Science Panel Recommendations

Table A-1. Recommendations and observations from the Hubert et al. (2016) Population Monitoring Science Panel. The Hubert Science Panel did not assign priorities to these recommendations and observations, but priorities were assigned by the Population Monitoring Work Group (PMWG) to the recommendations. Priority: 1 = high, 2 = moderate, 3 = low, 0 = no consideration by PMWG.

Number[1]	Page	Recommendation	Panel Priority	PMWG Priority
1	28	Separate the catch and effort data from the small-mesh seine and the fine-mesh seine into two data sets and compute separate CPUE indices for each gear type, as well as for individual age classes captured in each gear type.	--	1
2	28	The CPUE from the small-mesh seine is primarily an index of the relative abundance of a single cohort of RGSM (i.e., the most recent cohort) that is recruited into the gear late in the summer and captured into the summer of the following year. The precision of the index can be improved by exclusion of older cohorts. A separate CPUE index can be computed for older cohorts. Consider the use of length-at-age data and frequency histograms to identify cohorts.	--	1
3	28	Only larval fish should be included in the computation of CPUE indices from the fine-mesh seine because of this gear's selectivity for this life stage.	--	1
4	28	An aspect of the CPUE data that warrants attention is the treatment of zero catches in data analyses. Inclusion of dry sample sites as zero CPUE values when analyzing CPUE data for RGSM in the MRG should be avoided. Field data records and the database in which the RGSM CPUE data are stored allow dry sampling sites to be distinguished from sites that were sampled and no RGSM were caught. The problem arises during statistical analyses because the naughty naughts (observations of zeros at dry sampling sites) are treated in the same manner as the zero catches at fished sites where no RGSM are caught.	--	1
5	28	Survey designs should strive to minimize false zeros resulting from: (1) an inappropriate sampling design (e.g., sampling in mesohabitats avoided by RGSM) and (2) ineffective survey methods (e.g., insufficient sampling effort to detect an organism when it is present).	--	1 and 2

Number[1]	Page	Recommendation	Panel Priority	PMWG Priority
6	29	The proportions of various mesohabitat types sampled are likely to bias CPUE indices because the catchability coefficient probably differs among mesohabitat types and RGSM are likely to be selective for specific mesohabitat types. We recommend that better understanding of the influence of mesohabitat type on CPUE be developed and used to account for variability in CPUE indices. Further, we recommend that estimation of mean site-specific CPUE be improved by addressing the variable number of mesohabitats that are sampled at any given site and the amount of sampling in each mesohabitat type. We recommend estimation of mean site-specific CPUE from individual seine hauls (which are distinguishable in the database as of 2006); mean CPUE at each site is then computed from the individual CPUEs at each of the 18-20 mesohabitat units sampled per site.	--	1 and 2
7	29	Environmental factors (e.g., turbidity, water temperature, substrate size, depth, current velocity, and discharge) during sampling are likely to bias CPUE indices because of their influence on catchability. We recommend that better understanding of the influence of measurable environmental factors on the catchability of each seine type be developed and used to account for variability in CPUE indices.	--	3
8	29	Factors influencing detection and catchability of RGSM in seines need to be determined and incorporated into the sampling design to permit more robust estimation of CPUE.	--	1
9	29	Measures of CPUE for RGSM from the MRG are currently identified as recovery standards for the species. We recommend modification of recovery standards to be explicit regarding the gear, sampling design, sampling techniques, data analysis, and life stage, as well as protocols used to compute the CPUE index.	--	0
10	29	We recommend depiction of the relationship of hydrological covariates and estimates of the mean annual CPUE for RGSM derived from the mixture model. Those relationships should use the October data from 1993 to 2014. Further, we recommend that such analyses be repeated for catch data collected in 2006 to the present, but using the individual seine-haul approach to estimate CPUE.	--	1
11	29	We recommend that the assumptions of the mixture models be fully defined and that the results of analyses be interpreted with consideration of the assumptions and the effects of the potential violation of assumptions.	--	1

Number[1]	Page	Recommendation	Panel Priority	PMWG Priority
12	29	A greater number of sampling sites would improve the accuracy and precision of status assessments and improve estimates of RGSM CPUE and spatial distribution, especially at the reach scale. A greater number of sampling sites in each of the three reaches would facilitate status and trend estimates at the reach scale. To make statistically rigorous reach-scale CPUE estimates, 20-50 sites per reach are recommended. A design with substantially more sites and longer site lengths should be more effective at detecting RGSM when they are at low densities or demonstrating patchy distributions.	--	1
13	29	When river flows decline so that dry sampling sites occur among the 20 fixed sites sampled by the Monitoring Program, the ability to make inference regarding CPUE of RGSM over the MRG is impaired. The current 20-fixed-site sampling is not adequate when dry sampling sites occur. An ancillary randomized sampling design is recommended at such times to be able to make inferences about RGSM abundance and distribution throughout the entire MRG. Such a random sampling design would entail sampling at many more sites over the length of the MRG. An ancillary design of this type would enhance the feasibility of assessing the abundance and distribution of RGSM in the MRG during years of low flows and when the species is likely to occur in low abundance.	--	0
14	30	Consider using key drivers of mesohabitat variability, such as current velocity, substrate size, and water depth at specific locations where seines are deployed, to replace the mesohabitat factor in the mixture models.	--	2
16	30	Examine the historical availability of mesohabitats in the MRG relative to discharge. If these two measures can be linked, then annual or monthly discharge may provide a good surrogate of mesohabitat availability.	--	2
17	30	Evaluate alternatives to the parametric mixture model, in particular, Bayesian hierarchical models, for estimating annual CPUEs.	--	2
18	30	Use classification and regression trees, boosted regression trees, or random forests to examine relationships between hydrologic variables and CPUE for identifying thresholds above or below which CPUE exhibits changes.	--	1.5

