Population Monitoring Work Group Meeting

October 2, 2018

Meeting Materials:

Meeting Agenda

Meeting Minutes

Evaluation of Capture Efficiency of the Rio Grande Silvery Minnow [presentation]

Age Composition of Rio Grande Silvery Minnow: Application of Distribution Separation Methods [presentation]

Catch-Per-Unit-Effort of Rio Grande Silvery Minnow at Mesohabitat-Specific Levels [presentation]

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Population Monitoring Workgroup
Meeting Agenda

October 2, 2018
9 AM to 4:45 PM

WEST Offices
8500 Menaul Blvd NE
Conference Room A-319

Greetings and Introductions (Rick Billings and Dave Wegner)

Agenda Review (Dave Wegner)

9:30 am – 12:00 pm   Morning Presentations/Discussions

- Analysis of Noon Recommendation E3 (Mesohabitat) by R. Valdez (45 min)
- Paired net depletions sampling for small-bodied fish by M. Porter (45 min)
- Analysis of Noon Recommendation E1 (Age Composition) by R. Valdez (45 min)

Discussion on technical analyses and results

Working Lunch

1:00 – 4:00 pm. Information Exchange and Workgroup Assignments

- Discussion of data characterizations and analytical approaches by C. Yackulic and S. Howlin

- Schedule Analyses/Presentations of additional Hubert and Noon Recommendations (prioritized?)

- Schedule other analyses and/or presentations of related research (e.g., other fish monitoring methods and modeling tools)

4:00 – 5:00 pm. Business

- PopMon Workgroup Co-Chair (interim or permanent?)

- Data Set finalization and upkeep – how, who, when?

- Potential coordination with Reclamation and PopMon Workgroup on 2016 BO's HBO

- Review and refine/approve (?) PopMon Workgroup FY2019 Work Assignment (Charge) per EC request – (integrate into tasks/schedule any new work discussed above)

Middle Rio Grande Endangered Species Collaborative Program
Est. 2000

Population Monitoring Work Group (PMW)
Meeting Minutes

October 2, 2018 9:00 AM – 5:00 PM
Location: 8500 Menaul Blvd. NE, Conference Room A-319

Decisions

- ✓ Form base model small group consisting of Charles Yackulic, Rich Valdez, Micky Porter, Ara Winter, Kate Mendoza, Ashley Tanner, and Thomas Archdeacon (if available).
- ✓ The group will table the establishment of an interim co-chair until Rick Billing's return.

Action Items

WHO	ACTION ITEM	DUE DATE
WEST	Will send the Dan Goodman report(s) for distribution to the group.	ASAP
Rich Valdez	Will form a letter that expresses concerns with the parameters used in HBO that will be forwarded to Eric Gonzales (Reclamation) for the record.	ASAP
Lana Mitchell	Invite work group to choose availability for next PMW meeting via Doodle Poll.	ASAP
Lana Mitchell	Set up a Google Drive folder for the group, and request email addresses to be used for access.	ASAP
Charles Yackulic, Shay Howlin	Work with small group to develop a conceptual base model for the group	November 16, 2018
Mick Porter	Will work with small base model group and Ara Winter on functional analysis of CPUE flow	November 16, 2018
Rich Valdez	Will work with Shay Howlin and Mo Hobbs on survival analysis related to Noon et al. panel.	November 30, 2018
Ashley Tanner, Eric Gonzales	Review and update the statuses of the Hubert et al. and Noon et al. panel recommendations.	November 30, 2018
Eric Gonzales	Will interface with PMW on Phaedra Budy's (Utah State University) contract (phase 1) and will include Mickey Porter and Mo Hobbs	Ongoing
Dave Wegner, Grace Haggerty, Dave Campbell, Matt Wunder, Rick Billings/ Kate Mendoza and/or Mo Hobbs	Will review and refine the PMW FY2019 Work Assignment (Charge).	November 30, 2018

Next Meeting

- The next PMW meeting is TBD for the early December timeframe.

    - Rich Valdez will present technical analysis on Survival Analysis from Noon Science Panel
    - Ara Winter will present a conceptual model addressing how CPUE relates to flow, and as related to habitat.
    - Analysis/presentation of additional Hubert and Noon panel recommendations.

Agenda Review (Dave Wegner)

- The meeting will begin with presentations on work that's been going on, and then shift to business in the afternoon.
    - Charles Yackulic (USGS) and Shay Howlin (WEST, Inc.) are here as experts and will offer back to us ideas, options, different approaches, even different analysis ideas.
    - The PMW charge received more comments at the latest EC meeting (copies were made available to the work group).
    - In an effort to make sure the PMW membership is up to date, a list of contacts was passed around. The group was encouraged to identify those people who are no longer engaged so they could be taken off the list.
        - Ara Winter and Kim Eichhorst (not present) of Bosque Ecosytem Monitoring Program (BEMP) were welcomed as new additions to the work group.
    - Debbie Lee, WEST, read a short list on the science process derived from the last EC meeting.

Analysis of Noon Recommendation E3: "Catch-Per-Unit-Effot of Rio Grande Silvery Minnow at Mesohabitat-Specific Levels" by Rich Valdez

- The following questions/comments and answers were exchanged:

  Question: Was there a QA/QC done on the consolidated database?
  Answer: Yes at the peer review panel level.

  Question: Do we have high confidence that these are the correct data?
  Answer: Yes. There are also additional sources of data that may be useful as well.

  Question: Do you have a graph of mesohabitat availability over time?
  Answer: No. The U.S. Geological Survey (USGS) looked at 15 stations over 2 different flows and saw significant variation in mesohabitat availability.

  Question: Can those USGS data be made available?
  Answer: Yes. They can be sent o Ashley (WEST).

  Question: Did you do the K-S test by station, or could you?
  Answer: No. That couldn't really be done as you would need haul data. Mesohabitats were pooled.

  Comment: There is a bias in the data towards main channel runs. They're frequently sampled and have a low CPUE.
  Response: Not exactly a bias, just a product of the state of the system.

  Comment: The presenter offered the idea of sampling only backwater.
  Response: It was thought that the inverse would be better. If corrected for variability, CPUE would not change very much.

Presentation of "Evaluation of Capture Efficiency of the Rio Grande Silvery Minnow" by Michael Porter

- The following questions/comments and answers were exchanged:

  Question: How did you orient sampling?
  Answer: Upstream to downstream, however that changed in backwaters and pools.

  Question: Where is this species in the water column?
  Answer: We can only speculate. There may be some fish going under the lead line.

  Question: Is there depth data?
  Answer: No, not in the population monitoring data.

  Comment: This is capture efficiency, not probability.

  Question: Does this information help assess the data? Does it give us more or less confidence in data?
  Answer: It reinforces the findings of the Hubert et. al panel. It offers some perspective on catchability, and understanding catchability may help us make better decisions.

  Question: When you looked at these more refined approaches, where you can get more fish in the net, does is help us improve monitoring?
  Answer: In shallow water, these refined approaches worked pretty well. One could weight other hauls to account for reduced catchability

  Question: If you took the block net away, are these data similar or dissimilar to those collected by ASIR?
  Answer: Similar.
  Follow up: This was recently done and the same results were not observed, particularly with regard to capturing larger fish. Something isn't lining up here as the same methods were followed. You might need to add the two nets together, and then compare the resulting data to those collected by ASIR. In addition, these methods will require more people (and as a result, be more expensive), however they aren't necessarily resulting in better data.

  Comment: I'd like to see a break down in CPUE. Are you seeing different size and age fish? If you're not seeing different size fish across years, you can assume you're not seeing many 2 year olds.

  Comment: Would beach behavior be different? We only know relative catchability over both methods.

Analysis of Noon Recommendation E1: "Age Composition of Rio Grande Silvery Minnow, Application of Distribution Separation Methods" by Rich Valdez

- The following questions/comments and answers were exchanged:

Comment: The Bhattacharya and NORSEP length modal separation graph seemed to indicate a second spawning in late summer, however this could be attributed to November augmentation.

Comment: These curves/this analysis is really telling us about the growth of 1st year fish. It gets less reliable as you look to older fish.

Question: In bad years, how does growth look different?
Answer: Not seeing an absence of age 0 fish. In every year, there appears to be some amount of recruitment.

Comment: Outliers would not impact modal progression analysis (ELEFAN-Shepard's method) because it's based on modes of progression of the first year of life, when they reach almost a maximum growth, but you're not going to see if they grew well or poorly in any given year.

Question: Is the data sensitive enough to develop and do covariate analysis?
Answer: That will be a question for the experts.

Question: What does "For age 0 RGSM only" mean? Age in the database is calculated based on length and time of year. How are age classes followed through time in your graphs?
A: ASIR's age designations were used, with age 1 being fish greater than 60mm or caught after December.

Question: Could the age/length relationship in 2006 be examined again? We might not expect to see recruitment during that year.
Answer: Sure.

Question: Is this variation in growth unique? Could we look at growth rate by year?
Answer: This analysis could be affected by outliers. It was suggested that $L\infty$ be plotted by year.

- A discussion on the impact of larger fish took place. In 2017, the CPUE index was high and there was minimal recruitment. It could be an opportunity to see how many 2017 fish persisted in 2018, and into 2019 if it is another low water year.

Information Exchange and Workgroup Assignments

- A discussion of data characterizations and analytical approaches by Charles Y. , Shay H. and other participants took place in which resulted in the following three questions and ideas were posed for potential analyses:

  Q1 What are the management decisions/actions and can they be linked to the population monitoring data, specifically CPUE (because right now, that's what we have)?

  Q2 How does CPUE relate to flow and habitat, including timing, magnitude, and duration of inundation?

        - Assess by reach
        - Use it as a predictor of CPUE. (Tom Dunne developed model).
    Q3 What is the relationship between stocked fish and the natural population?

    Potential Analyses:

    - Which gives you the biggest bang for the investment?
        - CPUE over time; then one could related CPUE to management actions. However, we would need to identify what the management actions were/are.
        - Examine the relationship between flow and CPUE
    - How are stocked fish surviving and contributing to the overall population in the river? One participant suggested a Cormack-Jolly-Seber approach to answering that question. This analysis would help determine the number of fish to augment in the fall.
    - Is the mixture model the most appropriate?
        - CPUE mixture model assessment/assumptions and alternatives
        - What is the model we would like to have? We need something to help us make decisions in the face of uncertainty.
        - Subset: include stock recruitment

- A discussion was started with questions from Charles Y. and Shay H., and encouraged further discussion which is summarized below:

  Question: How do we identify the analyses we are doing? Is there a conceptual model or do we just have the panel recommendations? How did prioritization of the panel recommendations happen? Specifically, what factors were used?
  Answer: Initially, the highest priorities were the Hubert panel recommendations that were related to reanalysis. Some of the recommendations would actually require folks to collect new data, which factored into the priority discussion.

  Question: How many of the panel recommendations were discussed during the initial priority conversation?
  Answer: Roughly half of the panel recommendations can be reconciled with the present ASIR monitoring data, and about half of those can be addressed by this group. The other half of the panel recommendations will need additional work, and possibly data collection (from a total of 32 recommendations).

  - A number of stations and samples have been added. It's a matter of "x" number more. Rich V. proposed he do power analysis to see what additional samples will give us. There's large variability in precision, and it was suggested that more sampling may not result in better data.
  - The group needs to discuss: what do we want these data to do? Do we want to use these data to make recommendations, and ultimately recommendations on management actions?

  Question: I see this as an issue of population status versus population trend. Which do you have to manage on?
  A: We manage on value of that CPUE.

  - The Biological Opinion (BO) is based on a certain CPUE number over time. Where are those thresholds, how reliable is that information?
  - How sensitive is that CPUE and do we need to refine that? Can that be done from the existing data?
  - The CPUE in the BO gives us a target. It doesn't specify how to manage to avoid that target. As a manager, what are the tools to keep from getting to 0.3?
  - So can we use what we have and base it on current October census count?

- We don't have water, money or a place to store the fish. The species doesn't have any kind of water rights. We're trying to get to the best actions with the tools we have. Can we get to a self-sustaining species on the MRG? How do we justify using water for RGSM survival rather than for a RGSM spawning spike?
  - We're looking to link management actions to survival and recruitment success.
  - If we won't have water to maintain, maybe we can establish a habitat that might help in lean water years. But we don't know that. We're trying to figure out non-water solutions for species, especially when we do have water.
- We have different management requirements, so it may be necessary to develop different models for different management goals.
  - It was suggested that there is a strong correlation between October RGSM CPUE and hydrological conditions that year for the entire MRG, however the relationship is weaker if you if you do the analysis by reach. We may need models at different spatial scales, particularly with regard to managing the floodplains.
  - It was stated that peak flow conditions can largely be attributed to snow runoff and nature rather than management actions. We need to better understand what management actions we can take, what their effect on RGSM will be, and when we should take them.

Question: Is there an area we need Shay and Charles to focus on first?

  - The peer review panel said given the species and conditions, CPUE was probably the best measure of abundance. The question now is how is are RGSM behaving? How sensitive are RGSM to flow and different conditions? How can we use that behavioral information? We're not modelers. More integrative type minds can help us with those questions.
  - It was suggested that they first look at the population monitoring database and assess the sensitivity of CPUE. Does something need to come first or concurrently?
  - We started a stock recruitment type model. Dan Goodman then started to put together a Bayesian type model, but it was never picked up again. What really are the needs of the Program and the managers? We surveyed the stakeholders; we may want to revisit that.
  - A lot of emphasis is put on the October RGSM CPUE. Dan Goodman looked at spring recruitment in relation to hydrological parameters and got a better fit than with the October CPUE index.
  - A couple of different areas of interest were identified related to: frequency of flows causing inundation, the way inundation is managed, duration of inundation, and the overall effects on the floodplain.
  - It was stated that RGSM survival, specifically among different age classes of fish, may warrant more investigation.

Question: Is there flexibility in water availability?

Answer: Reclamation can get us upward of 20,000 acre-feet, and they work to meter that water out.
Question: Do you use CPUE to make decisions regarding that 20,000 acre-feet?
Answer: No. It is used as a regulatory matrix, but not for management.

- It was stated that it may be helpful to develop a model that uses CPUE to help decision-makers, incorporating the potential variability of the hydrological conditions and more. This may help managers identify potential management actions.
  - Do we have data to do what he describes?
  - The following example was given: One biologist tells me that I need to create overbanking for 14 days, another says 7. I want to know the amount of water it would take to do that over both time intervals during different times of the year. CPUE isn't sensitive enough to determine how RGSM will subsequently respond to these actions.

- CPUE is sensitive to flow.
  - We don't understand the causation and nuances of that relationship. What is the magnitude of the effect?
  - For example: one year we had high flow and poor recruitment. Spawning was triggered, however we did not see the recruitment response we would expect.
  - A discussion regarding life stage, flow, and inundation began. It was hypothesized that inundation for a long period of time at low flows may be important to developing RGSM, as opposed to a short period of inundation at high flows.

- It was suggested to have a list of goals for Shay and Charles by the end of this session.
  - One suggestion was to relate flow to CPUE.
  - Hydrology data and CPUE data are noisy, and management actions are dependent on sorting out some of that variability. We're closing that gap, but that gap is important; if it is 11 days and not 7, it will make a difference.

  Question: Do we have the data to conduct that analysis today?
  A: Yes, indirectly.
  - There was concern expressed over low flow periods, particularly with regard to subsequent years of low flow conditions. Is the answer to have hatcheries put 10 times as many fish to put in the river when we have water? Does the population monitoring data give us what we need, or is there anything else we need to assess how to get through low-flow conditions?
  - Is CPUE sensitive enough to help management make a decision?
  - In the Noon et al. panel recommendations, D4 (page 24) was given a low priority. This recommendation asks: "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?" While it was given a low priority, the group indicated that it was not because it wasn't important.
  - If you assume CPUE correctly reflects abundance of fish over time, then you can correlate CPUE to different management scenarios. For example, we could then assess whether a spring pulse or keeping things wet through the summer is a better use of water.

    - There was some discussion regarding the connection, or lack thereof, between management and CPUE data. It was stated that managers are discouraged because they're not seeing the RGSM response they were hoping for.

    Question: Is there anything we can do to identify additional management options or to assist managers is making better decisions?
    Answer: It depends on how important survival and recruitment is.

    - It was suggested that monitoring continue in October during high flow years and research money be spent on understanding spring CPUE values in bad years.
    - It was stated that there is a gap in knowledge regarding survival of older (4-5 year old) fish.
    - What is the relationship between stocked fish and natural population? What is the survival of hatchery fish after release?
    - Stocked fish numbers are based on CPUE.

    Question: Are there other analyses that we should put up here as a first cut?
    Answer: Charles replied that when he looked over the recommendations, he asked, "what are the management actions and what data are available?" He thought an integrated analysis may be useful as it incorporates everything, though it will usually result in recommendations for additional research. Understanding what model the group wants helps him decide if the group has the right data.

    - It would be helpful to assess the utility of CPUE versus having everything you want.
    - Some discussion took place regarding the mechanics of such a model, including the place for expert input and the ability to address management-related questions. It was stated that the group can use thresholds that matter to understand value of management actions in this model, however it would be helpful to start with a population model to see if additional data is needed.
    - It was decided to move forward with the model, and to continue to use this model as needed in the AM framework.

  - The group identified a few people to work with Charles Y. and Shay H. on a population model, including: Rich V., Ara W., Shay H., Ashley T., Kate M., and Mick P.
    - Charles Y. will write his general thoughts on paper on how to proceed with a population model and give them to the small group. After review, they will give this proposal to the larger group.
    - The group can assist in coming up with covariates, questions they want to address, and more.

  - ➢ WEST will send the Dan Goodman report(s) for distribution to the group.
  - ➢ Charles Y. and Shay H. will work with small group to develop a conceptual base model for the group.

  - ➢ Ashley T. and Eric G. will update the statuses of the Hubert et al. and Noon et al. panel recommendations.

- Schedule other analyses and/or presentations of related research. Various ideas were contributed:

- It was suggest that some analyses/discussion take place with respect to the schooling nature of RGSM and the potential impact on CPUE. How does the sampling design and schooling nature and distribution of the fish potentially impact CPUE?
- ➢ Rich V. will work with Shay H. and Mo H. on survival analysis related to the Noon et al. panel.
- ➢ Ara W. volunteered to take a first cut at Q2 (How does CPUE relate to flow and habitat, including timing, magnitude, and duration of inundation?) by the next meeting, with input from Mick P.

Business

- The PMW was asked how it would structure itself light of the chair needing a prolonged absence. The group was asked if it would like an interim or permanent co-chair to run meetings.
    - An update on the chair's status is expected in mid-November, so it was decided that the PMW could wait for the chair's likely return and decide on a co-chair then.
- How does the group keep a record of any of these analyses?
    - In the end, the goal is to provide a small report/documentation and accompanying data of analysis that would become a part of a master database and a packaged consolidated report. The DBMS could be used for this. The database would also include peer review reports and other pertinent documents that form the basis of the analysis. Perhaps WEST has a share folder site that participants can gain access to.
    - Ideally, the Program DBMS would be the storage place for the PMW work documents; however, it is still under construction. The WEST share folder site runs into accessibility issues when participants do not log off properly, among other challenges.
    - ➢ WEST will set up with a Google Drive folder for the group's documents and data.
- The work group discussed potential coordination between Reclamation and the PMW on the assessment of the 2016 BO's HBO.
    - A participant expressed problems with parameters used in the HBO with regard to the minnow. A participant from Reclamation said the contractor in phase 1 is tasked to look at that. It was recommended that concerns be brought to Reclamation's attention in the form of a letter.
    - A commitment was made from Reclamation to interface with PMW and to keep lines of communication open. There will be opportunities for the PMW to interact with those conducting the HBO assessment in the future, and the PMW will be made aware of those opportunities.
    - ➢ Rich V. will form a letter that expresses concerns with the parameters used in HBO that will be forwarded to Eric G. (Reclamation) for the record.
    - ➢ Eric G. will interface with PMW on Phaedra Budy's (Utah State University) contract (phase 1) and will include Mickey Porter (USACE) and Mo Hobbs (ABCWUA) as needed.
- The EC requested at their last meeting, that PMW FY2019 Work Assignment (Charge) be further reviewed and refined and to integrate into tasks/schedule any new work discussed above.
    - ➢ Dave W., Grace H., Dave Campbell, Matt Wunder, and Rick Billings (and/or Kate Mendoza and Mo H.) will review and refine the PMW FY2019 Work Assignment (Charge).

Present

Name	Agency
Thomas Archdeacon	U.S. Fish & Wildlife Service
Dave Campbell	U.S. Fish & Wildlife Service
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	Western Ecosystems Technology, Inc.
Debbie Lee	Western Ecosystems Technology, Inc.
Mike Marcus	Assessment Payers Association of the MRGCD
Kate Mendoza	Albuquerque Bernalillo County Water Utility Authority
Lana Mitchell	Western Ecosystems Technology, Inc.
Mick Porter	U.S. Army Corps of Engineers
Ashley Tanner	Western Ecosystems Technology, Inc.
Rich Valdez	SWCA Environmental Consultants
Dave Wegner	Western Ecosystems Technology, Inc.
Ara Winter	Bosque Ecosystem Monitoring Program
Matt Wunder	N.M. Department of Game and Fish
Charles Yackulic	U.S. Geological Survey
Stephen Zipper	SWCA Environmental Consultants

Evaluation of Capture Efficiency of the Rio Grande Silvery Minnow

Michael Porter, Ph.D.

October 2018

US Army Corps of Engineers
BUILDING STRONG®

Catchability*

The extent to which a fish stock is susceptible to fishing;
The proportion of the stock removed by one unit of fishing effort.

*Bonar, S.A., W.A. Hubert, and D.W. Willis 2009.
Standard Methods for Sampling North American Freshwater Fishes.

