PVA Biology Work Group Meeting
June 11th and 12th, 2012
US Bureau of Reclamation
555 Broadway Blvd. NE, Albuquerque, NM 87102

June 2012 Actions

- Jason Remshardt will research the application process to the Landscape Conservation Cooperative (LCC) funding opportunities and provide the information to Dagmar Llewellyn and the PVA work group. *(from 06/11/12)*
- Dagmar Llewellyn will work with David Gensler to provide the PVA with 5 150-year GCM hydrology sequences for both the no action and proposed action. *(from 06/11/12)*
- Dave Gensler will follow up with the PHVA work group on a timeline for receiving the GCM sequences for the proposed action and no action scenarios. *(from 06/12/12)*
- Dr. Miller will develop a written description of the methodologies used in his preliminary model run to distribute to the PVA work group. *(from 06/12/12)*
- PVA work group members will review and/or cross check Dr. Goodman's report for discussion at the July PVA meeting. *(from 06/12/12)*

Ongoing Actions

- Yvette Paroz will check the ASIR data to determine if the mesohabitat/surficial area is in GIS or electronic file formats. (*from 05/16/12)*
- Jason Remshardt will email the FWS Population Monitoring data with mesohabitat/depth/velocity/substrate information (1999 to 2001; 2002-2012) to Dr. Goodman and copy Yvette Paroz for posting to the Program's website. (*from 05/16/12)*
- Yvette Paroz will provide Dr. Goodman with Reclamation's Fish Datasets that include information on depth/velocity/substrate; these datasets will also be posted to the Program's website. (*from 05/16/12)*
- Peter Wilkinson will follow up with Grace Haggerty on her action (from December 2011) to forward the Doug Wolf "I-40 to Central Inundation" Presentation to Mick Porter. (*from 05/16/12)*
- Rich Valdez will send his temperature/minnow length (hatch & growth rate) work to Mick Porter. (*from 05/16/12)*

Decisions

- Meeting attendees agreed that all of the unapproved past notes will be considered approved after they are reviewed by Dave Gensler; if there are any significant changes or comments to the notes they will be circulated to the work group.
- The May 14th, 15th, and 16th draft notes were approved with the addition of a correction to information provided at the last PVA meeting: It had been said that Jesse Roach's monthly time step model does not include monthly operations; however it has since been learned that the model does include monthly operation.
- For this iteration of the models the PVA work group accepts the data that are archived on Dr. Goodman's website as provided by the originators to Dr. Goodman and as reconciled by Dr. Goodman and there is agreement with using these data sets as the consensus data for use in the PVA models for this iteration. The datasets and the pedigree are shown and documented on Dr. Goodman's website. The PVA work group requests the originators of the data review and concur with the validation or reconciliation of the population monitoring data. The egg monitoring data is considered provisional and is not considered appropriate for inclusion in the model at this time.

Requests

- The PVA made an official request that PHVA provide 5 150-year GCM sequences for both the no action and proposed action.