Number[1]	Page	Recommendation	Panel Priority	PMWG Priority
19	30	Implement directed studies using different sampling designs, such as multi-year, multi-site, before-after-control-impact (BACI) designs to enhance understanding of the response of the population to changes in river discharge, habitat rehabilitation projects, and availability of mesohabitats.	--	3
21	30	Conduct stock-recruitment studies to determine how the abundance of fall recruits relates to the abundance of spring spawners. Investigate the effects of spring and summer discharges on the stock recruitment relationship to enhance understanding of the dynamics of RGSM. Implement a spring sampling protocol at spawning sites to estimate the number of spring spawners, and compare with October results for several years; such studies may provide useful data on RGSM population dynamics and limiting factors.	--	3
22	30	Complete a study of age-specific fecundity and survival rates based on pre-breeding (fall) population estimates, spring spawners, and hatchery supplementation. Results from this study could be used to estimate population recovery and extirpation potentials as a function of altered flow regimes and stocking.	--	3
23	30	Consider genetic fingerprinting and epigenetic studies, including bar-coding and gene-expression, of presumed wild and hatchery fish to help determine hatchery contributions to the spring spawners and the long-term risks to the wild population.	--	0
24	30	Expand the analyses in Dudley et al. (2015) to assess flow regime and habitat fragmentation effects on RGSM occurrence and abundance and suggest preliminary flow regimes for rehabilitating the wild RGSM population.	--	3

[1]numbers 15 and 20 are missing in the original report by Hubert et al. (2016), apparently as an inadvertent error in numbering

Table A-2. Recommendations from the Noon et al. (2017) Adaptive Management Science Panel. The Noon Science Panel assigned priorities to these recommendations, and some priorities were assigned by the Population Monitoring Work Group (PMWG). Priority: 1 = high, 2 = moderate, 3 = low, 0 = no consideration by PMWG, Important = Recommendation is important, but not priority was assigned.

Number	Page	Recommendation	Panel Priority	PMWG Priority
A1	17	Clarify the relationship between the annual catch-per-unit-effort and true population size by estimating catchability.	1	1
A2	18	Determine the key, age-specific, life history sensitivities of the RGSM (that is, use Eigen- analysis methods to determine which vital rates [survival and/or reproduction] most affect rates of population change.	1	3
A3	18	Estimate age-specific survival rates	1	3
A4	19	Estimate age-specific fecundities of wild fish.	1	3
A5	19	Using statistical modeling, estimate the relationships between RGSM demographic rates and A.) hydrological factors (flow magnitude and duration, summer drying of the channel); and B.) abiotic environmental factors (temperature, turbidity, salinity); and C.) biotic factors (predation, completion, prey availability).	1	3
A6	20	Evaluate the existence and strength of any density-dependent factors that may be limiting population growth.	2	--
A7	20	Model the potential effects of hatchery augmentation on population dynamics and the significance of hatchery fish to achieving recovery objectives.	Important	--
A8	20	Determine if the collection and translocation of salvage fish during summery drying periods contributes significantly to population dynamics.	Important	--
B1	21	Development and deployment of "vertically-integrating" Moore egg collectors	1	--
B2	21	Improved assessments of relations between possible environmental cues that trigger spawning activity.	1	--
B3	21	Establish size-specific fecundities of natural-spawning RGSM.	2	--
C	22	Clarify the detail of annular mark formation on otoliths and firmly establish the longevity of RGSM	2	--

Number	Page	Recommendation	Panel Priority	PMWG Priority
D1	22	Estimate the spatial extent and hydraulic quality used by RGSM for key life-stages (spawning, larval rearing, juvenile and adult survival). Estimate how these habitats are distributed in the river channel and floodplain in each MRG reach under a range of discharges and seasonal flow regimes.	Important	--
D2	23	Establish the proximate trigger(s) for spawning by evaluating the effects of flow velocity, temperature, rate of increase in flow velocity, or some combination of these factors.	Important	--
D3	23	Determine the roles and relative contributions to fish production (age 0 recruitment and survival of all age-classes) of channel and floodplain habitat in a reach of channel and floodplain typical of the MRG.	Important	--
D4	24	What is the management potential for fish production (recruitment and survival of age 0 fish) in each reach of the MRG if the annual peak flow, and thus the nature and range of available habitats, is permanently limited below historic levels of availability?	Important	--
E1	24	Establish the age composition of the RGSM population, including A.) application of distribution separation methods to estimate age composition, and B.) gear selection study.	1	--
E2	25	Determine how the vertical and horizontal distribution of RGSM eggs in the MRG mainstream channel varies as a function of flow and location?	1	--
E3	25	Calculate revised CPUE values as mesohabitat-specific levels and do not combine across mesohabitat types. The meso-habitat specific CPUE calculated for the most abundant high density mesohabitat type should be used for assessment of trend in abundance of the RGSM population at the October sampling date.	2	2

Table A-3. Consolidated and categorized recommendations from the Hubert et al. (2016) and Noon et al. (2017) Science Panels.