Detection Probability *

The probability of capturing
a single individual with
a specified amount of effort using
a defined sampling method.

Assumptions:
Species detection probability was reasonably similar across sites.
Species detection probability was reasonably similar across years.

2005

RGSM probability of detection estimates

Parameter	Probability of Detection Estimate	Standard Error of Estimate	Lower 95% CI of Estimate	Upper 95% CI of Estimate
p: All RGSM	0.6814	0.0151	0.6511	0.7101
p: Age-0 RGSM	0.6740	0.0152	0.6436	0.7031

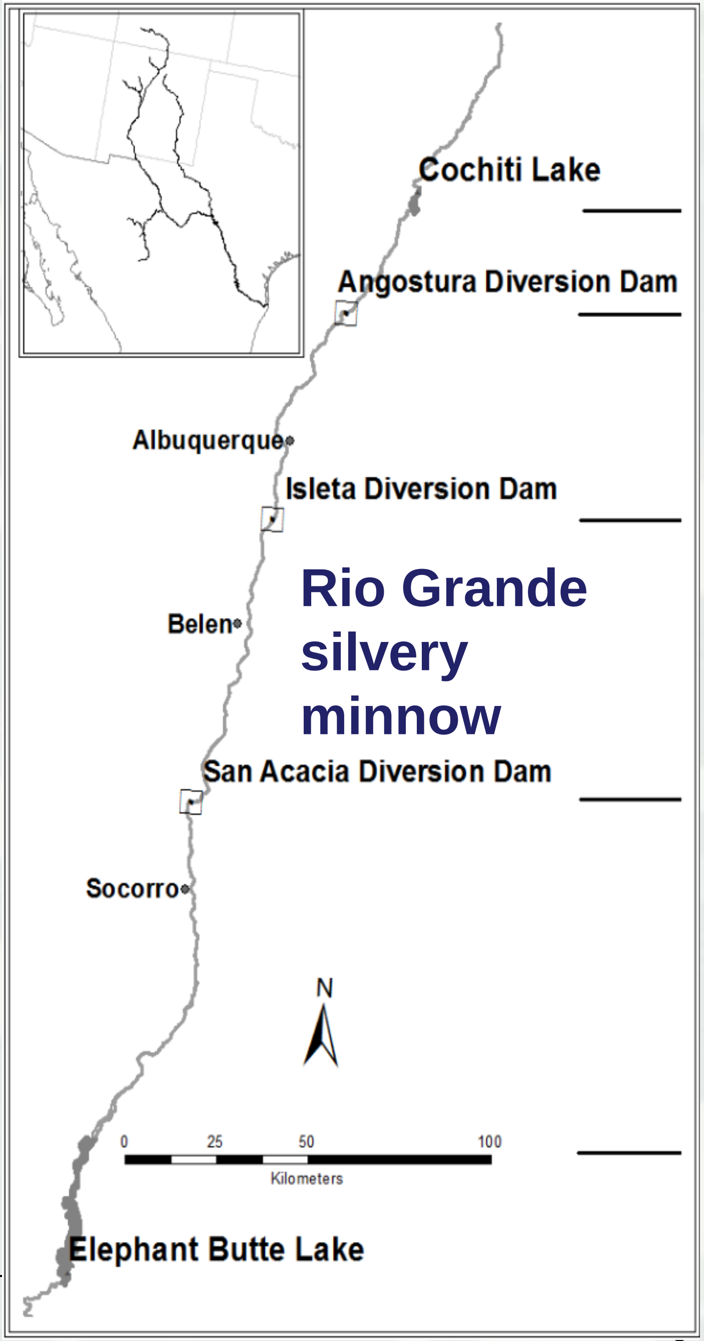
2006

RGSM probability of detection estimates

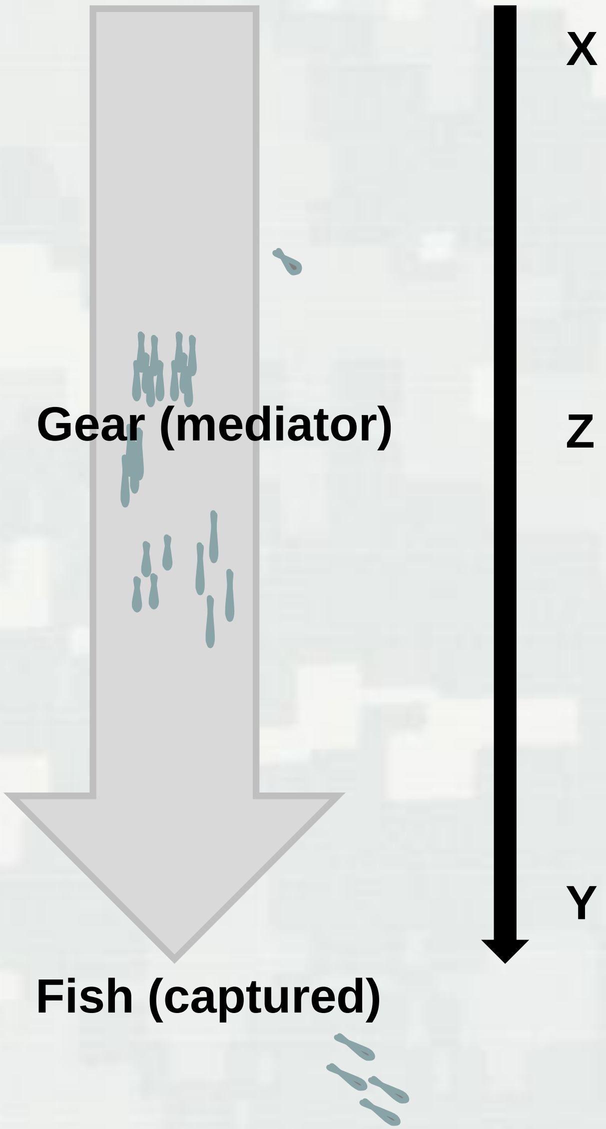
Parameter	Probability of Detection Estimate	Standard Error of Estimate	Lower 95% CI of Estimate	Upper 95% CI of Estimate
p: All RGSM	0.4034	0.0230	0.3593	0.4491
p: Age-0 RGSM	0.3629	0.0292	0.3078	0.4218
p: Age-1 RGSM	0.2957	0.0282	0.2435	0.3538

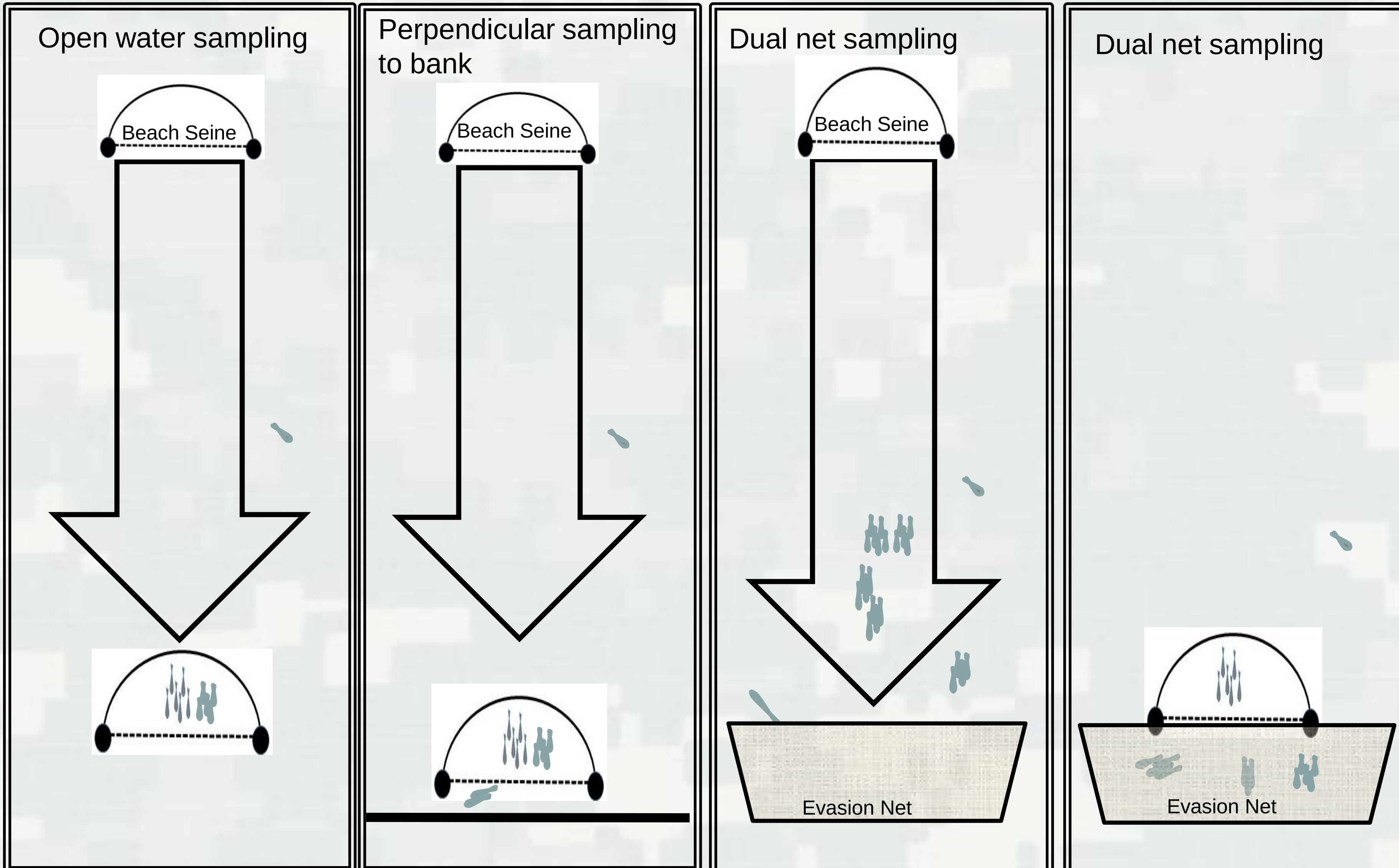
Capture Efficiency*

The percentage or proportion of the true number of individuals present at a sampling site that are captured with a specified amount of effort using a type of gear or capture method.



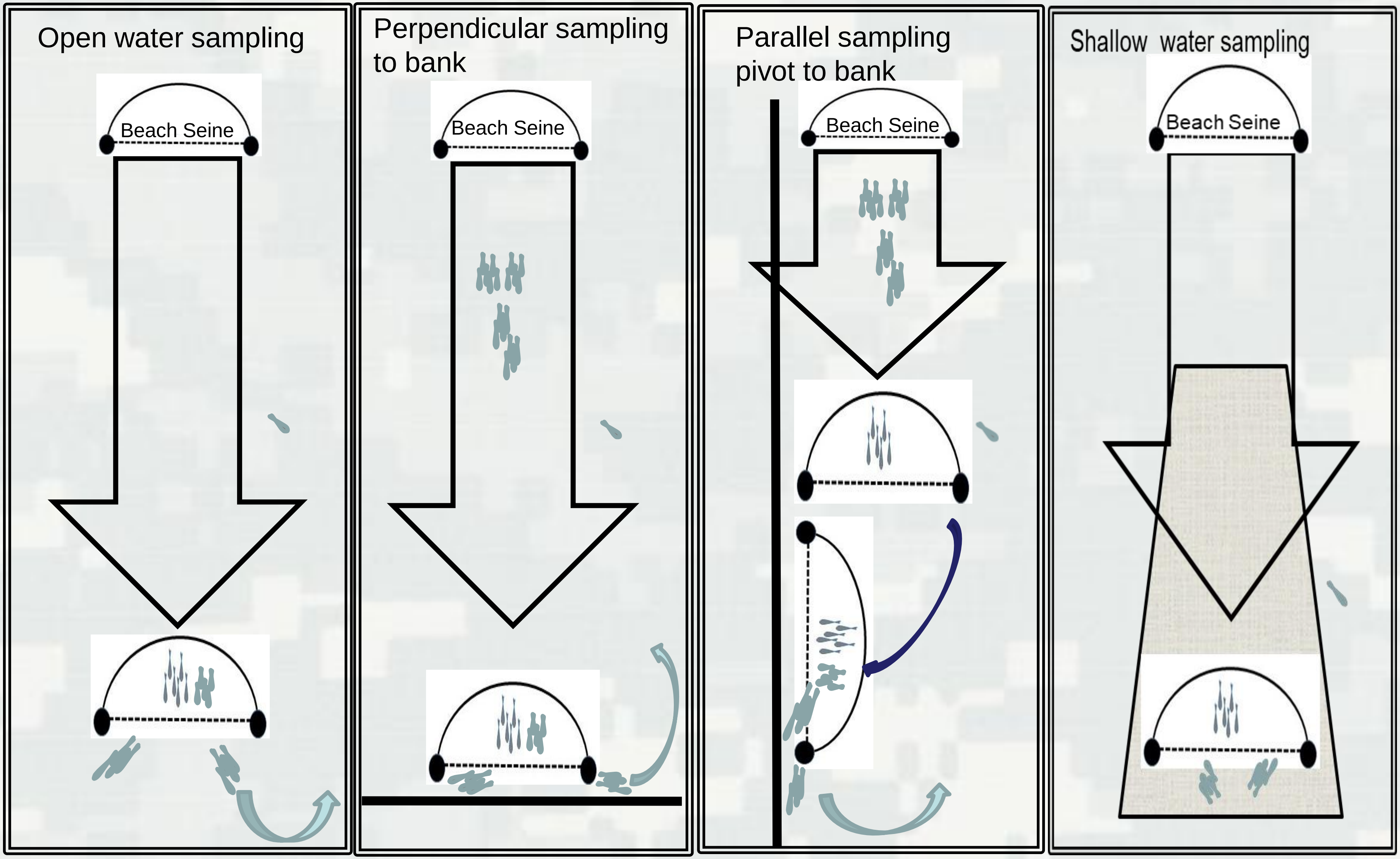
Fish (number in sample area)




Open water sampling
Beach Seine
Perpendicular sampling to bank
Beach Seine
Dual net sampling
Beach Seine
Evasion Net
Dual net sampling
Evasion Net

Capture Efficiency
By size and species

		Cyprinella lutrensis		*Hybognathus amarus*		*Platygobio gracilis*	
		Beach	**E-net**	**Beach**	**E-net**	**Beach**	**E-net**
Size group	**<20 mm Capture**	0.734	0.266	0.711	0.289	0.821	0.179
	<20 mm Error	0.176	0.551	0.148	0.481	0.118	0.724
	20-30 mm Capture	0.676	0.324	0.499	0.501	0.743	0.257
	20-30 mm Error	0.180	0.459	0.288	0.288	0.209	0.649
	>30 mm Capture	0.631	0.369	0.294	0.706	0.516	0.484
	>30 mm Error	0.231	0.473	0.544	0.211	0.329	0.349
Habitat CPUE	**Backwater** **1093 m^2, n=78**	50.524	21.653	25.652	69.063	27.744	7.834
	Pool **3655 m^2, n=220**	30.411	17.889	19.829	19.094	5.759	4.430
	Riffle **978.25 m^2, n=45**	9.475	7.407	4.651	11.628	11.628	14.729
	Run **13781.5 m^2, n=667**	11.366	4.381	8.799	11.376	9.170	5.320

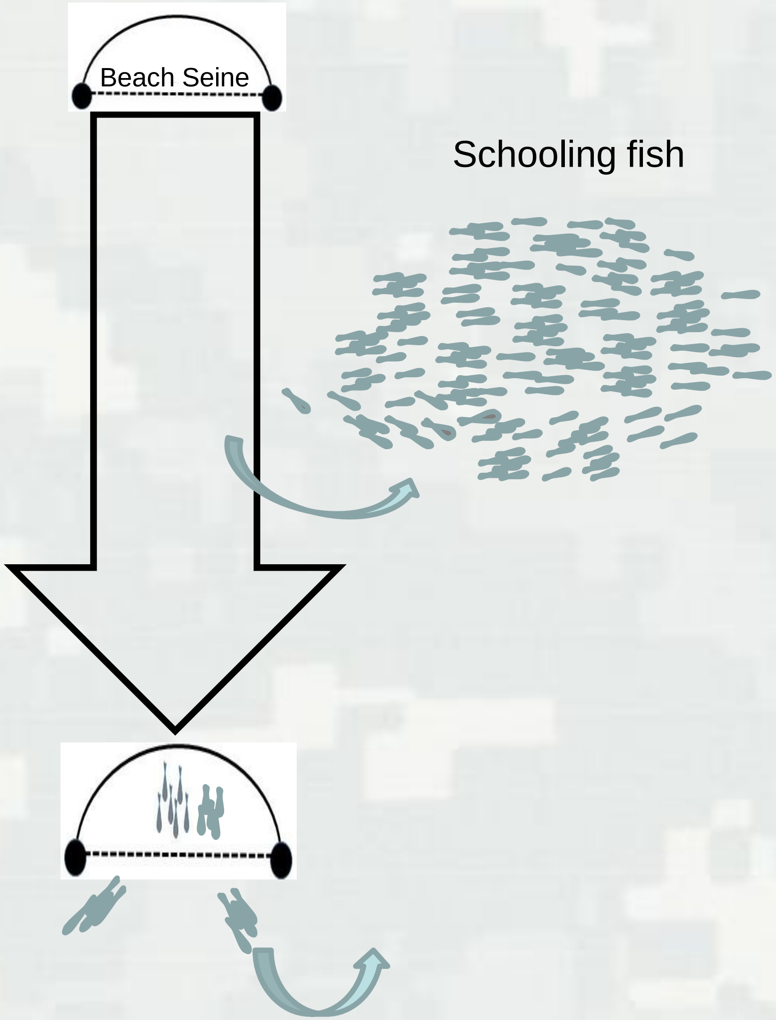

Open water sampling
Beach Seine
Perpendicular sampling to bank
Beach Seine
Parallel sampling pivot to bank
Beach Seine
Shallow water sampling
Beach Seine

Next steps

- Classify capture techniques and record use when sampling
- Identify flows for assigning capture efficiency values
- Identify which analyses are informed by capture efficiency
- Assign capture efficiency values based on local flow
- Develop analyses to compare seine data with fyke net data
- Other ideas?

Questions?

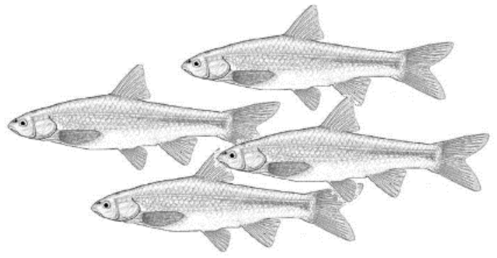
Open water sampling



Age Composition of Rio Grande Silvery Minnow

Application of Distribution Separation Methods

Noon Science Panel Recommendation E1



A Data Analysis Done for and in Collaboration with the Population Monitoring Workgroup

Richard A. Valdez, Ph.D., SWCA, NMISC

Population Monitoring Workgroup Meeting

October 2, 2018

Recommended Study E1 (Noon et al. [2017] Science Panel**)

"E1. Establish the Age Composition of the Rio Grande Silvery Minnow Population (Tier 1 Study). Two distinct studies are needed to address this issue:

E1a. Application of Distribution Separation Methods to Estimate Age Composition.

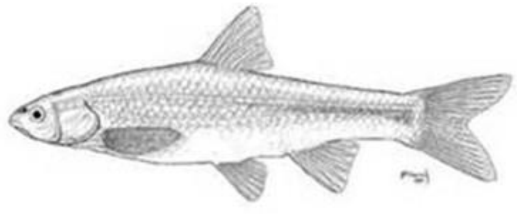
- *Ideally, small samples of RGSMs should be aged each year (October and spring) to provide estimates of mean length and variance in length at age. Annual estimates allow for time-dependent assignments to age-class and provide insights into how size is varying over time. These estimates would be used as input for R package "mixdist" (MacDonald 2015) that is designed to separate overlapping distributions into component distributions and thereby allow estimation of age composition."* ***(use instead ELEFAN, D. Pauly)***

"E1b. Gear Selection Study

- We recommend that quantitative comparisons of RGSM catches in fyke nets and in beach seines should be carried out in flooded floodplain habitat where both gear types can be effectively deployed (see Gonzales et al. 2014). Comparison of length frequencies of fish collected in the two gears should allow generation of a **size selection curve** for the beach seine gear under the (reasonable, but difficult to test) assumption that the (passive) fyke net gear is non-selective with respect to size of fish."

**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.

Three Parts—Analytical Methods



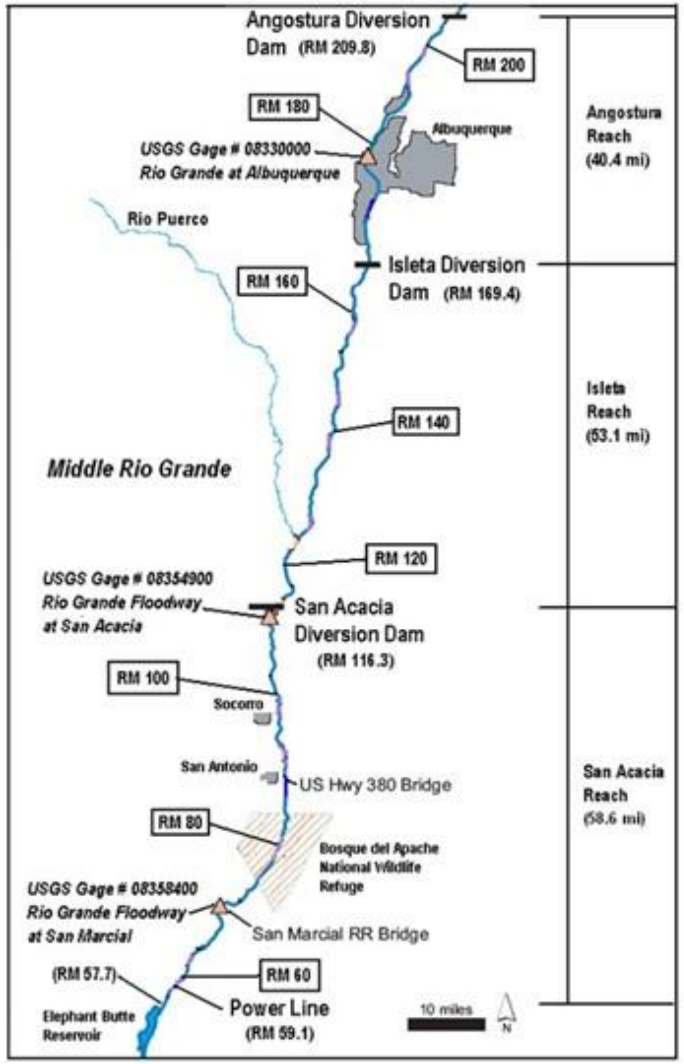
Rio Grande Silvery Minnow

1. Monthly length-frequency distributions and use of modal separation:
    a. Monthly length-frequency analysis, and
    b. Bhattacharya method and NORMSEP.**
2. Growth models to estimate length-at-age:
    a. Modal progression (ELEFAN, Shepard's Method**), and
    b. von Bertalanffy growth function (VBGF and SVBGF).
3. Compare fish lengths for seines, block nets, and fyke nets:
    a. Gear size selection curves

**Sparre, P., and S.C. Venema. 1998. Introduction to tropical fish stock assessment. Part I: Manual. FAO Fisheries Technical Paper 306/1, Rev. 2, Rome, Italy. (FiSAT II – FAO ICLARM Fish Stock Assessment Tool)

Part 1. Fish Lengths in Database by Reach (1993-2016)

Of 64,470 RGSM, 61,850 (96%) were measured for standard length



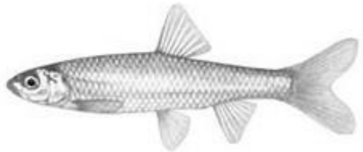
First recruit into seine gear type

Month	Angostura				Isleta				San Acacia				Total
	0	1	2	Total	0	1	2	Total	0	1	2	Total	
Jan		25	9	34		65	24	89		132	13	145	268
Feb		264	51	315		466	48	514		4457	259	4716	5545
Mar		38	53	91		93	19	112		367	24	391	594
Apr		376	58	434		206	38	244		1052	83	1135	1813
May		181	7	188	1	225	22	248	214	1091	52	1357	1793
Jun	764	171	16	951	2897	210	5	3112	684	465	28	1177	5240
Jul	1527	81	10	1618	3848	77	20	3945	12994	545	32	13571	19134
Aug	1607	79	7	1693	1838	50	8	1896	5920	280	17	6217	9806
Sep	844	42	10	896	1113	65	7	1185	1883	59	3	1945	4026
Oct	1524	56	17	1597	1281	52	11	1344	5451	99	17	5567	8508
Nov	12	2	1	15	13	3	5	21	205	9	2	216	252
Dec	356	69	25	450	992	70	13	1075	3177	133	36	3346	4871
Total	**6634**	**1384**	**264**	**8282 (13%)**	**11983**	**1582**	**220**	**13785 (22%)**	**30528**	**8689**	**566**	**39783 (64%)**	**61850**

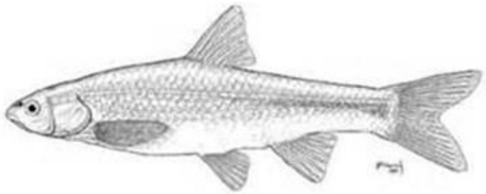
Minimum, Maximum, and Mean Standard Length of RGSM by Month and Reach (1993-2016)

First recruit into seine gear type

Min = 5 mm SL



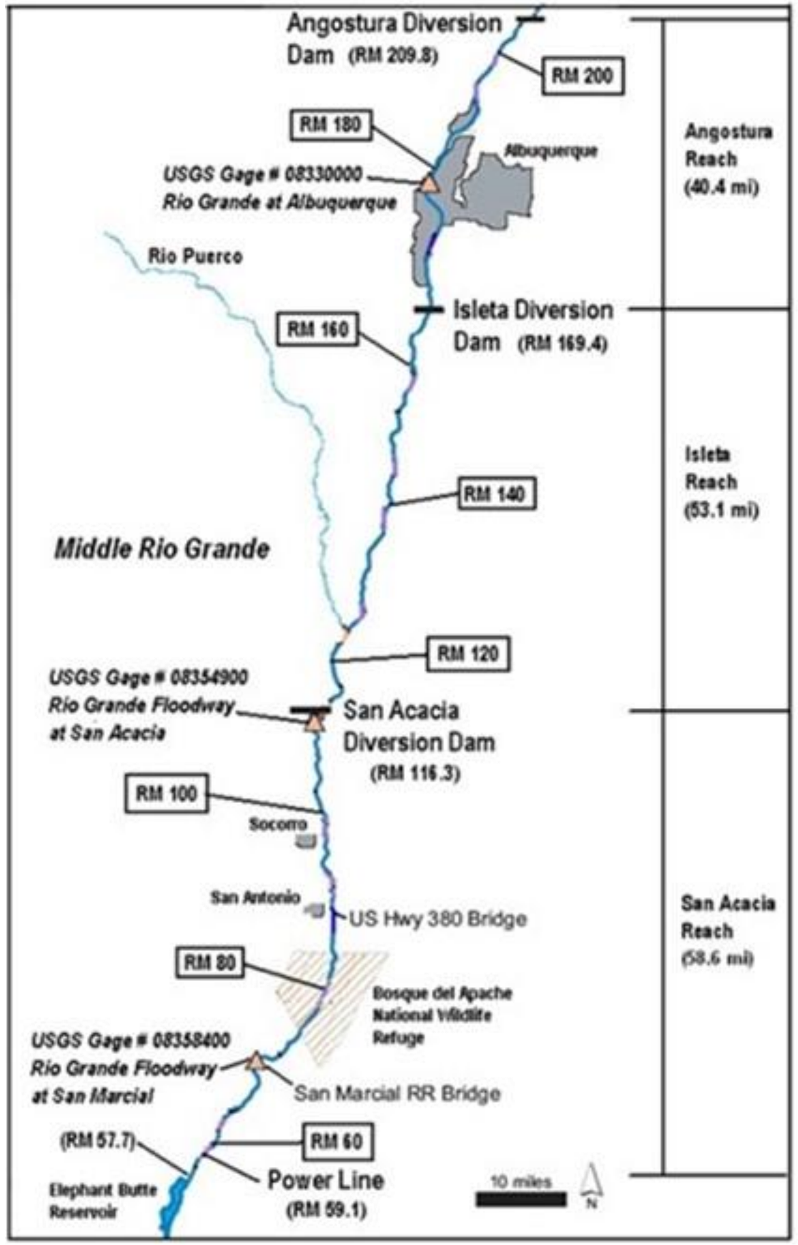
Mean = 33.9 mm SL

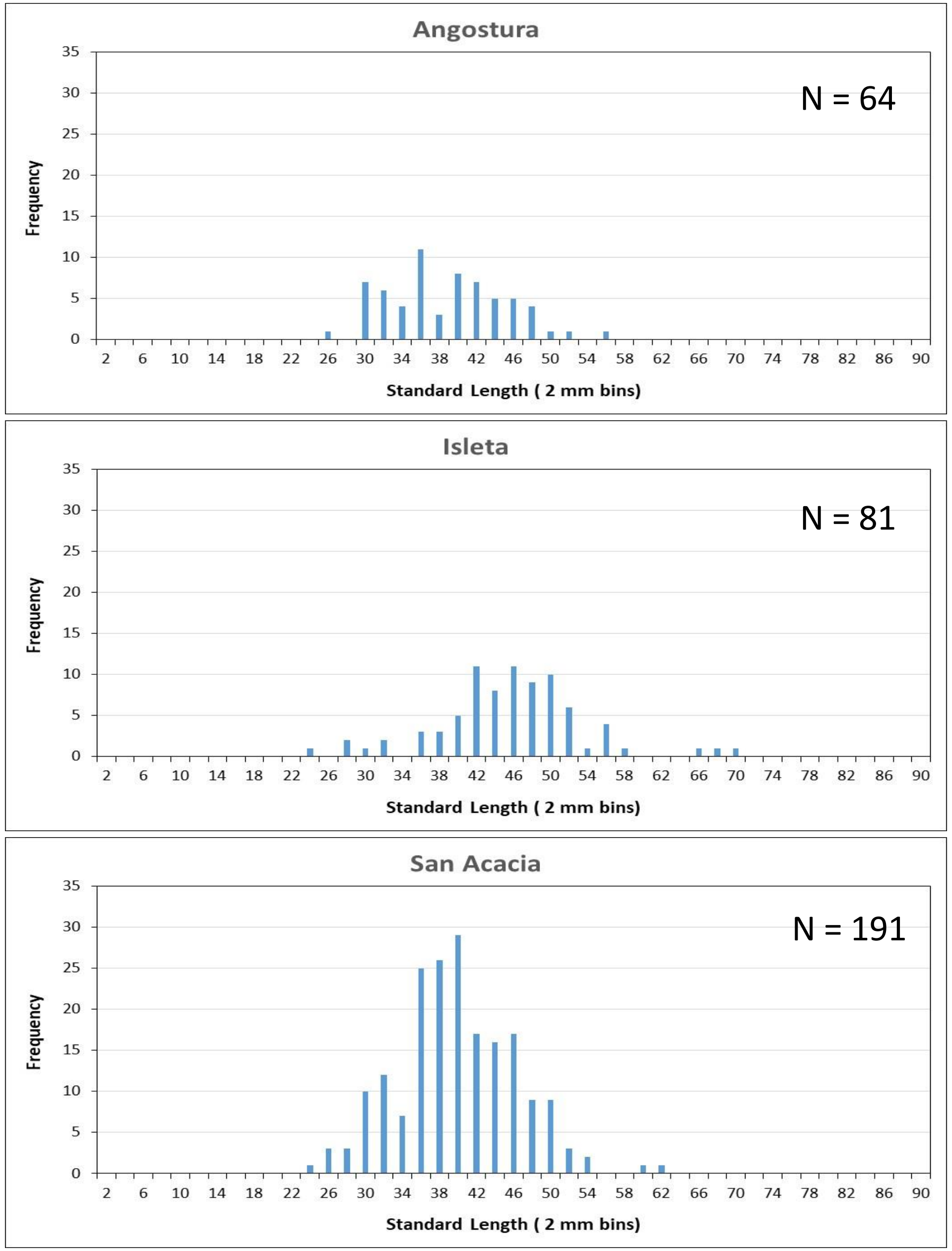


Max = 90 mm SL

Month	Angostura			Isleta			San Acacia			All Reaches		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Jan	31	73	54.97	27	77	53.17	25	82	50.75	25	82	52.09
Feb	29	85	48.60	30	84	50.17	20	81	43.59	20	85	44.48
Mar	30	74	58.40	29	80	49.81	22	82	40.20	22	82	44.80
Apr	32	85	48.64	31	80	50.60	26	78	50.16	26	85	49.86
May	24	78	51.51	8	76	54.88	5	86	41.93	5	86	44.73
Jun	5	73	17.93	5	73	13.92	6	90	27.79	5	90	17.77
Jul	7	83	22.18	8	78	25.72	8	76	26.87	7	83	26.24
Aug	13	87	30.11	13	88	31.43	12	80	31.12	12	88	31.01
Sep	19	83	38.70	12	76	44.75	17	72	36.33	12	83	39.34
Oct	22	78	42.46	24	83	48.38	18	80	37.65	18	83	40.25
Nov	32	71	48.93	27	81	58.43	23	79	46.81	23	81	47.91
Dec	29	82	50.24	20	85	50.10	24	82	44.88	20	85	46.53
Total	**5**	**87**	**34.17**	**5**	**88**	**31.89**	**5**	**90**	**34.54**	**5**	**90**	**33.90**

Size Distribution Differs by Reach





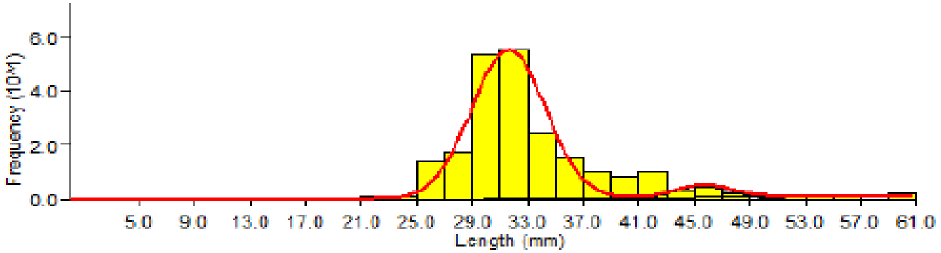
10/4/2016

Size difference by reach:

- Numbers of fish usually greatest in San Acacia.
- Fish length influenced by spawning time, growth, survival, etc.
- Hence—Fish from San Acacia Reach were used in analysis.

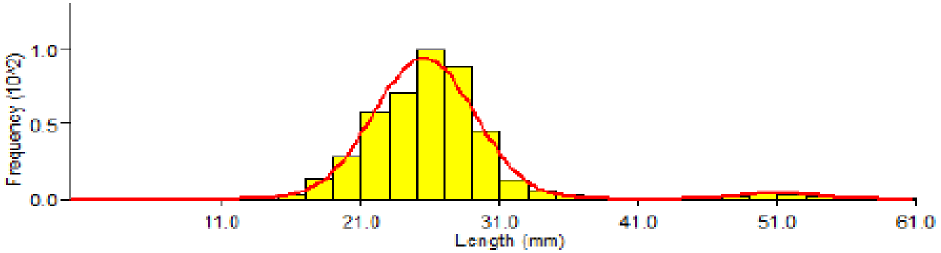
Bhattacharya and NORMSEP Length Modal Separation (San Acacia – 1997)

3/3/1997



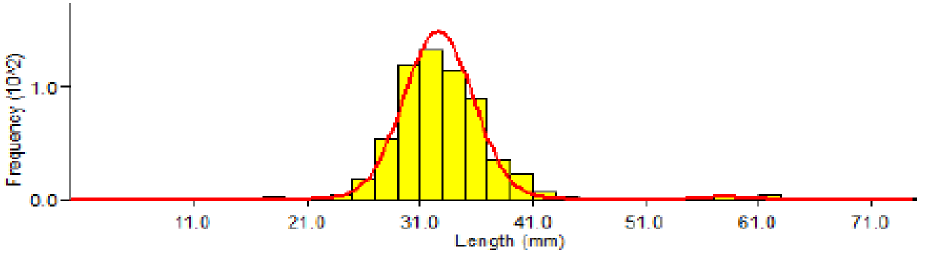
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	31.6	31.6	2.66	183	n.a.
2	45.59	45.59	2.02	11	5.98
3	55.07	55.07	10.5	13	1.51

7/3/1997



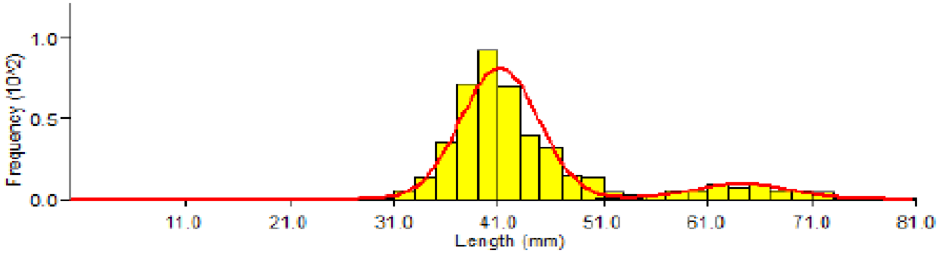
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	25.51	25.51	3.64	426	n.a.
2	51	51	2.7	13	8.04

8/20/1997



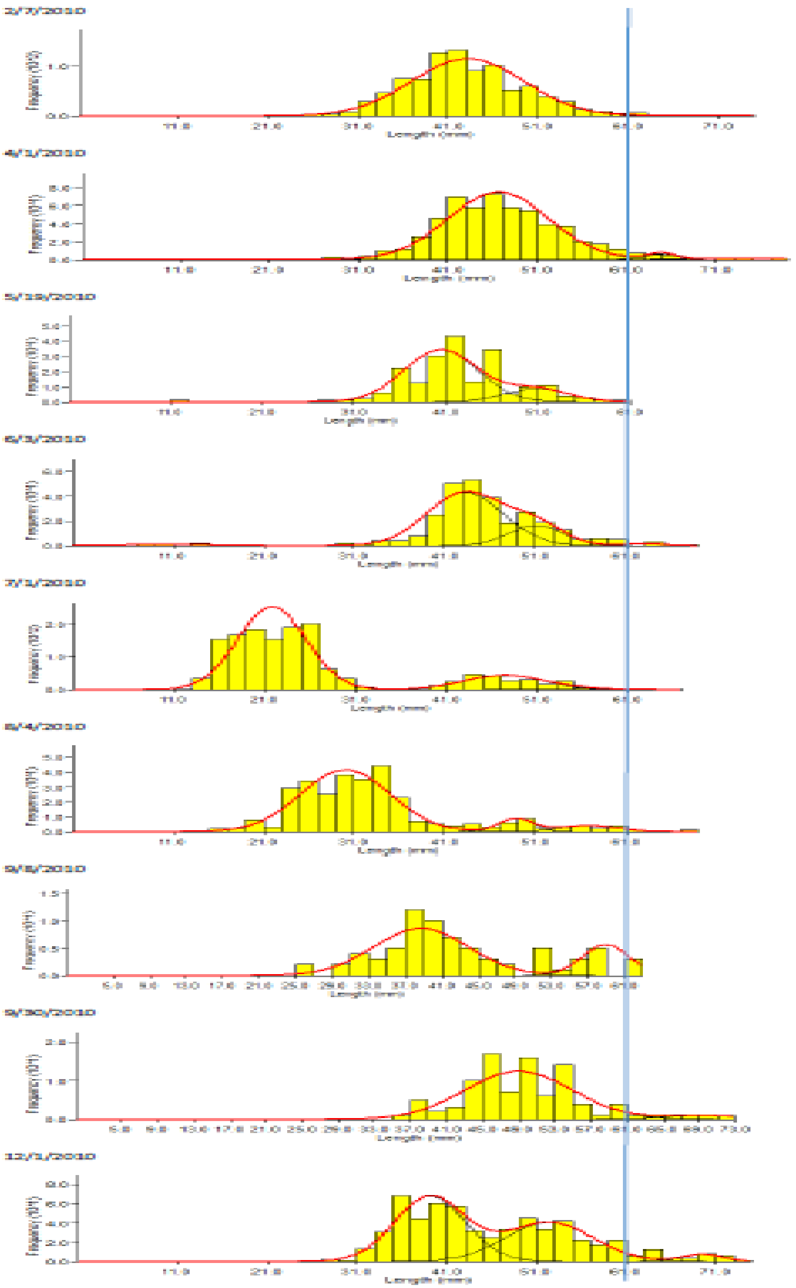
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	32.64	32.64	3.07	572	n.a.
2	58	58	1.7	4	10.63

10/15/1997



Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	41.11	41.11	3.74	380	n.a.
2	64.21	64.21	4.58	54	5.55

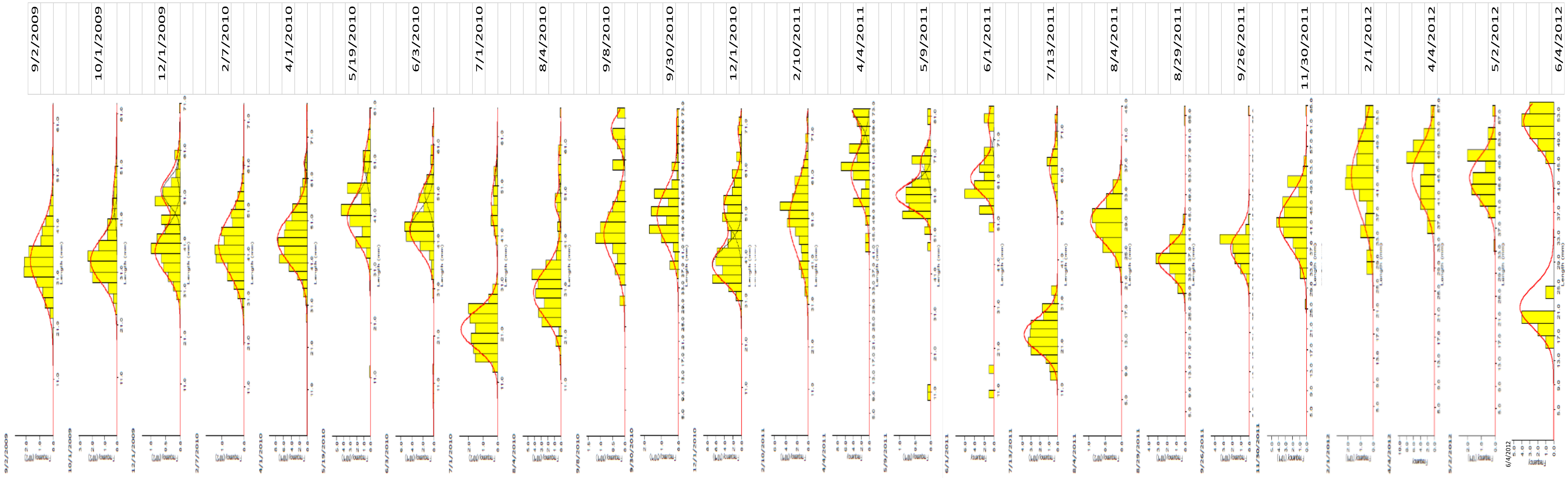
Bhattacharya and NORMSEP Length Modal Separation (San Acacia – 2010)



2/7/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	43.12	43.12	6.23	890	n.a.
	2	68.71	68.71	4.15	6	4.93
4/1/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	46.62	46.62	5.61	523	n.a.
	2	64.85	64.85	1.62	13	5.04
	3	75	75	34.68	43	0.56
5/19/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	40.44	40.44	4.02	172	n.a.
	2	50.95	50.95	3.43	37	2.82
6/3/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	10.33	10.33	4.39	6	n.a.
	2	43.19	43.19	4.21	226	7.64
	3	51.06	51.06	3.1	63	2.15
	4	63	63	1.91	4	4.77
7/1/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	21.77	21.77	3.78	1190	n.a.
	2	47.27	47.27	4.39	237	6.24
	3	54.63	54.63	4.18	13	1.72
8/4/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	30.03	30.03	4.97	258	n.a.
	2	48.81	48.81	1.88	21	5.48
	3	56.71	56.71	3.2	16	3.11
9/8/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	38.69	38.69	5.22	56	n.a.
	2	58.91	58.91	2.57	18	5.19
9/30/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	49	49	5.97	93	n.a.
	2	69.13	69.13	4.12	5	3.99
12/1/2010	Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
	1	39.18	39.18	3.96	334	n.a.
	2	52.45	52.45	4.87	248	3.01
	3	69.5	69.5	2.31	21	4.75

Length-Frequency (Bhattacharya/NORMSEP) ASIR Database, San Acacia Reach (2009-2012)

- Length modes show fish growth; rapid in summer, slow in winter.
- Predominantly 1 to 3 length groups.
- Small numbers of larger fish.
- First appearance of year class usually in June or July.