Number	Priority SP/PMWG	Hubert	Noon	Consolidated Recommendation	Progress (see Literature Cited)	Status
Population Dynamics / Noon et al. = Priority 1						
1	1/1	--	A1	Clarify relationship between annual CPUE index and true population size.	• Dudley et al. (2011a, 2011b, 2011c, 2012) implemented population estimation. • Goodman (2012) evaluated Population Estimation Program. • Valdez (2018a) evaluated relationship between CPUE and true population size (presented to PMWG 6/20/2018).	Remains unresolved
2	1/3	--	A2	Determine which age-specific vital rates (survival, reproduction, etc.) most affect population change.	• Goodman (2010) did deterministic dynamics of environmental correlates. • Miller (2012) performed sensitivity analysis as part of PVA. • Yackulic (2018) model in progress (presented to PMWG 12/12/2018).	Ongoing
3	1/3	--	A3	Estimate age-specific survival rates.	• Goodman (2009) estimated survival from quarterly comparisons of CPUE. • Miller (2012) reconciled survival rates from PVA. • Valdez (2018b) estimated survival of wild RGSM (presented to PMWG 12/12/2018).	Ongoing
4	1/3	22	A4, B3	Estimate size and age-specific fecundities of wild fish.	• Platania and Altenbach (1996) did clutch and batch production and fecundity estimates in a lab. • Caldwell et al. (2019) evaluated reproductive potential of captive RGSM. • Archdeacon?	Information needed on wild RGSM

Number	Priority SP/PMWG	Hubert	Noon	Consolidated Recommendation	Progress (see Literature Cited)	Status
5	1/3	10	A5	Model relationships between demographic rates and hydrological factors (flow magnitude, duration, drying), abiotic factors (temp, turbidity, salinity), and biotic factors (predation, completion, prey).	• Miller (2012) related demographic rates to hydrological factors as part of PVA. • Archdeacon (2016) evaluated reduced spring flow. • Yackulic (2018) model in progress. • Walsworth and Budy (2020) model in progress. • Hatch and Cowley (2020)?	Ongoing
Population Dynamics / Noon et al. = Priority 2						
6	2/--	--	A6	Evaluate existence and strength of density-dependent factors that may limit population growth.	• Miller (2012) evaluated as part of PVA. • Goodman (2010) evaluated as part of PVA. • Yackulic (2018) model in progress.	Ongoing
Population Dynamics / Noon et al. = Other Important Studies						
7	Import/--	--	A7	Model potential effects of hatchery augmentation on population dynamics.	• Miller (2012) evaluated as part of PVA. • Archdeacon and Remshardt (2012). • Archdeacon (2015) provides annual reports on augmentation. • Yackulic (2018) model in progress. • Hatch and Cowley (2020)?	Ongoing
8	Import/--	--	A8	Determine if collection and translocation of salvaged RGSM during summery drying contribute to population dynamics.	• Archdeacon (2017) gave a presentation on Fish Rescue.	Ongoing
Reproductive Biology of Rio Grande Silvery Minnow / Noon et al. = Priority 1						
9	1/--	--	B1, E2	Develop and deploy "vertically-integrating" Moore egg collectors; determine vertical and horizontal distribution of RGSM eggs as a function of flow and location	• Porter (2018) designed a multi-level vertical egg collector.	Work initiated; more needed

Number	Priority SP/PMWG	Hubert	Noon	Consolidated Recommendation	Progress (see Literature Cited)	Status
10	1/--	--	B2, D2	Assess effect of environmental cues (flow, velocity, temp, flow change) on spawning onset and activity.	• Cowley et al. (2009) evaluated effect of salinity on specific gravity of eggs. • Krabbenhoft et al. (2014) evaluated phenology. • Valdez (2010, 2019, 2020a) evaluated temperature degree-days for hatching.	Ongoing
Age and Growth / Noon et al. = Priority 2						
11	2/--	--	C	Clarify annular marks on otoliths and firmly establish longevity of RGSM.	• Horwitz et al. (2018) used scales and otoliths for juveniles and adults. • Zipper et al. (2020a; 2020b) verified otolith age for larvae.	Unresolved
Physical Habitat Relations of RGSMs / Noon et al. = Other Important Studies						
12	Import/--	--	D1	Estimate spatial extent of habitat and hydraulic quality used by RGSM for key life-stages (spawning, larval, juvenile, adult).	• Tetra Tech (2014) evaluated habitat for occupied, feeding/rearing, spawning/ egg/larval habitat. • Walsworth and Budy (2020). • Colorado State University (2020)? • Yackulic (2020). • Hatch and Cowley (2020)?	Evaluation ongoing by several groups
13	Import/--	--	D3	Determine roles and relative contributions to fish production by age in channel and floodplain habitats.	• Tetra Tech (2014). • Walsworth and Budy (2020). • Colorado State University (2020)? • Yackulic (2020). • Hatch and Cowley (2020)?	Evaluation ongoing through modeling
14	Import/--	--	D4	Evaluate management potential for fish production (recruitment and survival of age 0 fish) in each reach if annual peak flow and available habitat is permanently limited below historic levels.	• Tetra Tech (2014). • Walsworth and Budy (2020). • Colorado State University (2020)? • Yackulic (2020).	Evaluation ongoing through modeling