Modal Progression Analysis (ELEFAN—Shepard's Method)

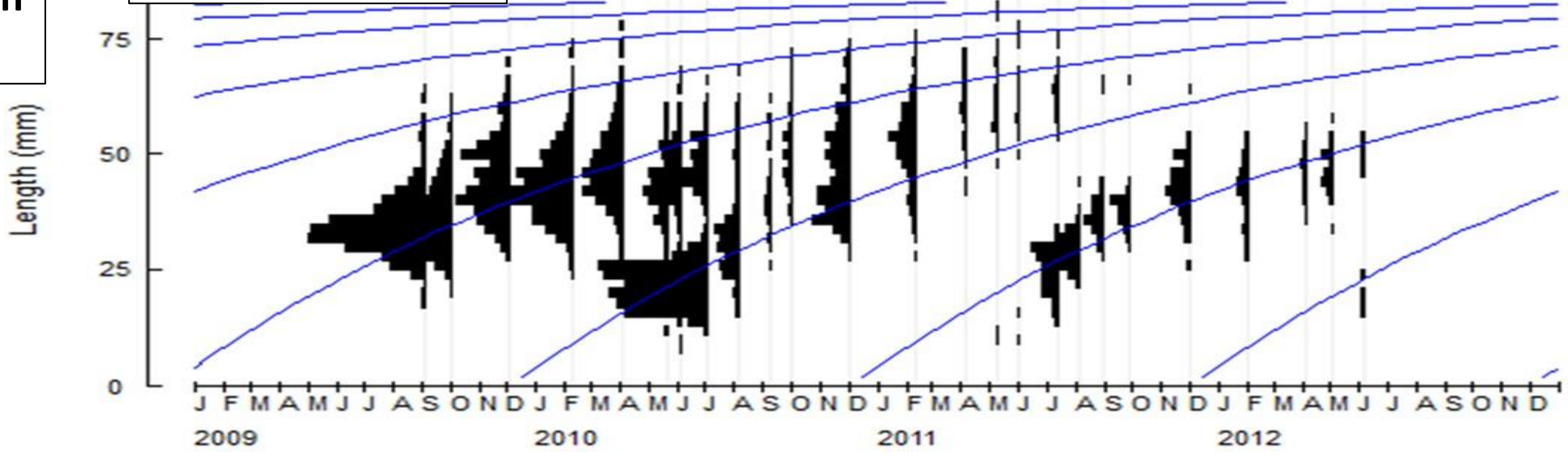
von Bertalanffy Growth Function (VBGF)

$L_t = L\infty * [1 - \exp(-K*(t-t_0))]$

2009 – 2012 year classes

VBGF

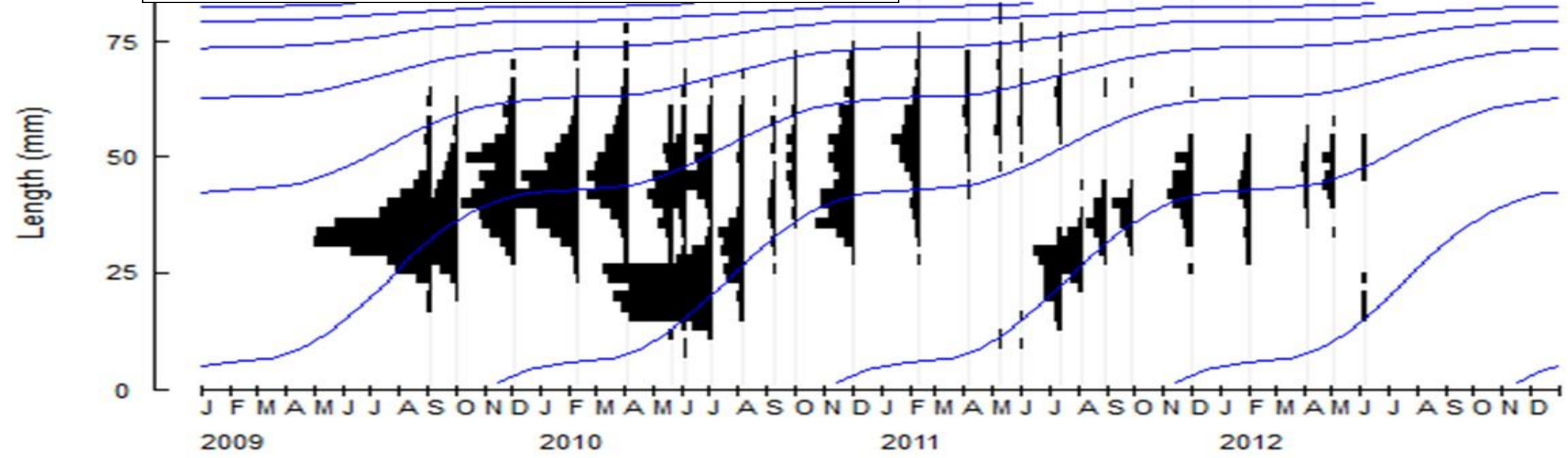
- L∞ = 86.1 mm SL
- K = 0.620



$L_t = L\infty * [1 – \exp(-K*(t-t_0) - (C*K/2pi) * (\sin(2pi*(t-tw))))]$

SVBGF

- L∞ = 86.1 mm SL
- K = 0.620
- Amplitude (C) = 0.90
- Winter Pt. (tw) = 0.10



Modal Progression Analysis (ELEFAN—Shepard's Method)

$$L_t = L\infty * [1 - \exp(-K*(t-t_0))]$$

First Order Von Bertalanffy Growth Function (VBGF):

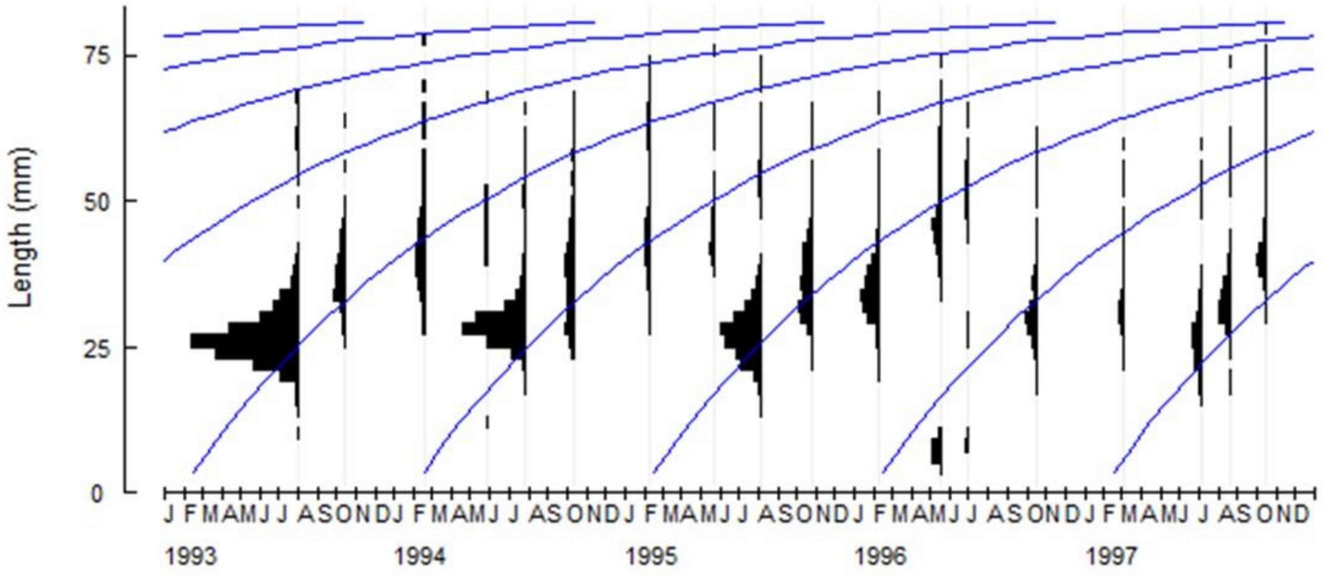
- Poor fit to monthly modes of length frequency histograms.
- Most collections have few larger fish.
- Difficult to track length modes for more than 2-3 years.

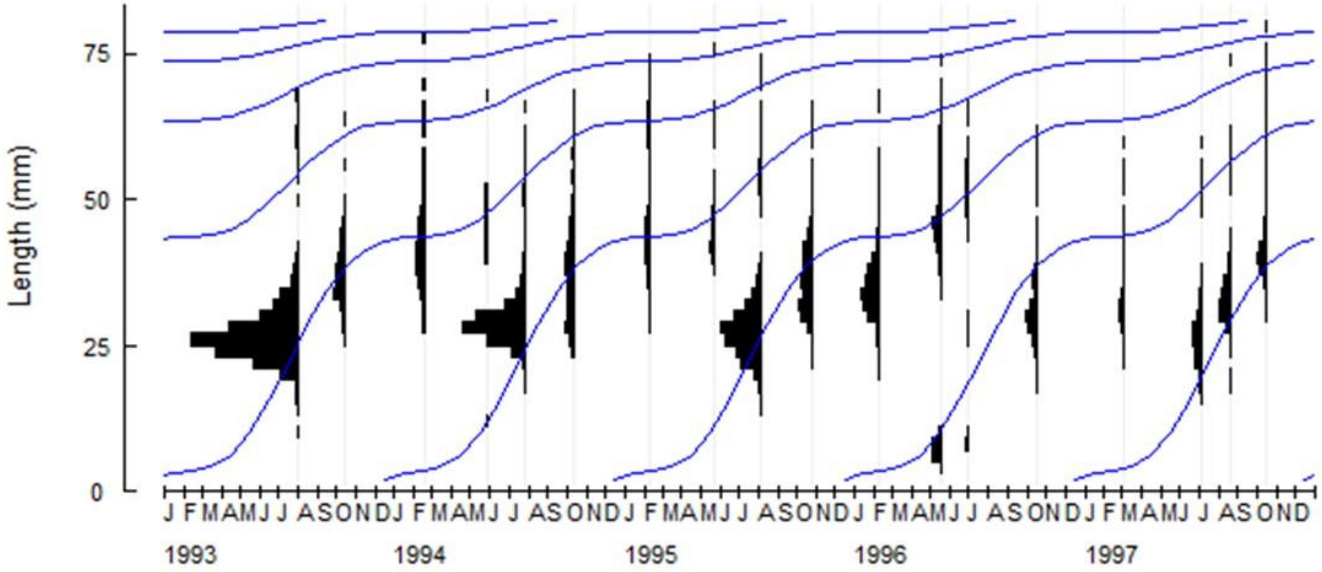
$$L_t = L\infty * [1 - \exp(-K*(t-t_0) - (C*K/2pi) * (\sin(2pi*(t-tw))))]$$

Seasonalized Von Bertalanffy Growth Function (SVBGF):

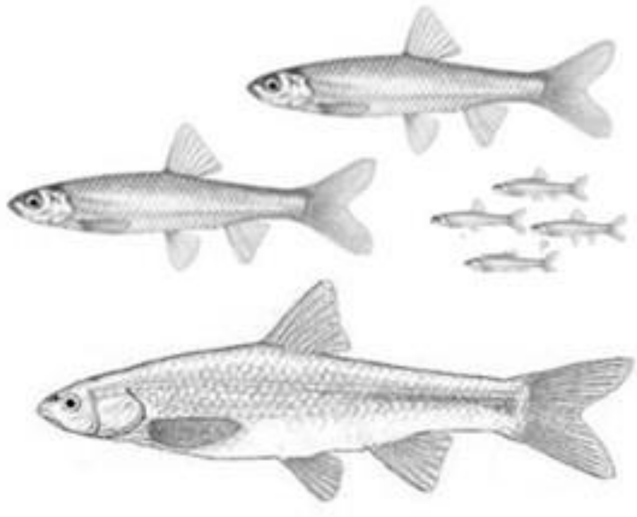
- Accounts for slow winter growth.
- Better fit with SVBGF, shows seasonal growth rates.

1993 – 1997 year classes





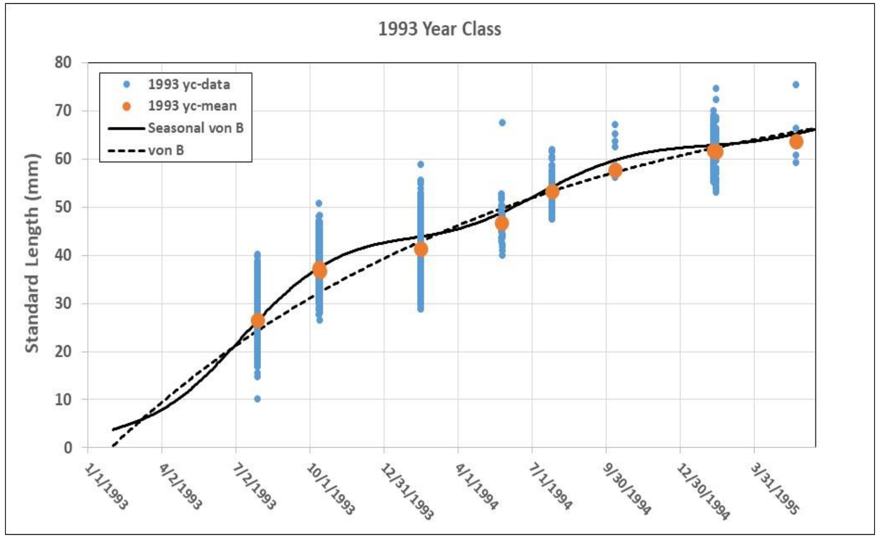
Part 1 Summary—Modal Separation Using ASIR Database:

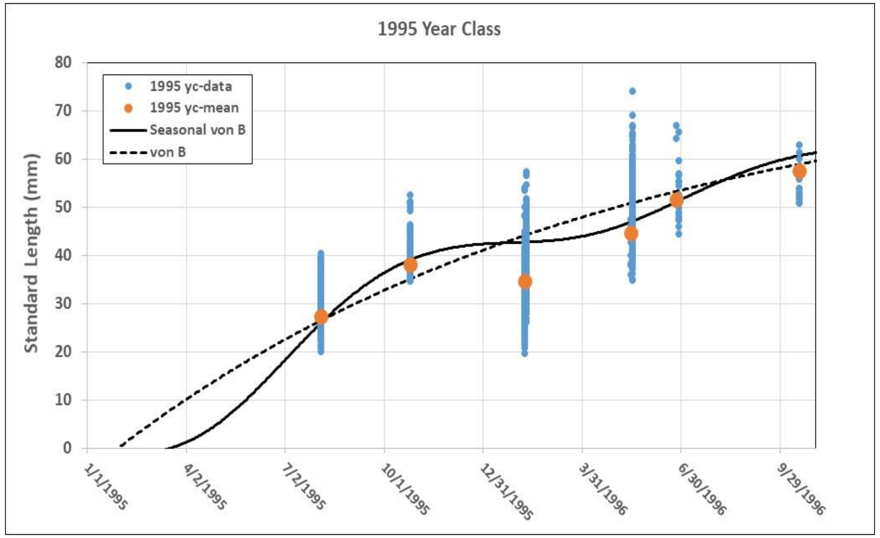


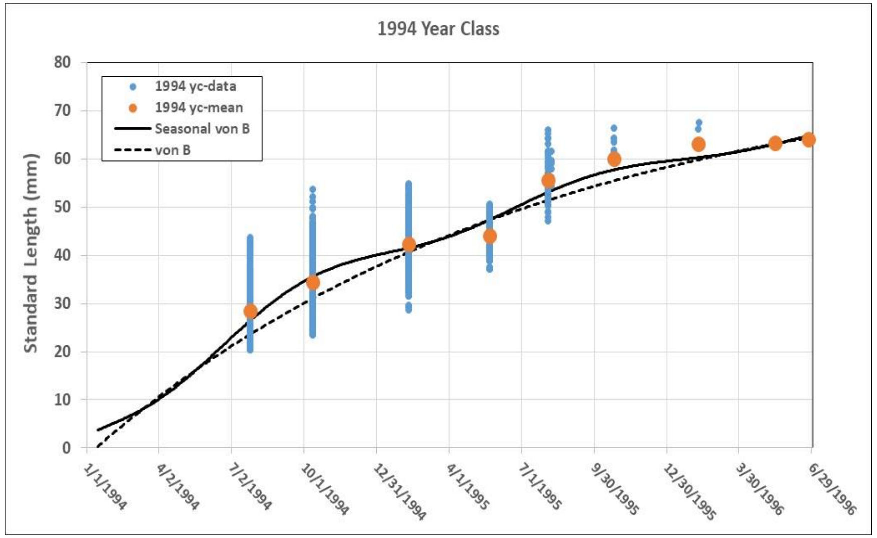
- Modal separation possible for only 1-3 length groups.
- Larger fish (> 60 mm SL) present in small numbers.
- Different seasonal growth rates apparent (slow in winter).
- Seasonalized VBGF best describes growth after July.

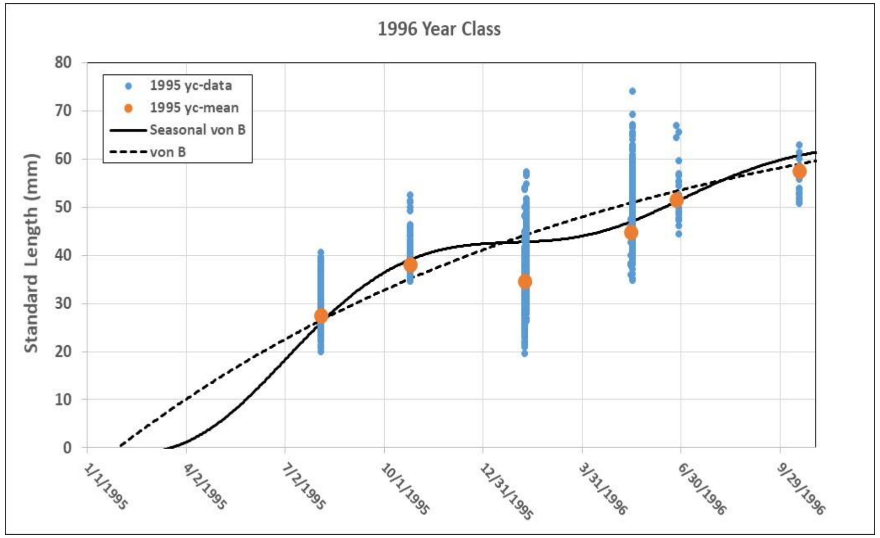
Part 2. Growth Models
(1993-1996 year classes using mean monthly SL of age 0)

- For age-0 RGSM only.
- Mean SL by month.
- San Acacia Reach.
- Better fit for SVBGF than SVBGF.
- No samples before July.