Number	Priority SP/PMWG	Hubert	Noon	Consolidated Recommendation	Progress (see Literature Cited)	Status
Sampling Methodologies / Noon et al. Priority 1						
15	1/--	--	E1	Establish age composition of RGSM population, including application of distribution separation methods.	• Valdez (2018b) evaluated age composition using distribution separation methods (presented to PMWG 10/2/2018). • Winter (2018) provided a Bayesian analysis of von Bertalanffy growth function (presented to PMWG 12/12/2018).	Ongoing
16	1/--	--	E1	Evaluate size and age of fish captured by gear type with gear selectivity.	• Widmer et al. (2012) PP to Science Workgroup, 8/21/2012. • Gonzales et al. (2012) evaluated fyke-net catches. • Valdez et al. (2020b) evaluated gear selectivity (presented to PMWG 10/2/2018).	Ongoing
17	2/2	--	E3	Calculate revised CPUE values using most abundant high CPUE mesohabitats for assessment of trend in abundance at October sampling date.	• Valdez (2018c) computed CPUE at mesohabitat-specific levels (presented to PMWG 10/2/2018).	--
Sampling Methodologies / Hubert et al. Recommendations Sorted by PMWG Rankings = Priority 1						
18	--/1	1, 2, 3	--	Separate catch and effort data from small-mesh and fine-mesh seines and compute CPUE for each gear type and by age (larvae, age-0, age 1, age 2+).	• Dudley et al. (2020) have computed larval and standard seine CPUE annually since 2018.	Ongoing
19	--/1, 2	4, 5	--	Evaluate effect of zero catches on CPUE (zero as dry site, no fish captured).	• Dudley et al. (2020) have evaluated effect of zero catches on CPUE annually since 2018.	Ongoing
20	--/1, 2	6	--	Evaluate effect of sample design on zero CPUE.	Effect of sample design on zero CPUE has not been evaluated.	Not Initiated

Number	Priority SP/PMWG	Hubert	Noon	Consolidated Recommendation	Progress (see Literature Cited)	Status
21	--/3, 1	7, 8	--	Evaluate detection and catchability (*p*-hat) of RGSM in seines, including effect of environmental factors (turbidity, temp., substrate, depth, velocity, discharge) during sampling on CPUE.	• Archdeacon and Davenport (2013) evaluated detection and population estimation.	More work needed
23	--/1	11, 14, 17	--	Evaluate mixture model for computing RGSM CPUE, and other models, including Bayesian hierarchical models; consider using key drivers of mesohabitat variability (e.g., velocity, substrate, depth) to replace the mesohabitat factor in mixture models.	The mixture model has not been evaluated in this manner.	Not Initiated
24	--/1, 0	12, 13	--	Increase sample sites by 20-50 sites per reach, and evaluate effect on CPUE; add random sites to replace dry sites.	• Dudley et al. (2020) added sample sites starting in 2018. • Archdeacon et al. (2015) Compared fish communities at random and non-random sites.	Needs additional evaluation
Sampling Methodologies / Hubert et al. Recommendations Sorted by PMWG Rankings = Priority 1.5/2						
26	--/1.5	18	--	Use classification and regression trees, boosted regression trees, or random forests to examine relationships between hydrologic variables and CPUE for identifying thresholds above or below which CPUE exhibits changes.	This has not been implemented.	Not Initiated
25	--/2	16	--	Examine historical availability of mesohabitats relative to discharge. If linked, annual or monthly discharge may be surrogate for mesohabitat availability.	This has not been examined.	Not Initiated

Number	Priority SP/PMWG	Hubert	Noon	Consolidated Recommendation	Progress (see Literature Cited)	Status
Sampling Methodologies / Hubert et al. Recommendations Sorted by PMWG Rankings = Priority 3						
27	--/3	19	--	Implement studies using different sampling designs (multi-year, multi-site, before-after-control-impact [BACI]) to better understand population response to changes in river discharge, habitat rehabilitation projects, and mesohabitats.	This has not been implemented.	Not Initiated
28	--/3	21	--	Conduct stock-recruitment studies to determine how abundance of fall recruits relates to abundance of spring spawners.	• Miller (2012) • Walsworth and Budy (2020). • Yackulic (2020). • Hatch and Cowley (2020)?	Ongoing
30	--/3	24	--	Expand the analyses in Dudley et al. (2015) to assess flow regime and habitat fragmentation effects on RGSM occurrence and abundance and suggest preliminary flow regimes for rehabilitating the wild RGSM population.	• This has not been implemented.	
Sampling Methodologies / Hubert et al. Recommendations Sorted by PMWG Rankings = Priority 0						
22	--/0	9	--	Evaluate recovery standards by gear, sample design, techniques, data analysis, and life stage.	Is evaluating recovery standards the charge of the PMWG?	Not Initiated
29	--/0	23	--	Consider genetic fingerprinting and epigenetic studies, including bar-coding and gene-expression, of presumed wild and hatchery fish to help determine hatchery contributions to spring spawners and long-term risks to wild population.	Is this an issue for the Genetics Group?	Not Initiated

Memo

To: Population Monitoring Workgroup

From: Rich Valdez, PMWG Co-Chair

Subject: Next Steps in Modeling Process—Ideas from Dr. Yackulic

Date: March 18, 2020

The following was transmitted to me via e-mail from Dr. Charles Yackulic on March 18, 2020, partly in response to "Follow-up Questions on Integrated Model for Rio Grande Silvery Minnow":

In terms of next steps, this is what I think might make sense:

Step 1) Consider some revision to model inputs. In particular,

a) adding habitat data by developing relationship between velocity and mesohabitat (I've already been working with Mick on this).

b) trying to figure out the early years and whether there are data issues (I've looked at this already and data is certainly sparser in those early years and there are a couple weird years - on the other hand I hate throwing out data - Also, if we just look at 2002 to present, 2004 still looks like a bit of an outlier in terms of high age-0 abundance for the number of age - 1+ we think are in the system). One thought I had after looking over the questions you sent me was that I should look at the size data and consider adding in an additional age classes (I know folks wanted this early on, but I was trying to limit complexity when we were considering additional spatial complexity and now that we have limited spatial complexity it means we can consider additional age classes).

c) consider adding additional age classes (see b and based on comments you sent).

d) consider modifying habitat data by the drying data - I know how we would do this, but want to talk to a few folks familiar with the system to see if this makes sense - we could do this as a group.

e) try analyzing augmentation data with a spatial analysis just to make sure we don't get different answers (issue here is that as long as monitoring sites are randomly distributed with respect to augmentation release sites we ought to be okay, but sounds like they have not always been distributed this way)

f) could try to integrate salvage data.

Although this seems like a lot and will take a while to work through, they all seem like things I can move through and check off without a whole lot of help from the group. In contrast, step 2 is going to require quite a bit of input.

Step 2) Develop future scenarios. (This can be done in parallel with step 1) I think key here is to consider some fairly different hypotheses about how to manage flow and other management actions - what are the specific ideas out there about how timing, magnitude and duration should be prioritized? This requires some facilitated brainstorming with the group. With what we have done on the modelling side, the simulations will be super easy - the hard part is defining the scenarios. Do we want to include some in the box and some out of the box scenarios (i.e., within the current interpretation of the Law of the river) or only within the box scenarios? I think this part requires some phone calls with the group (perhaps a smaller group to decide on the process and the larger group to get ideas on the biology).

Follow-up Questions on Integrated Model for Rio Grande Silvery Minnow
From Population Monitoring Workgroup
PRELIMINARY—March 15, 2020

1. The timing of spawning and runoff may not be consistent every year. In many years, spawning starts prior to or with early runoff. In other years, spawning takes place during increased flows of spring runoff. The timing, magnitude, and duration of floodplain inundation is an important aspect of the reproductive success of the species, and something that we want to better understand and test with the model.
2. What relationship of RGSM size to egg number was used in the model?
3. What conversion was used to derive abundance (N) from catch-per-unit-effort (CPUE)—the relationship from the 4-year ASIR study?
4. How does the model use the range of survival in simulations?
5. Can the model hold all variables stable and test only for different numbers of augmented fish—or salvaged fish—in a sensitivity analysis?
6. Displacement of stocked fish appears minimal. Will the USU/BOR movement study inform this issue, and how can we distinguish movement of hatchery fish from that of wild fish?
7. How is carrying capacity (Rf) a function of flow/inundation? Do these affect the alpha and beta parameters of the Beverton-Holt model—or do the recruits and spawners of each year set the BH parameters and thus Rf?
8. What is the relationship and timestep of flow and habitat (RU/RI and PO) that drive the model?
9. The mean annual survival estimates of age-1 fish derived by Goodman (2009) of 0.058, and Valdez (2010, 2018) of 0.04 and 0.027 are within the range of the annual adult survival rates as part of the model (slide 21). However, the rates for age-2 fish by Miller (0.05) and Valdez (2018) of 0.113 are higher than shown. Is the possible higher survival rate of age-2+ fish important for determining survival of older fish and their significance to the population, especially given that their fecundity is higher?
10. Is the survival of stocked fish an annual survival rate? If so, it is about 10 times higher than that of wild adults shown in slide 21—is this true?
11. It is unclear how the model handles river drying. Drying is a complex phenomenon and should be considered in both spatial and temporal scales?
12. Were any annual changes in RGSM abundance observed that suggesting an unexpected or unrealistic change in CPUE, indicating that the CPUE may not be a reliable index, especially at very low levels of abundance?