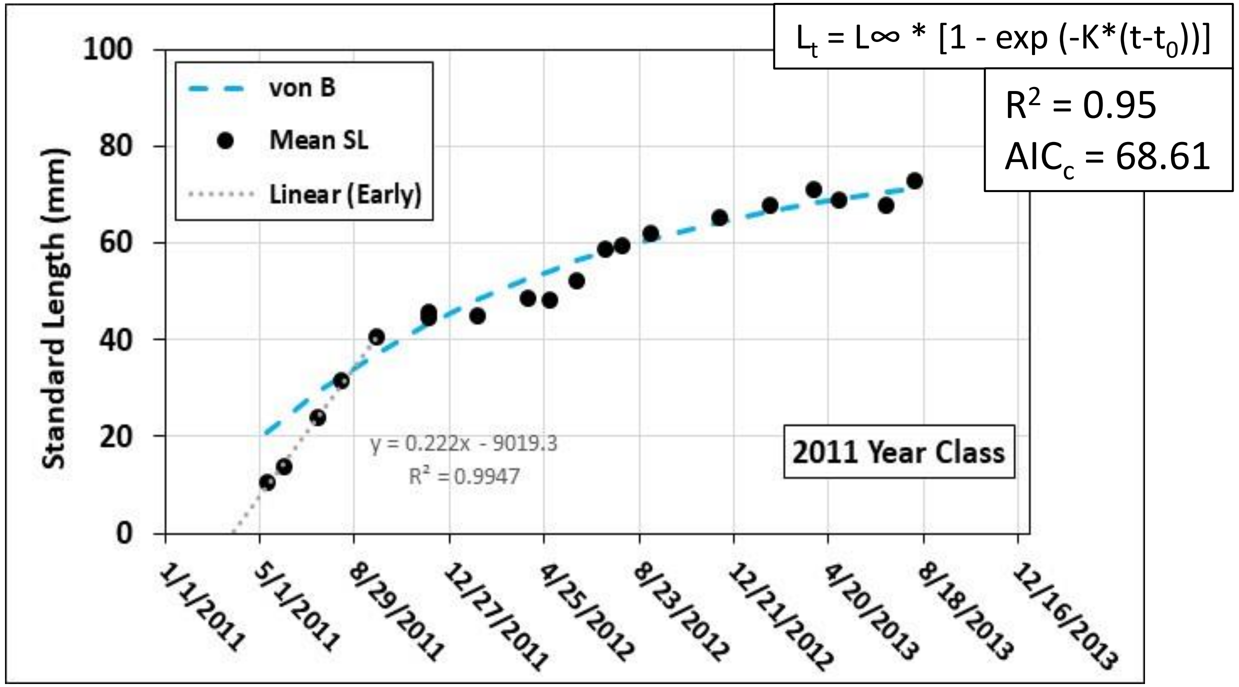


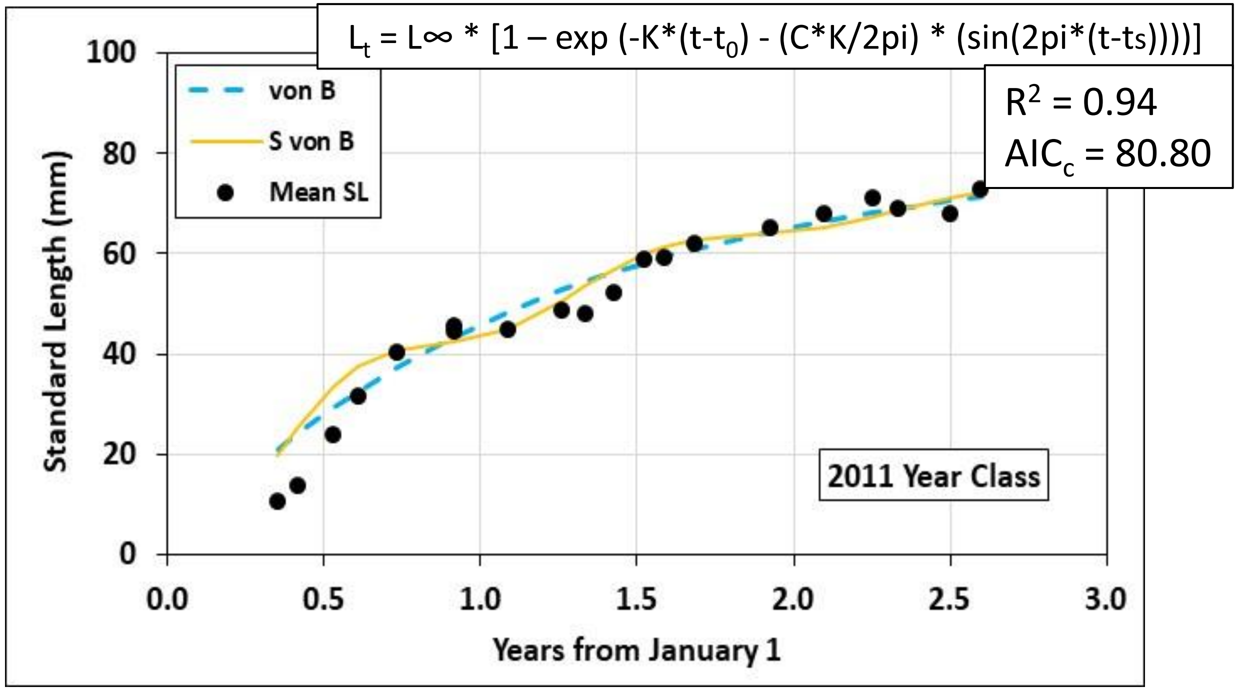




VBGF and SVBGF

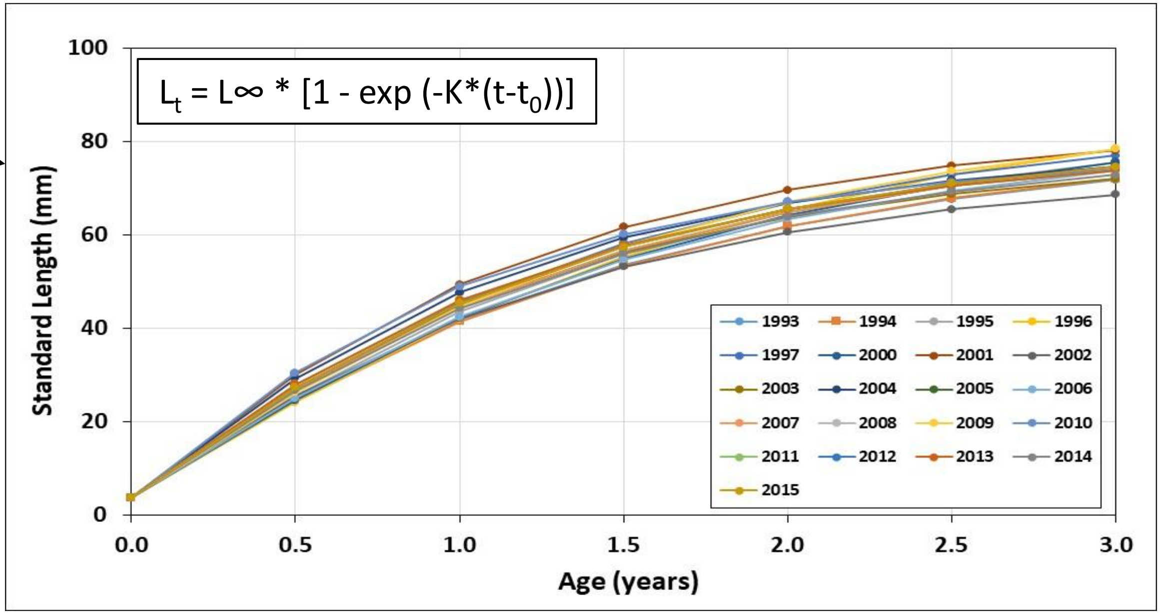
- For age-0 RGSM only.
- Mean SL by sample.
- Similar fit for VBGF and SVBGF.
- VBGF better model (lower AIC_c).
- Growth rate prior to July is rapid and linear.
- VBGF poor fit to early growth.





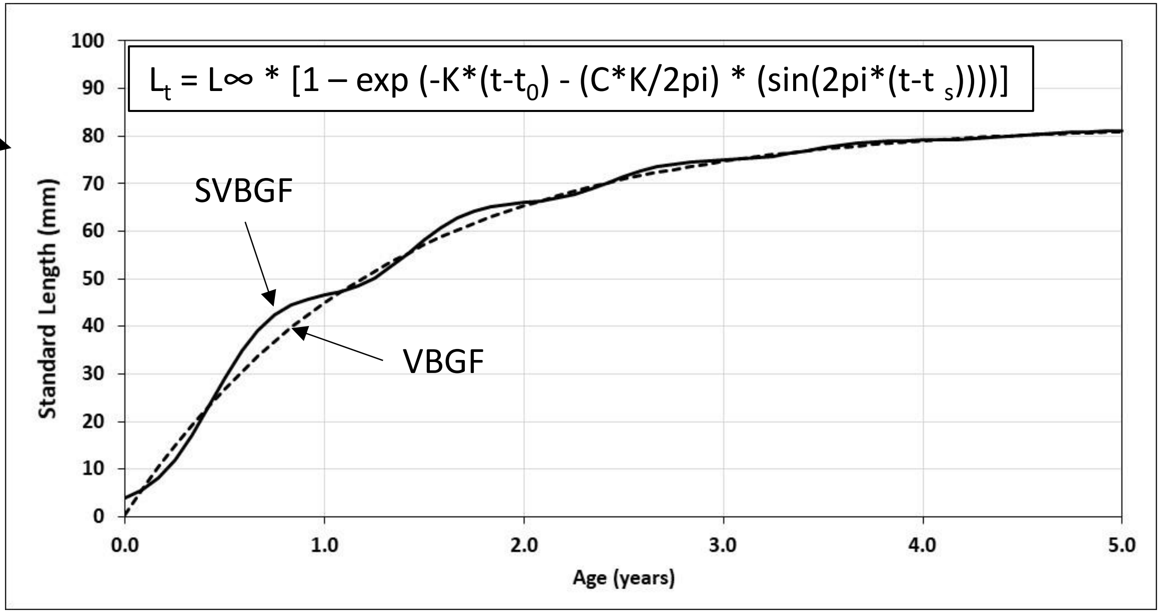
VBGF by year (21 year classes)

- Mean monthly length from preassigned ages
- Growth rate differs by year.
- L_∞ = 75 - 108 mm SL (x = 82.62)
- K = 0.55 - 0.98 (0.78)

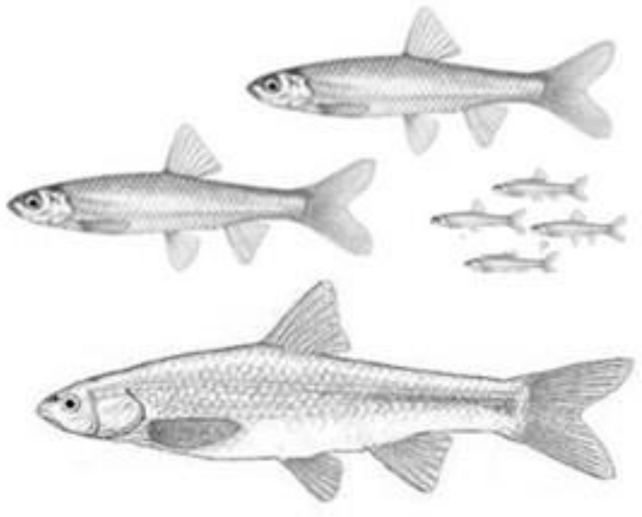


Idealized VBGF and SVBGF

- Seasonal growth dampens with age.
- L_∞ = 82.62 mm SL
- K = 0.78
- T_0 = -0.00685 (2.5/365)
- C = 0.70
- t_s = 0.5



Part 2 Summary—Growth Models:



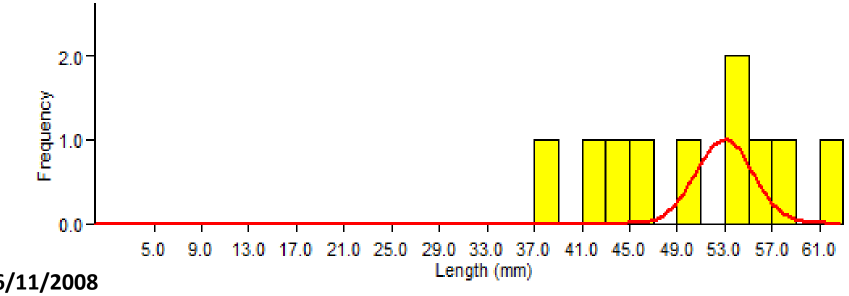
- Sample variability evident for mean lengths.
- SVBGF best for monthly means; VBGF best for sample means.
- Neither VBGF or SVBGF fit earliest growth, prior to July (Gompertz, logistic?).
- Growth rate differs by year.

Part 3. Compare Fish Lengths for Seines, Block Nets, and Fyke Nets

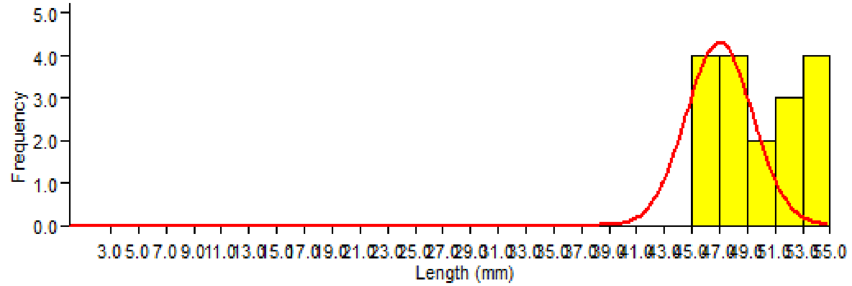
- ASIR Database = seines.
- USACOE (Porter) = block nets.
- SWCA (Gonzales) = fyke nets.
- USACOE (Porter) = fyke nets.

ASIR Database—Seines
Angostura Reach (2008)

5/14/2008



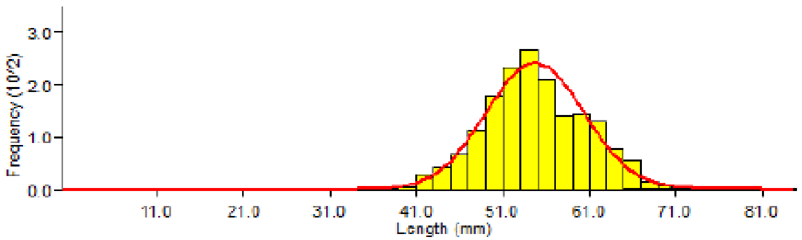
6/11/2008



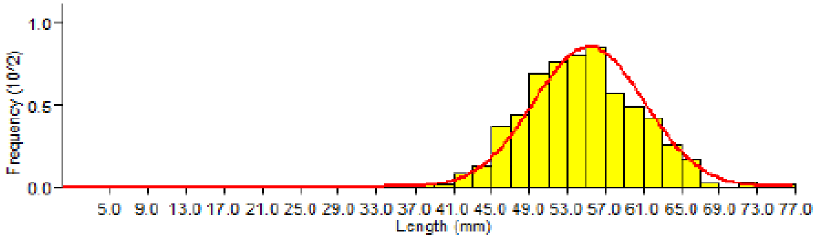
No Comparable Mainstem Samples Available

SWCA Nursery Habitat—Fyke Nets
Angostura Reach (2008-2009)

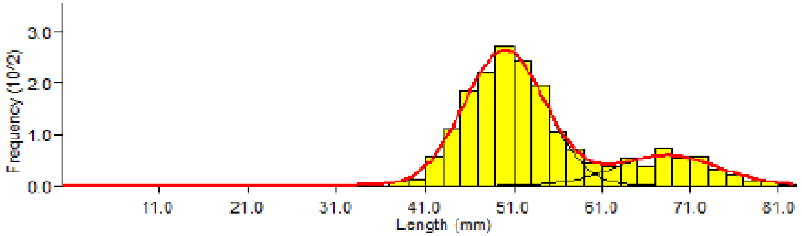
5/26/2008



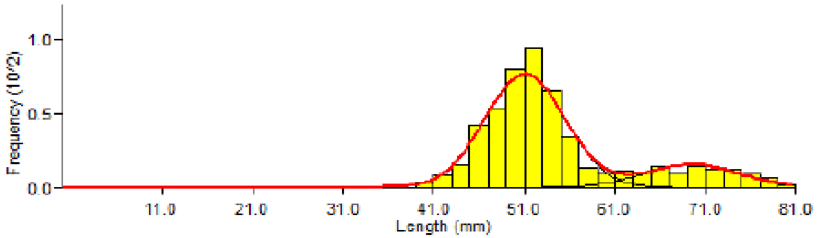
6/3/2008



5/13/2009



5/23/2009

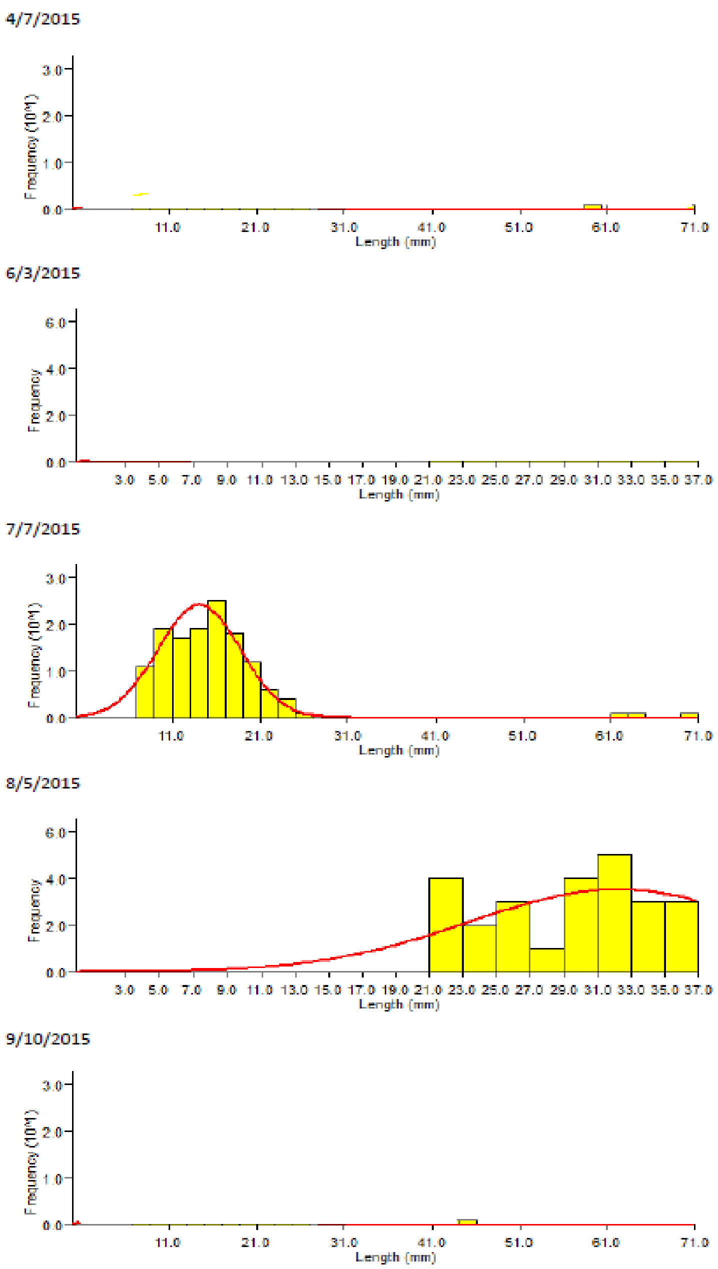


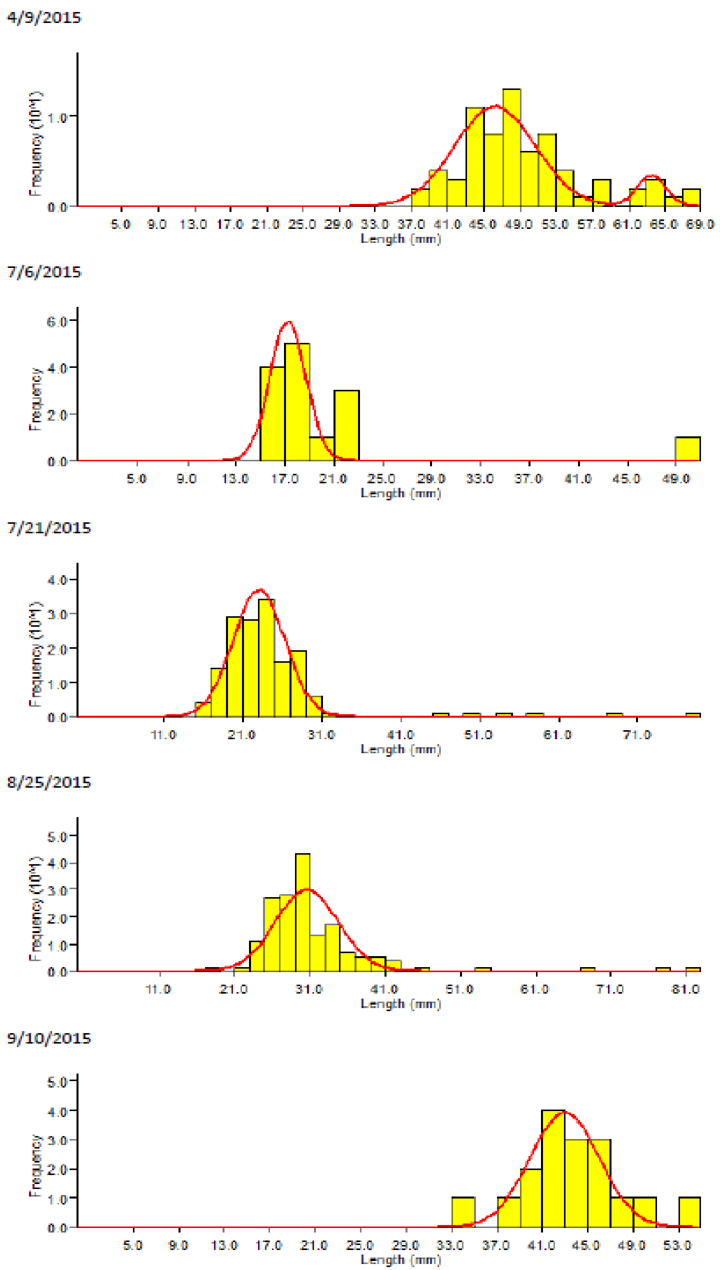
SWCA-Nursery Habitat					
5/26/2008					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	54.74	54.74	5.69	1714	n.a.
2	73	73	4.32	8	3.65
6/3/2008					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	55.3	55.3	5.83	623	n.a.
5/13/2009					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	50.03	50.03	4.6	1517	n.a.
2	68.35	68.35	5.8	427	3.52
5/23/2009					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	51.08	51.08	4.43	423	n.a.
2	69.54	69.54	5.14	98	3.86

Gonzales, E.J., G.M. Haggerty, and A. Lundahl. 2012. Using Fyke-Net Capture Data to Assess Daily Trends in Abundance of Spawning Rio Grande Silvery Minnow, North American Journal of Fisheries Management, 32:3, 544-547.

Gonzales, EJ, D Tave, and GM Haggerty. 2014. Endangered Rio Grande silvery minnow use constructed floodplain habitat. *Ecohydrology* 7: 1087–1093.

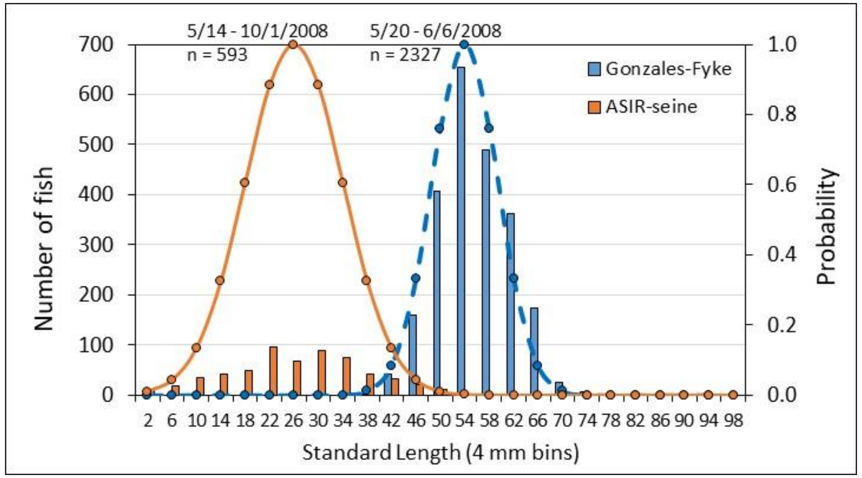
ASIR Database Angostura Reach (2015)	***Porter—Block Net Angostura Reach (2015)***





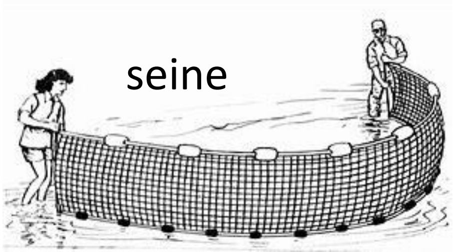
4/9/2015					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	46.23	46.23	4.47	62	n.a.
2	63.55	63.55	1.63	7	5.68
7/6/2015					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	17.24	17.24	1.48	11	n.a.
7/21/2015					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	23.06	23.06	3.29	152	n.a.
8/25/2015					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	30.57	30.57	4.19	157	n.a.
9/10/2015					
Group	Approx. Mean	Computed Mean	S.D.	Population	S.I.
1	43	43	3.06	15	n.a.

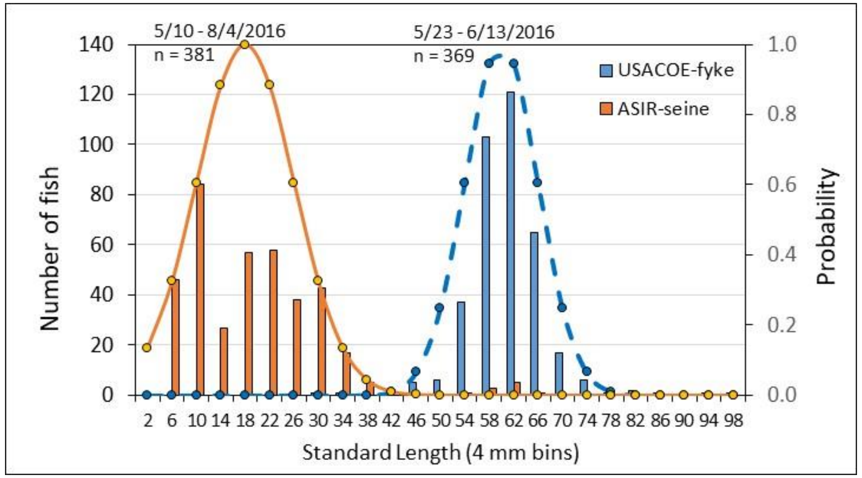
Gear Selection Curves
(Angostura Reach)



Fyke1 vs Seine

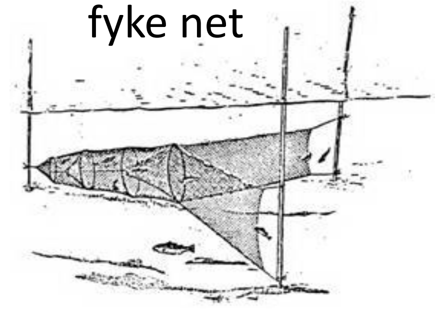
- Fyke L_{opt} = 54 mm
- Seine L_{opt} = 26 mm

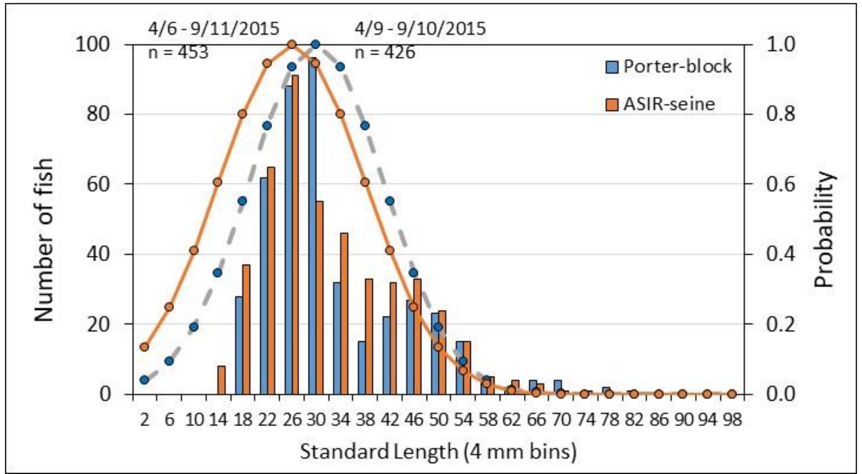




Fyke2 vs Seine

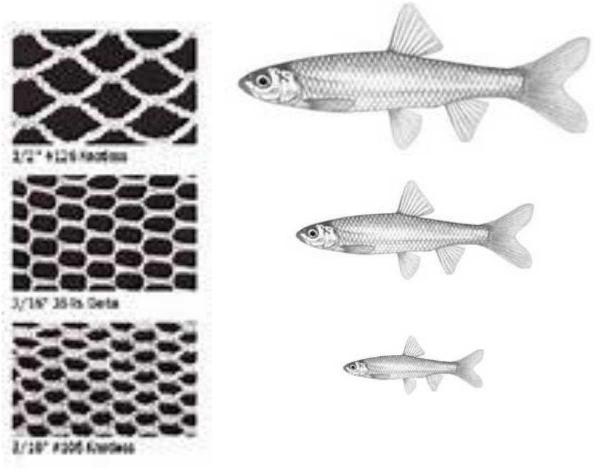
- Fyke L_{opt} = 60 mm
- Seine L_{opt} = 18 mm





Block vs Seine

- Block L_{opt} = 30 mm
- Seine L_{opt} = 26 mm

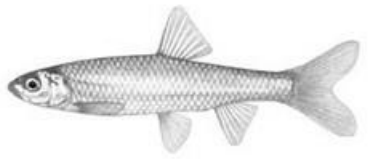


Summary

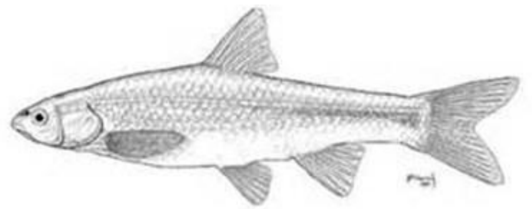
1. Current monitoring program does not provide full representation of fish lengths in the population:
   1. Smallest fish (first 60 days) are not represented.
   2. Largest fish are not fully represented (significant?).

2. Larger fish may be significant:
   1. Larger fish may be 1-3 years of age and not represent additional ages (4+ years).
   2. Larger fish may be older, indicating some “storage effect” (important for periods of low recruitment).
   3. Larger females likely carry more eggs.

3. Important to understand age structure:
   1. Storage effect?
   2. Added egg production from larger fish.



Age 1 = 2,362 eggs



Age 4 = 10,495 eggs

Hunter, F., C.A. Caldwell, W. Knight, and M. Ulibarri. 2016. Reproductive potential of wild Rio Grande silvery minnow (Hybognathus amarus). NMSU, Las Cruces, NM.

Gear Selection Curves

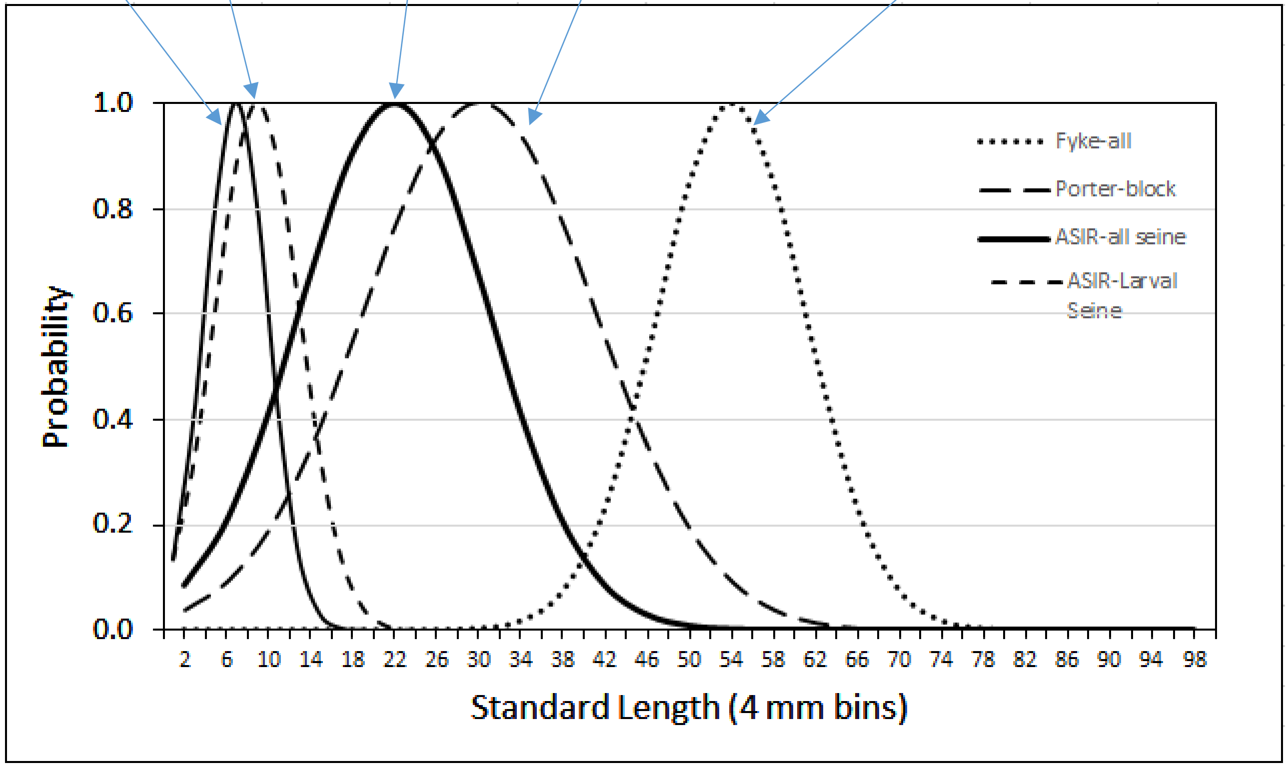
Regular Seine

Larval Seine

Block Net

Dip Net

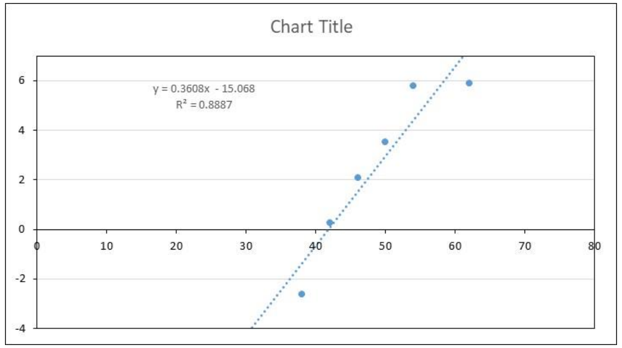
Fyke Net



Normal Probability Distribution Function (NPDF)

$$PN_L = e^{[-(L-L_{opt})^2/(2*SD^2)]}$$

Ln (L_b/L_a); y = a + b*X*



Optimum Fish Length (L_{opt}) and Standard Deviation (SD)

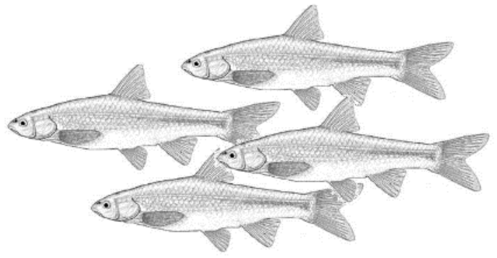
$$L_{opt}A = -2*[(a*ml_A)/(b*(ml_A+ml_B))]$$

$$L_{opt}B = -2*[(a*ml_B)/b*(ml_A+ml_B))]$$

$$SD = [-2*a*(ml_B-ml_A))/(b^2*(ml_A+ml_B))]^{1/2}.$$

Catch-Per-Unit-Effort of Rio Grande Silvery Minnow At Mesohabitat-Specific Levels

Noon Science Panel Recommendation E3



A Data Analysis Done for and in Collaboration with the Population Monitoring Workgroup

Richard A. Valdez, Ph.D., SWCA, NMISC

Population Monitoring Workgroup Meeting

October 2, 2018

Recommended Study E3 of the Noon et al. (2017) Science Panel:

- *"E3. Calculate Revised Catch-Per-Unit-Effort Values at Mesohabitat-Specific Levels and Do Not Combine Across Mesohabitat Types. The Mesohabitat-Specific Catch-Per-Unit-Effort Calculated for the <u>Most Abundant High Density Mesohabitat Type</u> Should Be Used for Assessment of Trend in Abundance of the Rio Grande Silvery Minnow Population at the October Sampling Date (Tier 2 Study)"*

The following is the rational provided by the Noon Science Panel for this recommended study:

- *"We propose that the current aggregated (across mesohabitat types) CPUE metric be replaced with a mesohabitat-specific metric calculated for a "high density" mesohabitat type that has substantial availability in all primary sampling reaches. The time-series of this metric should provide a more reliable indicator of trends in October abundance of RGSMs because it assumes only that catchability within this mesohabitat type are constant across years at the time of October sampling. As flows during October are probably low and have relatively little variation across years (relative to other months), we believe that this assumption is a reasonable one."*

Mesohabitat-specific Capture Probability

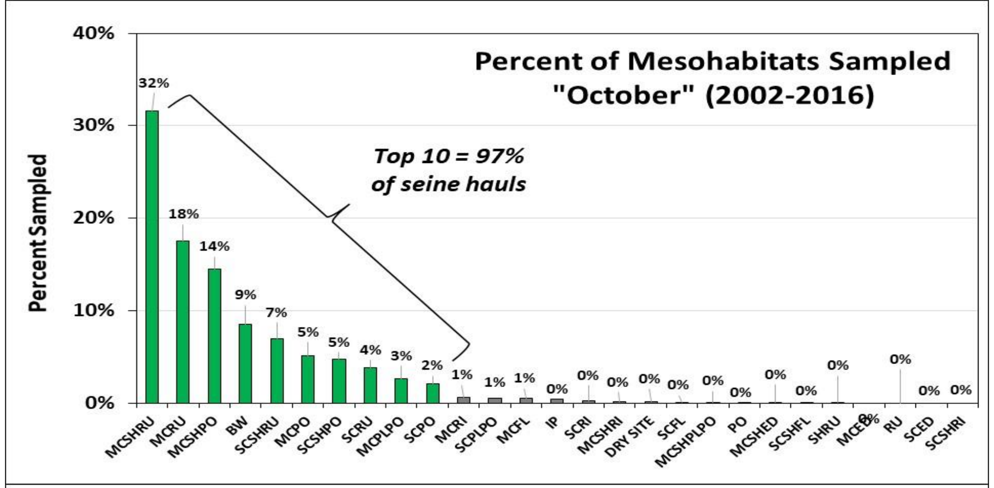
(Rio Grande silvery minnow)

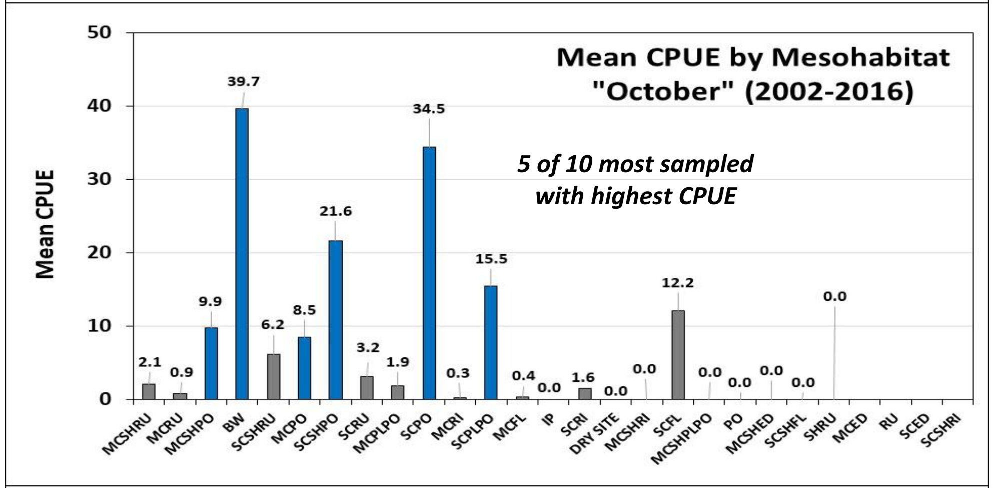
Available as closed habitat electrofishing—but not for seining

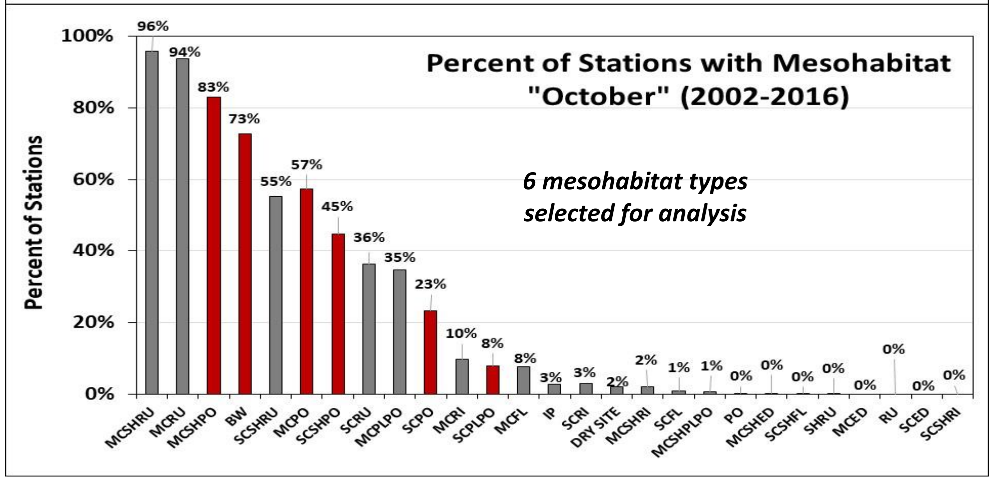
{Mesohabitat}	Capture Probability Estimate	Standard Error of Estimate	Lower 95% CI of Estimate	Upper 95% CI of Estimate
BW	0.7037	0.0191	0.6649	0.9010
PO	0.7153	0.0376	0.6363	0.8826
RU	0.8444	0.0382	0.7543	0.9800
SHPO	0.6858	0.0276	0.6294	0.8604
SHRU	0.7361	0.0157	0.7042	0.9385

"Multiple depletion passes within discrete mesohabitats were used to generate depletion model estimates using closed habitat electrofishing data collected from 2008 to 2010…" (page 21)**

**Dudley, R.K., G.C. White, S.P. Platania, and D.A. Helfrich. 2011. Rio Grande Silvery Minnow Population Estimation Program Results From October 2010. American Southwest Ichthyological Researchers, L.L.C., Albuquerque, NM.