Follow-up Questions on Integrated Model for Rio Grande Silvery Minnow
From Population Monitoring Workgroup
PRELIMINARY—March 15, 2020

1. The timing of spawning and runoff may not be consistent every year. In many years, spawning starts prior to or with early runoff. In other years, spawning takes place during increased flows of spring runoff. The timing, magnitude, and duration of floodplain inundation is an important aspect of the reproductive success of the species, and something that we want to better understand and test with the model.

    a. *Agreed, what we need to do is to figure out how to facilitate a conversation where we make different hypotheses about timing, magnitude and duration clearer such that we can operationalize them as covariates – this process should be independent of looking at data and more of just a structured brainstorming session.*

2. What relationship of RGSM size to egg number was used in the model?

    a. *None. The model tries to estimate the number of yoy in June as a function of the number of age 1+ present in April – it differentiates between fish stocked the winter before and those present in the system for longer (i.e., either wild reared or stocked more than a year before). One idea I had after looking through Colleen's work is that we might look at the size distribution from April across years to see how much it varies and whether the structure of the model needs to be modified (I'm basing this on the observation that standard length has a nice relationship with fecundity regardless of age).*

3. What conversion was used to derive abundance (N) from catch-per-unit-effort (CPUE)—the relationship from the 4-year ASIR study?

    a. *The conversion is based on the availability of pool and run/riffle habitat, the catch rates in these two habitats and an estimated capture probability for monitoring seining. The capture probability is estimated by comparing monitoring data to the ASIR data during the 4 year study. The availability of habitat is based on the various habitat sources (USGS study, habitat availability form asir studies, etc.) The relative catch rates are informed by the ASIR monitoring data in a given period. The other factor is that because there is an underlying population model, some information is being shared from other sampling in the same year.*

4. How does the model use the range of survival in simulations?

    a. *The model is not yet formulated for simulation, but that is a logical next step. The model estimates a range of survival from the data (including its variation over time) that can easily be used to parameterize a simulation model…if we had an*

agreement of what we wanted to simulate we could modify existing code very easily – the harder part is deciding what makes sense to simulate.

5. Can the model hold all variables stable and test only for different numbers of augmented fish—or salvaged fish—in a sensitivity analysis?

    a. *Yes, we could do that.*

6. Displacement of stocked fish appears minimal. Will the USU/BOR movement study inform this issue, and how can we distinguish movement of hatchery fish from that of wild fish?

    a. *The USU/BOR study will inform this to a certain extent (although I would like to see them adopt an analytical framework that allows them to distinguish initial stocking movement from movements after stocking). There are two way to get at movement of wild fish: 1) assume that stocked fish act like wild fish after some time period (i.e., focus on movements from USU/BOR study starting say 1 or 2 months after stocking, 2) actually capture some wild fish and pittag them and put them back in the river.*

7. How is carrying capacity (Rf) a function of flow/inundation? Do these affect the alpha and beta parameters of the Beverton-Holt model—or do the recruits and spawners of each year set the BH parameters and thus Rf?

    a. *The equations used are as follows:*

$$\#\text{ recruits} = \frac{a(N_{1+} + \beta N_S)}{1 + a(N_{1+} + \beta N_S)/R_f}$$

$$R_f = e^{c + d * flow + \varepsilon}$$

Rf acts like a carrying capacity and is calculated by the second equation where c is an intercept, d estimate the impacts of the flow covariate and ε allows for deviations from the parametric relationship. This Rf is then combined with other parameters and abundance to predict recruitment via the top equation, where a is an estimated parameter representing the maximum number of yoy per adult (i.e., when flow conditions are optimal such that Rf becomes big and the N's are low), N_{1+} *is the number of age 1+ fish,* N_S *is the number of fish stocked the winter before that survived through April, and* β *is the relative impact of stocked fish (i.e., if* $\beta = 1$ *stocked fish contribute the same as wild fish, if* β *near zero, stocked fish have minimal contribution and wild fish do all the reproducing.)*

I know equations aren't intuitive to everyone so I could try to code up an excel spreadsheet for people to play with if we thought that would help…

8. What is the relationship and timestep of flow and habitat (RU/RI and PO) that drive the model?

Habitat areas are calculated based on the average discharge from the days within a month when catch data was collected – these habitat areas are then multiplied by the

catch within the habitats and divided by the capture probability to get at the overall expected abundance for that month.

9. The mean annual survival estimates of age-1 fish derived by Goodman (2009) of 0.058, and Valdez (2010, 2018) of 0.04 and 0.027 are within the range of the annual adult survival rates as part of the model (slide 21). However, the rates for age-2 fish by Miller (0.05) and Valdez (2018) of 0.113 are higher than shown. Is the possible higher survival rate of age-2+ fish important for determining survival of older fish and their significance to the population, especially given that their fecundity is higher?