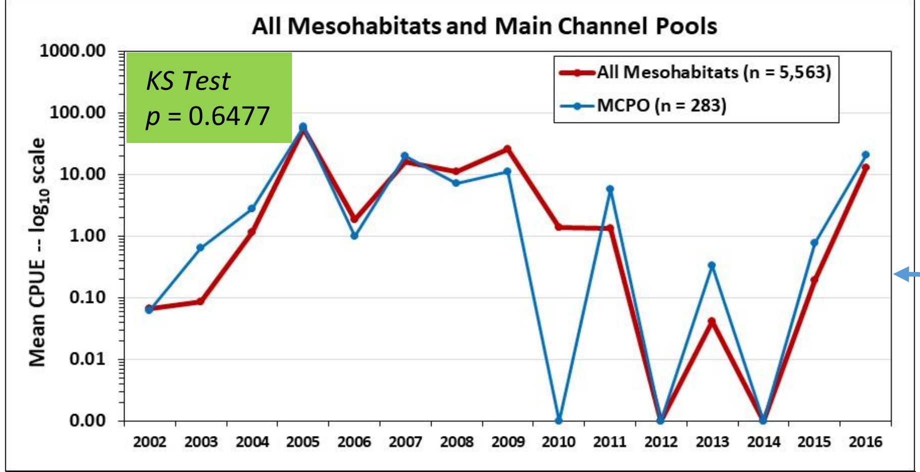


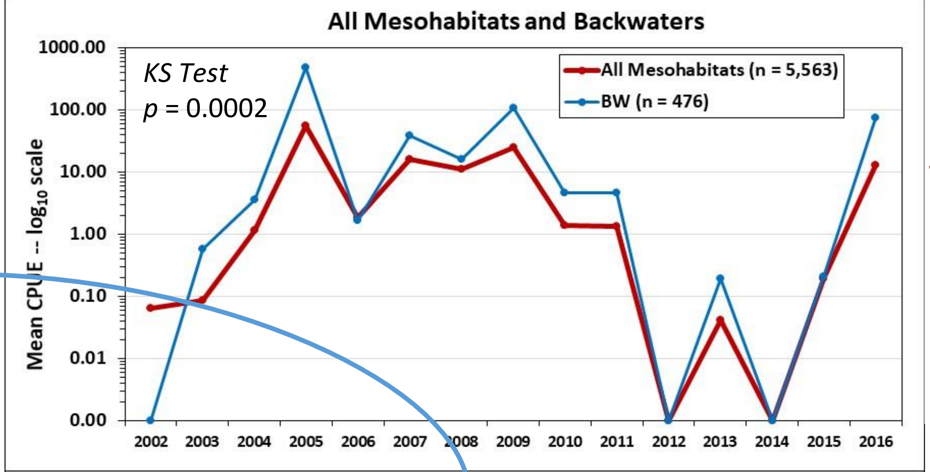
2. Mesohabitats with the highest CPUE

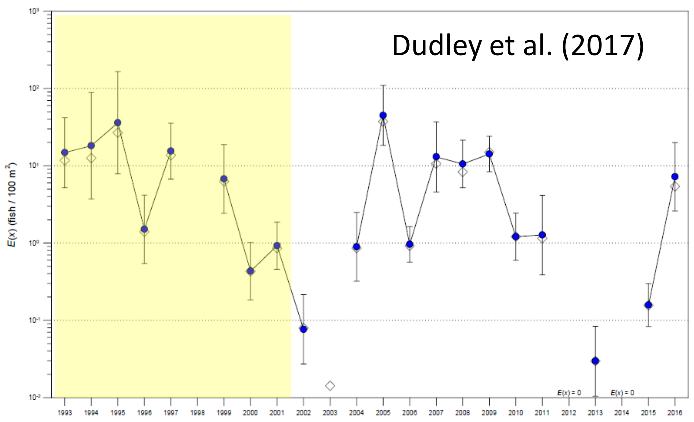
1. Mesohabitats most frequently sampled

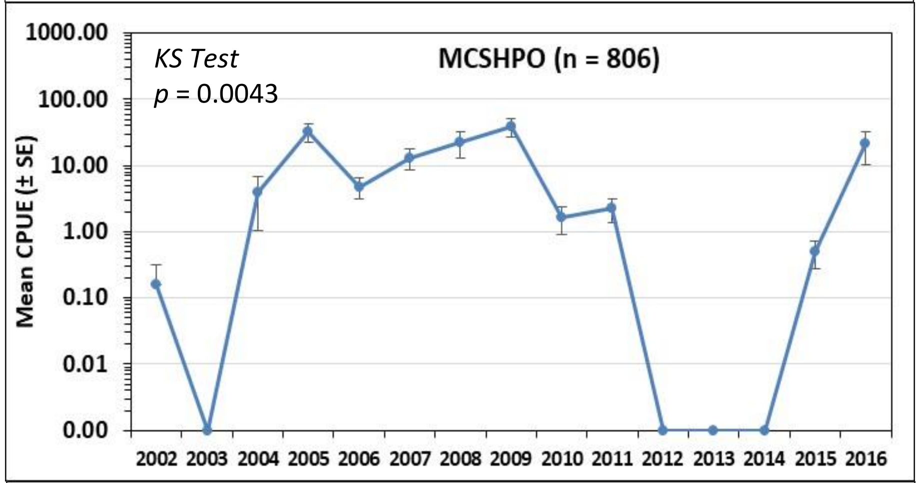
Stations with mesohabitat type

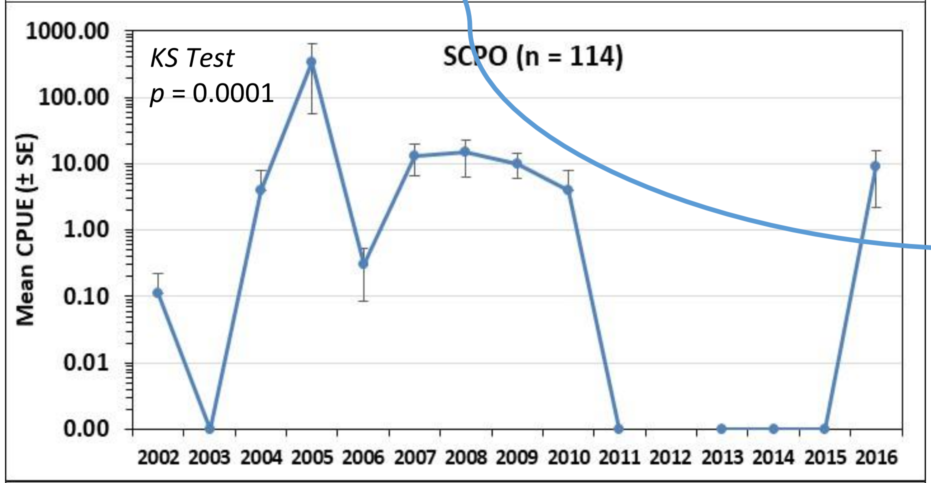
Number	Code	Mesohabitat Type	Samples (n = 5,569)			Stations (n = 300)	
			No. Hauls	Percent	CPUE	Number	Percent
1	BW	Backwater	476	8.55%	39.66	218	72.67%
2	IP	Isolated pool	21	0.38%	0.00	8	2.67%
3	MCED	Main channel eddy	0	0.00%	--	0	0.00%
4	MCFL	Main channel flat	29	0.52%	0.39	23	7.67%
5	MCPLPO	Main channel plunge pool	146	2.62%	1.86	104	34.67%
6	MCPO	Main channel pool	283	5.08%	8.54	172	57.33%
7	MCRI	Main channel riffle	33	0.59%	0.31	29	9.67%
8	MCRU	Main channel run	978	17.56%	0.92	281	93.67%
9	MCSHED	Main channel shoreline eddy	1	0.02%	0.00	1	0.33%
10	MCSHPLPO	Main channel shoreline plunge pool	2	0.04%	0.00	2	0.67%
11	MCSHPO	Main channel shoreline pool	806	14.47%	9.85	249	83.00%
12	MCSHRI	Main channel shoreline riffle	6	0.11%	0.00	6	2.00%
13	MCSHRU	Main channel shoreline run	1,758	31.57%	2.15	287	95.67%
14	PO	Pool	2	0.04%	0.00	1	0.33%
15	RU	Run	0	0.00%	--	0	0.00%
16	SCED	Side channel eddy	0	0.00%	--	0	0.00%
17	SCFL	Side channel flat	4	0.07%	12.15	3	1.00%
18	SCPLPO	Side channel plunge pool	30	0.54%	15.49	24	8.00%
19	SCPO	Side channel pool	114	2.05%	34.45	70	23.33%
20	SCRI	Side channel riffle	12	0.22%	1.61	9	3.00%
21	SCRU	Side channel run	211	3.79%	3.16	109	36.33%
22	SCSHFL	Side channel shoreline flat	1	0.02%	0.00	1	0.33%
23	SCSHPO	Side channel shoreline pool	263	4.72%	21.60	134	44.67%
24	SCSHRI	Side channel shoreline riffle	0	0.00%	--	0	0.00%
25	SCSHRU	Side channel shoreline run	386	6.93%	6.22	166	55.33%
26	SHRU	Shoreline run	1	0.02%	0.00	1	0.33%
	DRY	Dry sites	6	0.11%	--	6	2.00%
	Total		5,569	100%	--	--	--

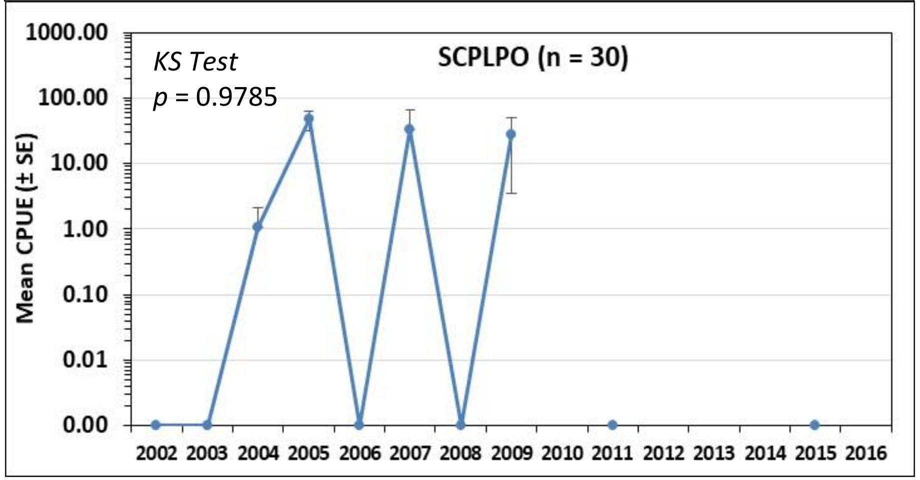


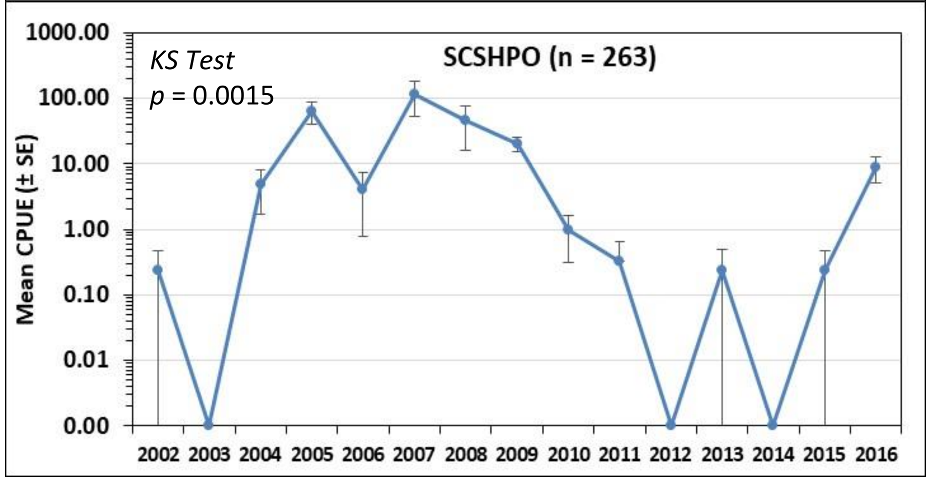








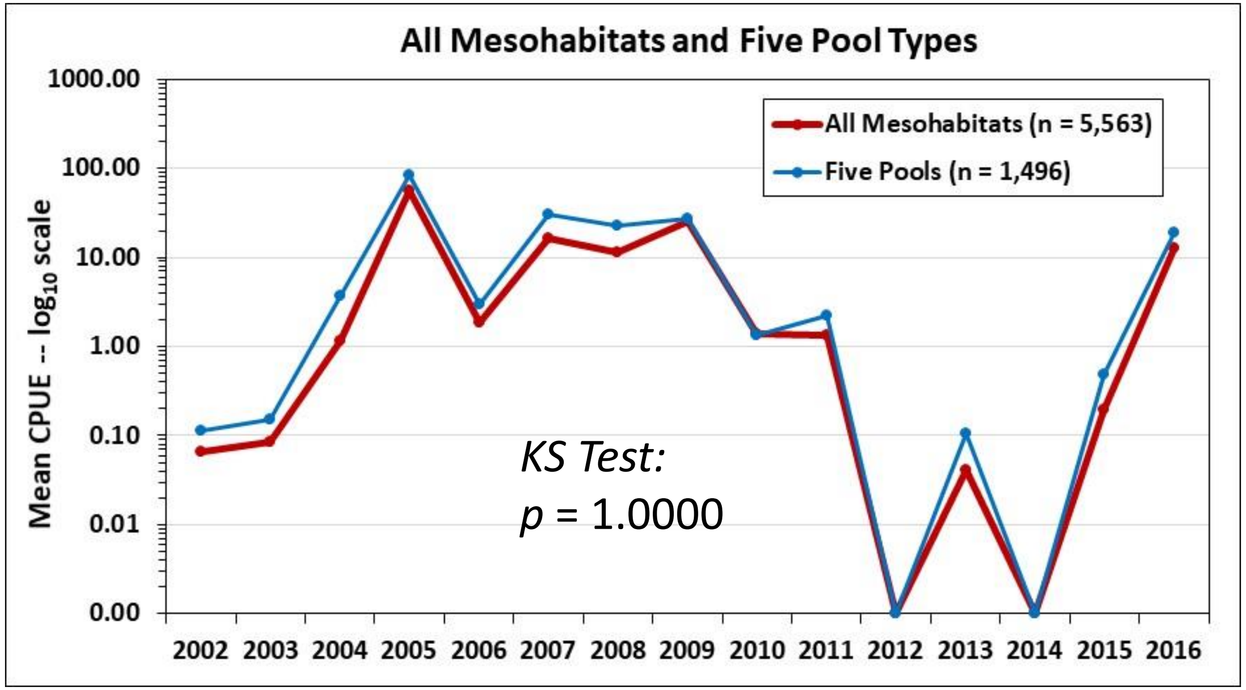




CPUE by Six Mesohabitat Types

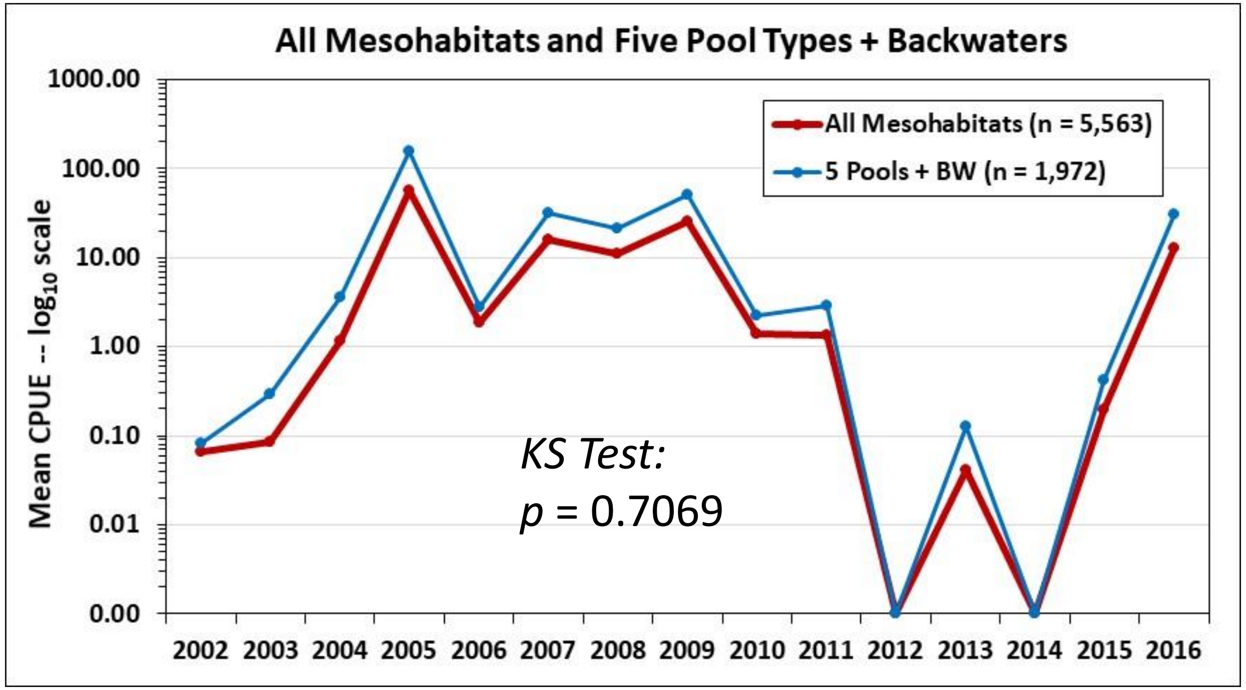
- Of 6 mesohabitat types, only MCPO provided mean annual October CPUEs not significantly different (Kolmogorov-Smirnov [K-S] test; $p > 0.05$) to CPUEs of all 22 mesohabitat types.

Note: all ages of RGSM were used in this analysis.



HOWEVER:

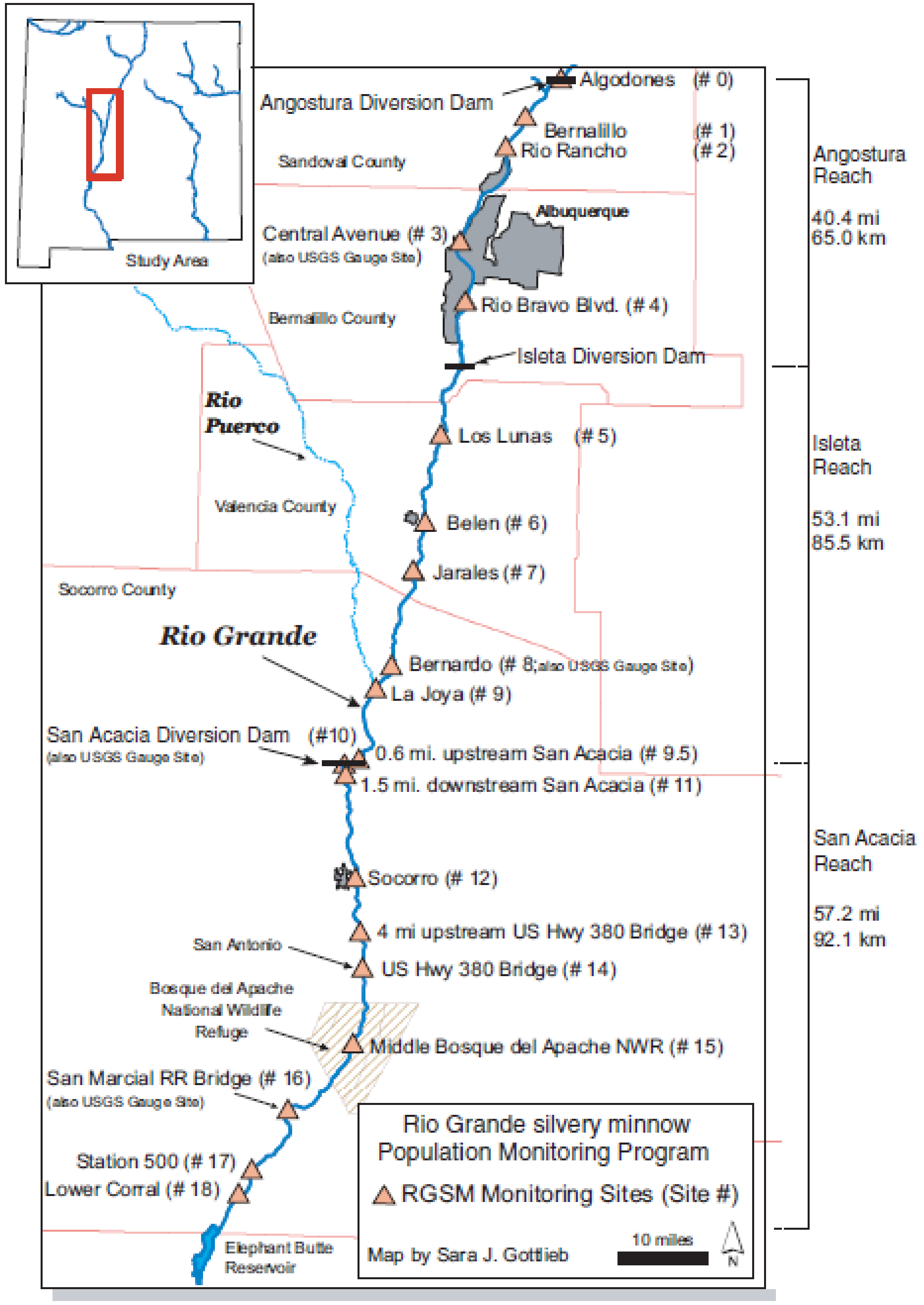
- Combining the five 'pool' types produces annual October CPUEs not significantly different from CPUEs of all mesohabitat types:
    - KS Test, p = 1.0000,
    - 'Pool' types elevates CPUE by 74%, and
    - 5 mesohabitat types increases chance of encountering sufficient numbers of mesohabitats for sampling.



- Combining the five 'pool' types + backwaters produces annual October CPUEs not significantly different from CPUEs of all mesohabitat types:
    - KS Test, p = 0.7069,
    - 'Pool' + BA elevates CPUE by 111%, and
    - 6 mesohabitat types increases chance of encountering sufficient numbers of mesohabitats for sampling.

Are Mesohabitats Available?