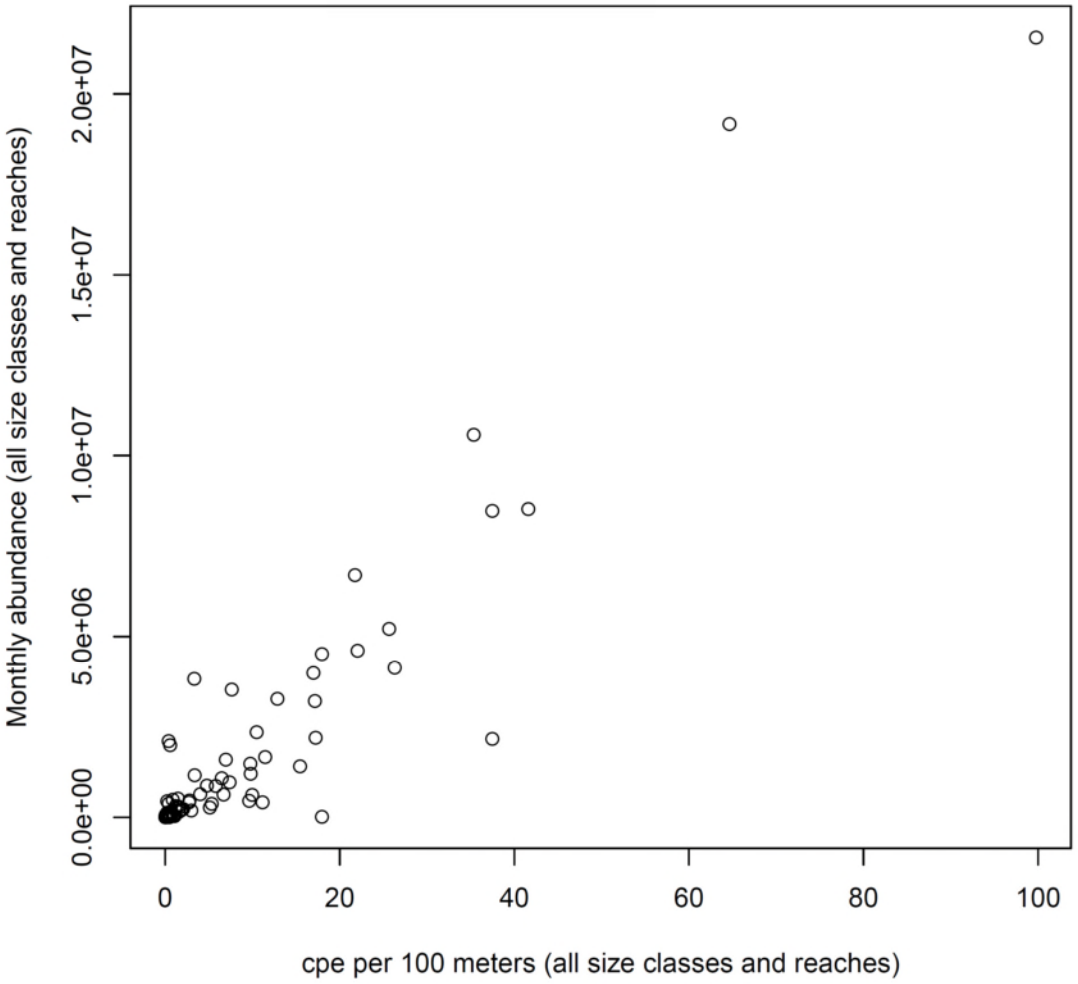
    a. *Yes, this could be and perhaps the model needs to be modified to allow for this. If enough folks in the group feel this is important, I can modify the model to allow for this.*

10. Is the survival of stocked fish an annual survival rate? If so, it is about 10 times higher than that of wild adults shown in slide 21—is this true? *No, that survival rate is just for the initial release – in other words, as soon as fish are put in the system this rate applies and then they adopt the vital rates of wild adults – so for example, the annual rate of stocked fish is something like 0.15*0.04 = 0.006 where 0.15 is the instantaneous survival and 0.04 is the annual survival over the rest of the year.*

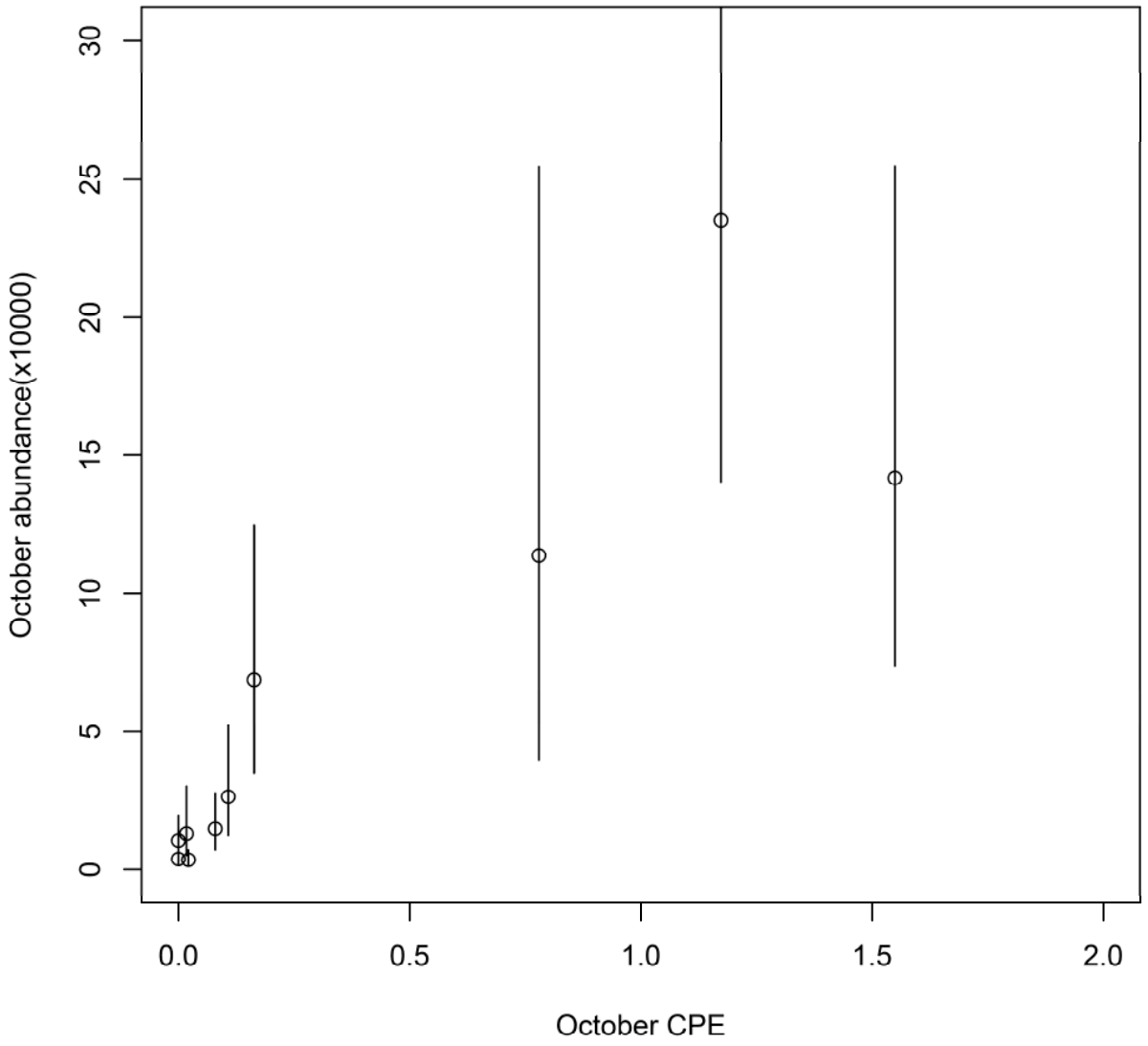
11. It is unclear how the model handles river drying. Drying is a complex phenomenon and should be considered in both spatial and temporal scales? *I tried incorporating drying into the more spatially resolute version of the model, by making fish either die or leave, but had trouble with it because of the lack of tagged wild fish. At present, the relatively coarse model could include drying as a covariate on survival (I haven't actually added it in, but I could). The other way the model could include drying is by modifying the expected habitat within a reach based on the drying data – I plan on doing this in the near future. The key here is that if a third of a reach is dried then that means there are 1/3 less fish for a given cpue then if it were not dried.*

12. Were any annual changes in RGSM abundance observed that suggested an unexpected or unrealistic change in CPUE, indicating that the CPUE may not be a reliable index, especially at very low levels of abundance?

    a. *That is a good question. The R^2 over the whole range was 0.88 when you aggregate cpe and N over all size classes and reaches within a given month of sampling. This is shown in first plot below that does not include uncertainty in abundance.*



b. The second plot (below) focuses only on October estimates and at the low end of cpe's. I tried to calculate cpe's the way I think you all do, but not sure it is exactly right (for example, do they use larval seines or only the big ones?) Note that I have added 95% CI's for abundance.


October abundance(x10000)
0
5
10
15
20
25
30
0.0
0.5
1.0
1.5
2.0
October CPE

c.

Middle Rio Grande Endangered Species Collaborative Program
Population Monitoring Work Group (PMWG)
2020 Work Plan

The Population Monitoring Work Group (PMWG) as tasked with providing technical review, focused assessment, and recommendations related to monitoring of fish populations in the Middle Rio Grande (MRG), as impacted by water management and river dynamics.

The PMWG plans to complete the following tasks in 2020:

Task	Subtask	Target Completion Date
1. Integrate and prioritize recommendations from the science panels	Track progress in addressing science panel recommendations	Provide summary progress on priority activities by November 20, 2020. EC update at Dec 2020 mtg
2. Analyze or review data used to support the integrated RGSM model	Prepare, analyze, or review up to four reports on; RGSM fecundity, age, survival, recruitment, or other analyses identified	Review and publish two reports through MRGESCP format and process by November 20, 2020 with provision to EC Dec 2020
3. Review a draft report of the Integrated RGSM Model methods and any preliminary results	Provide PMWG member reviews of a report documenting methods and data used. Provide reviews of preliminary results of Integrated RGSM Model	Review draft report by August 31, 2020, with comments by September 28, 2020. Comments on preliminary Integrated RGSM Model by Nov 20.