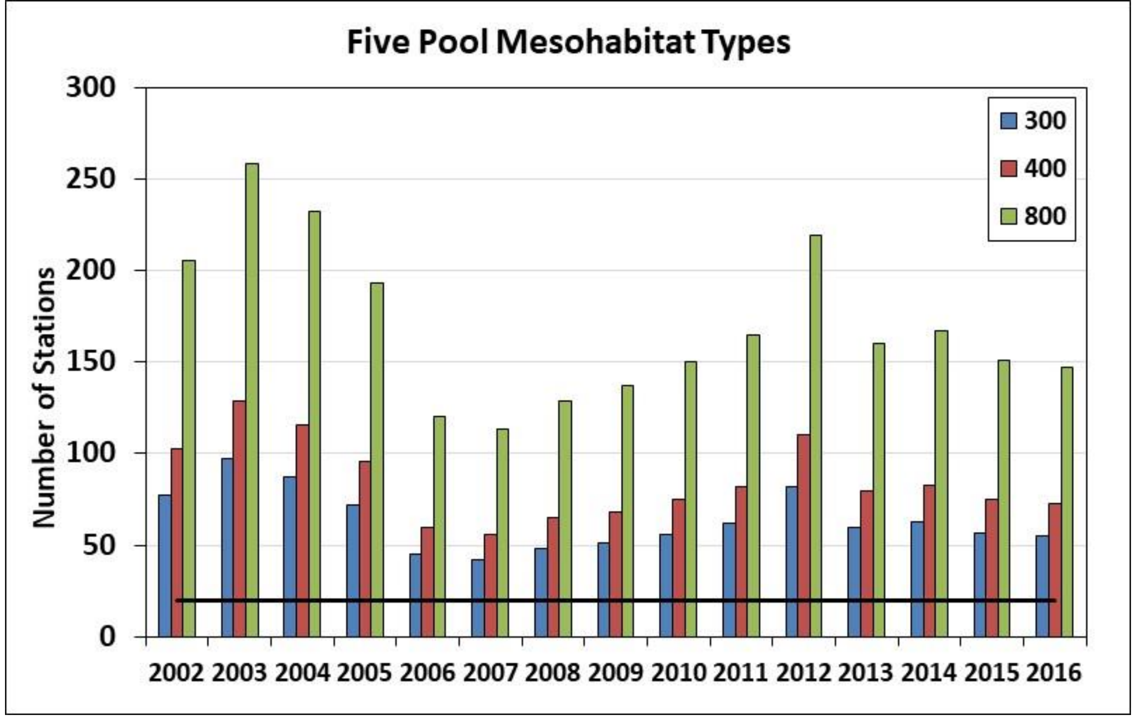
- Are the five or six select mesohabitat types available at the 20 fixed stations?
- If not, how many more stations would be needed to equal 400 seine hauls per month? (20 stations x 20 hauls = 400)
- This assumes the same sampling design and does not consider other designs.

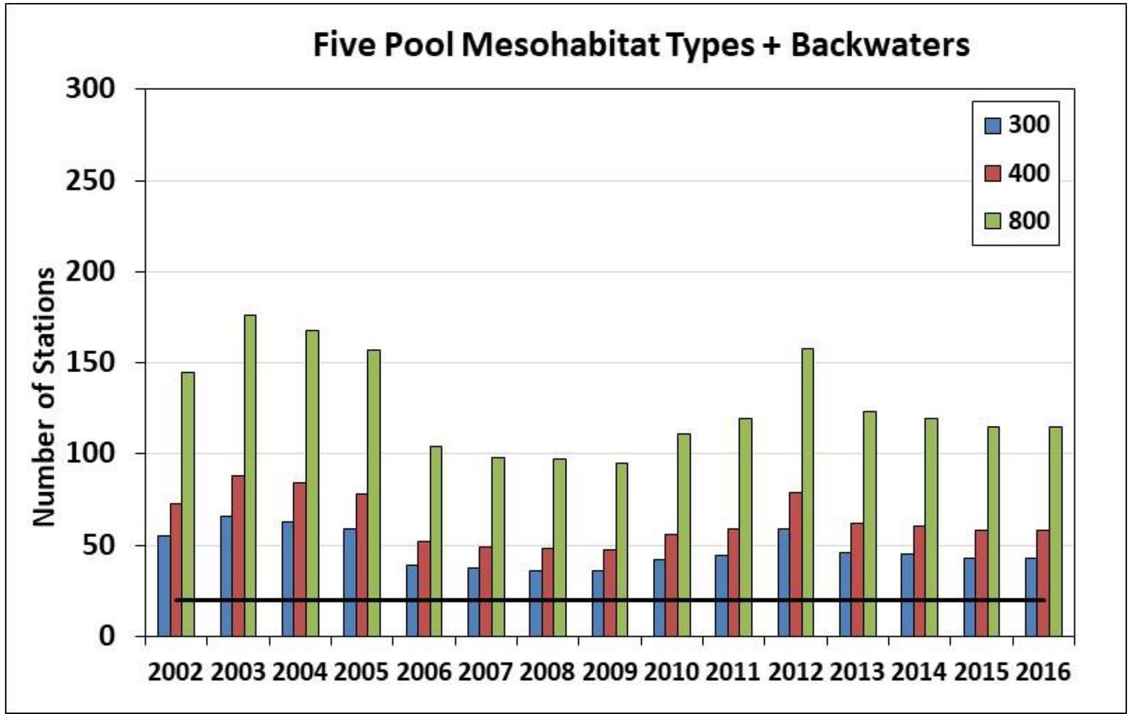


How Many More Stations Are Needed?

- 6 selected types = 35% of seine hauls.
- 5 'pool' types = 27% of seine hauls.
- Of 300 stations (Oct 2002-2016), 6 types were sampled in 8-83% of stations.
- How many stations are needed to equal 400 samples per month?
- How is CPUE precision affected by select types and sample size?

Mesohabitat	Hauls (n = 5,569)		Stations (n = 300)		
	No. Sampled	No. in Select Mesohabitats	No. Sampled	No. in Select Mesohabitats	% in Select Mesohabitats
BW	476	476	218	218	73%
IP	21		8		
MCED	0		0		
MCFL	29		23		
MCPLPO	146		104		
MCPO	283	283	172	172	57%
MCRI	33		29		
MCRU	978		281		
MCSHED	1		1		
MCSHPLPO	2		2		
MCSHPO	806	806	249	249	83%
MCSHRI	6		6		
MCSHRU	1,758		287		
PO	2		1		
RU	0		0		
SCED	0		0		
SCFL	4		3		
SCPLPO	30	30	24	24	8%
SCPO	114	114	70	70	23%
SCRI	12		9		
SCRU	211		109		
SCSHFL	1		1		
SCSHPO	263	263	134	134	45%
SCSHRI	0		0		
SCSHRU	386		166		
SHRU	1		1		
DRY	6		6		
Total	5,569	1,972 (35%)			





How Many More Stations?

For five 'pool' mesohabitat types:

- The current number of stations (20) per year would have to increase to:
  - 42-97 to obtain 300 seine hauls;
  - 56-129 to obtain 400 seine hauls; and
  - 113-258 to achieve 800 seine hauls.

For five 'pool' + BA mesohabitat types:

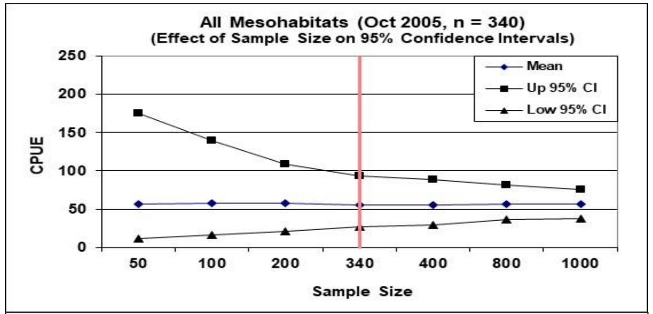
- The current number of stations (20) per year would have to increase to:
  - 36-66 to obtain 300 seine hauls;
  - 47-88 to obtain 400 seine hauls; and
  - 95-176 to achieve 800 seine hauls.

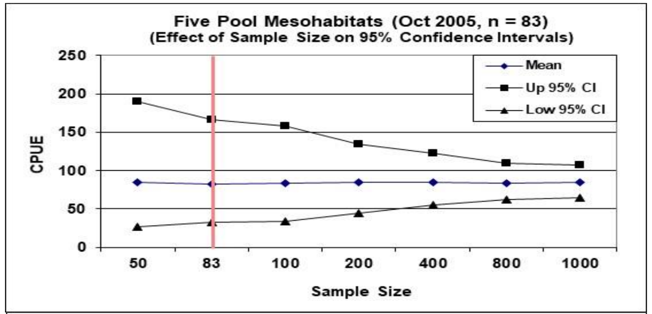
Effect of Sample Size on Precision

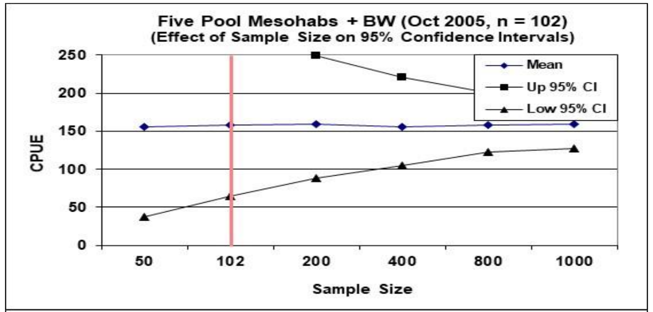
- Precision is measure of variability of individual observations around the estimate.
- In this case, the estimate is the mean October CPUE computed from individual seine hauls, and the individual observations are the by-haul CPUEs.
- Measures of precision include:
  - 95% confidence intervals, and
  - Coefficient of variation of the mean (CV, standard error/mean).
- Percent change detection was also evaluated.
- Sampling with replacement (bootstrap) was used to randomly select 50, 100, 200, 400, 800, and 1,000 samples.

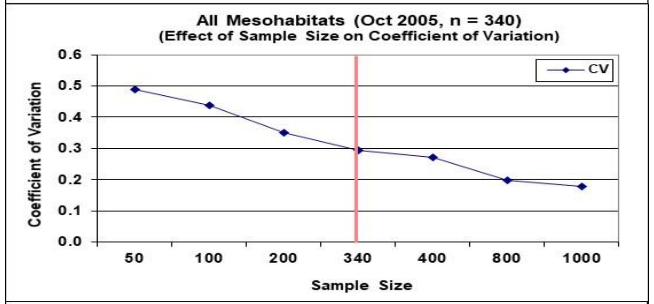
For a year of high density (2005)

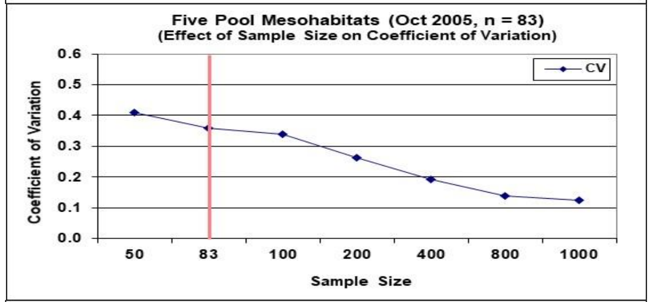
- Simulated mean CPUEs were ~50% higher for 5 ‘pool’ types and ~180% higher for 5 ‘pool’ types + backwaters.
- At 400 samples, CV of ~0.2 is lower (better precision) for ‘pools’ and ‘pools’ + backwaters, compared to ~0.3 for all mesohabitats.
- At 400 samples, change detection is 53%, 40%, and 37%; e.g., mean CPUE would have to change by ≥37% to be detected at 95% CI.

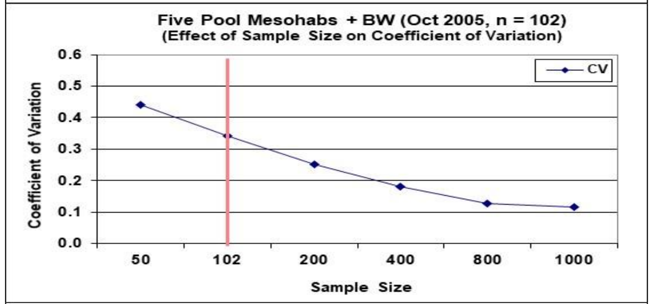


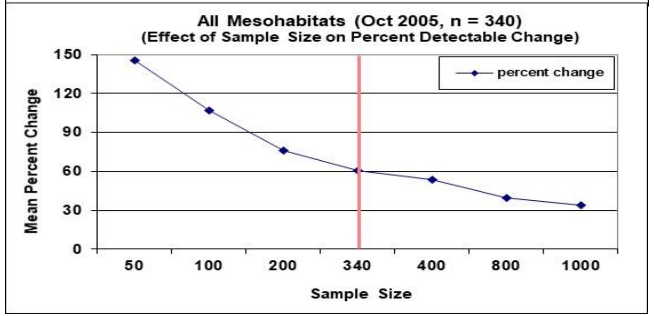


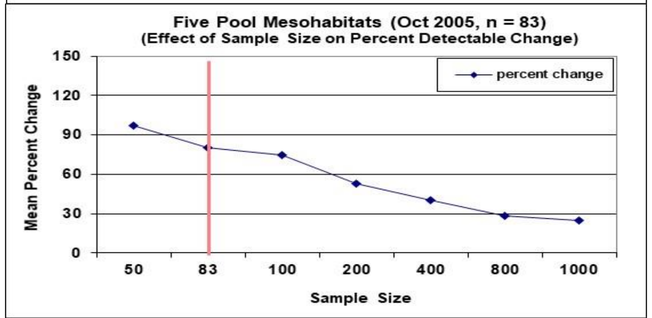


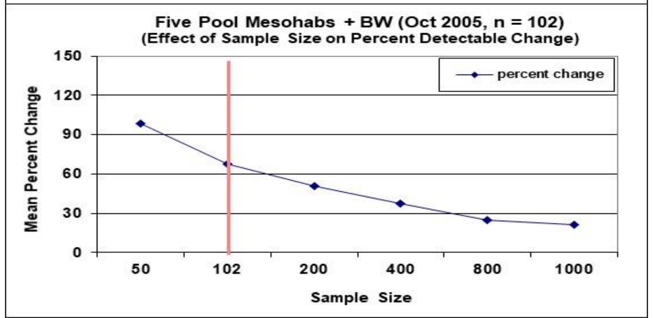






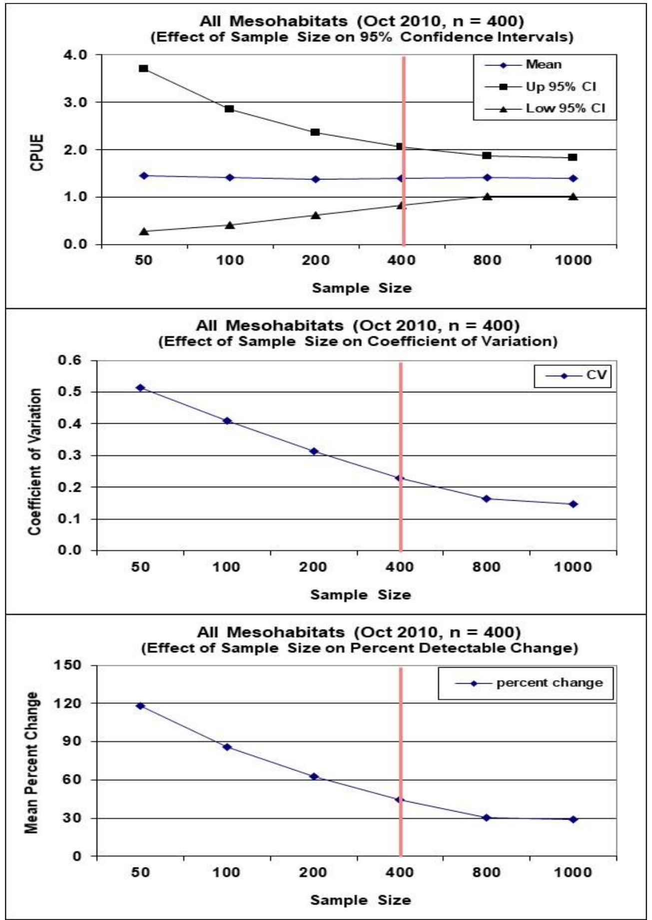


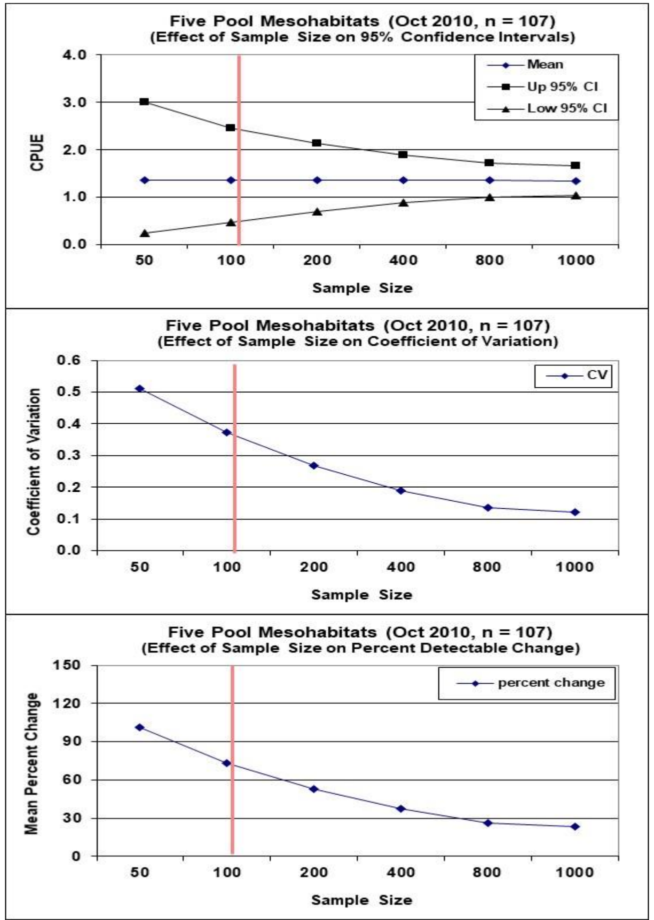


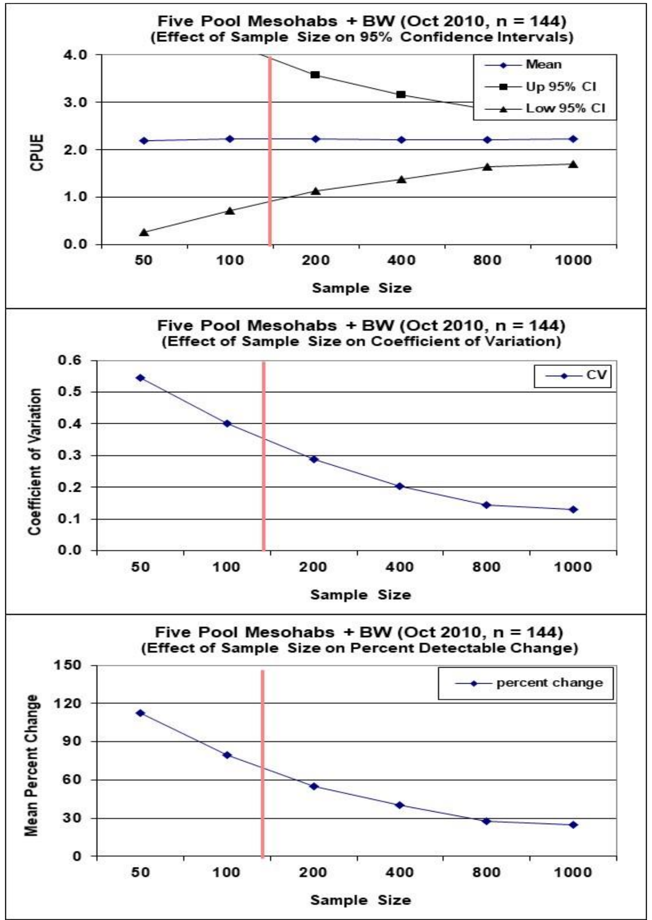


For a year of low density (2010)

- Simulated mean CPUEs were similar for five pool types and 164% higher for five pool types + backwaters.
- At 400 samples, CVs for all three data partitions were similar at ~0.2.
- At 400 samples, detectable change is similar at 37-44%.
- Hence, sample size has less effect on precision for low CPUEs than for high CPUEs.







Summary

1. Only MCPO provided mean annual October CPUEs not significantly different (K-S test; $p > 0.05$) to CPUEs of all mesohabitat types.

2. Mesohabitat types with highest CPUE were MCPO, MCSHPO, SCPLPO, SCPO, SCSHPO, and BW; these were combined for similar habitat characteristics and fish capture probabilities.

3. Mean annual October CPUEs for combined 5 ‘pool’ types (n = 1,496), and for the combined 5 ‘pool’ types + backwaters (n = 1,972), were each not significantly different (K-S test; $p > 0.05$) from October CPUEs of all mesohabitat types (n = 5,563).

4. These combinations can produce the same pattern of CPUEs with 73% and 65% fewer samples, respectively; however, unequal samples of BA could inflate and bias CPUEs.

5. At 400 samples, ‘pools’ and pools + backwaters improve precision (CV) by 29% and 34%, respectively, compared to all mesohabitat types.

6. Because the 6 mesohabitat types may not occur in every station, the number of stations would have to increase from the current effort of 20 per month (400 seine hauls) to 56-129 for the 5 ‘pool’ types, or 47-88 for the 5 ‘pool’ types + backwaters to achieve 400 seine hauls annually.