Meeting Summary

DAY 1: Monday, June 11th

- Dave Gensler brought the meeting to order. Introductions were made. The agenda was reviewed and rearranged to shift the critical discussions to Monday when Reese Fullerton (facilitator) was present. The regular business items (ex. draft note approval) were postponed until Tuesday.
- Dr. Goodman then presented his *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report dated May 1st, 2012.* He explained that the he started this process over a year ago motivated entirely by his own needs for the PVA and fully expecting to delve into the mathematics. The original intent was to determine how to estimate recruitment and survival from the Catch Per Unit Effort (CPUE) data. However, this "tour" of the population monitoring CPUE data fortuitously bears on questions that have since come up: (1) the U.S. Fish and Wildlife Service (Service) question regarding the ability of the PVA models to predict the recovery criteria metrics; (2) sufficient progress metrics in the Recovery Implementation Plan (RIP) Action Plan; and (3) commentary on the recovery criteria and use of the recovery criteria (or criteria like them) based on CPUE.
    - Dr. Goodman analyzed the data (provided from ASIR and J. Remshardt) to determine the historic record of the monitoring metrics.
        - *Completeness of the October Census:* The first issue in the criteria is the requirement for minnow presence in at least 20 sites. There have been 20 sites sampled only about half of the time; in fact, until 2001, there were always quite a bit less than 20 sites so there has not been many years of sampling to test the criterion exactly.
            - Dr. Goodman then raised the question of whether or not the October census is really carried out in October. It turns out that there is a range of sampling dates from late September to late October. This is not to the letter of the recovery criteria. If there is a time trend (i.e., the date matters to how many fish are seen), there will need to be a correction of that trend in order to standardize the results and/or extrapolate or back calculate to a reference date.
        - *Presence of Minnow at ¾ of Sites:* The analysis indicates that each reach has been in attainment about 2/3 of the time but not always/often simultaneously. Since the system is "regularly" meeting this threshold, it can be said that this is not that stringent a criterion. However, whatever this monitoring metric is measuring is extremely volatile (ex. 2003 to 2005). It appears that the population status can go from terrible to moderate to good very quickly. This means that this is not an indicator of a long-term property. This is not reassuring that this metric is a real measure of the health of the population.
        - *Presence of Young Of Year (YOY) at ¾ of the Sites:* Each reach has been in attainment about 1/2 of the time (the San Acacia reach doing a bit better), often, but not always, simultaneously. Again, there is volatile change from year to year (ex. from low fraction of sites with presence detected to very high fraction). There are times when one reach looks good but other reach(s) is below the threshold.
        - *Density >5 Fish Per 100 m^2, All Sites*: This metric has consistently been the farthest from attainment, even for one year (and the downlisting criterion requires 5 years). In no year on record have all the monitoring sites reported > 5 fish/100m^2. The largest fraction of sites over the entire river reporting > 5 fish/100m^2 was 0.75, in 2009.

- *Correlations:* Regarding how all 3 criteria correlate to the mean log density of fish in October that year, these 3 metrics are all essentially telling the same story – different ways of re-expressing the mean density of fish that year (which is highly correlated to the flow in May – July). This explains the volatility: dry spring = low numbers while wet spring = high numbers.
- *Historic Record wrap-up:* The interpretational conclusion is that the 3 population monitoring based metrics employed in the recovery criteria are redundant among themselves, and essentially reflect simply the mean log minnow density over the entire Middle Rio Grande (MRG). Mean minnow density and the 3 metrics in turn are positively correlated with spring flow for that year, confirming that these metrics are indicators of temporary properties, and are not, in themselves, indicators of a longer term measure of population health. However, ultimately, the CPUE numbers can be very useful as long as they are used appropriately.

o *Estimating the Noise in the Metrics*:

- While there are high correlations between the mean density and the fraction of sites above the 5 fish per 100m^2 threshold, that high correlation saturates around 15 fish per 100 m^2. As the mean density goes up so does the fraction of sites above the 5 fish per 100m^2 threshold but this stops at 15 fish per 100m^2. This means that even if there are more fish in the system, there will not be more sites above the 5 fish per 100 m^2. This is indicating some "perverseness" of the patchiness of minnow abundance and distribution.
- *Variance by Sample Period:* It was pointed out that the ASIR sampling tends to happen over several days and then there will be a span of time (several weeks or months) before sampling occurs again. The group of samples taking place within a few days in a reach constitute a sample period. The graph of within-sample-period variance against the within-sample-period mean (all reaches, all months, all years) shows that the variance is consistently and systematically higher than the mean, suggesting that the statistical distribution being sampled is a negative binomial, not a lognormal. This explains the appearance of high patchiness in the monitoring data, and provides a statistical method to quantify the patchiness as it affects estimates of other quantities from the data.
- Dr. Goodman then plotted all the individual sampling events (200+ on specific dates) against time for the 2004 brood of fish in the Angostura reach. (The brood starts with the YOY in 2004 and follows into 2005 as the Age 1 fish). The 2004 brood was selected as the first exploration because it had a lot of data points and the numbers were relatively high so there were less issues with "zeros."
  - . In an attempt to "fit" the underlying pattern to the scatter of points, a log transform was applied but did not make it normal. A regression of the mean of the negative binomial over time best describes the high variance early in time (young fish) and lower variance through time.
  - This is very consistent with the over dispersion of the negative binomial (and not a Poisson variation). The negative binomial is a statistical distribution that does explain this "pattern."
  - We now have a way to estimate the over dispersion that can be used for cases where there aren't as many samples. Dr. Goodman shared that this is just the first exploration (2004 brood, one reach) but that work has already begun to complete this analysis on all years and reaches.
- *Bayesian Fitting*: To characterize the graph of the 2004 brood samples, the size of the brood on May 1st has to be estimated (as the intersect value); the slope or rate of

exponential decay (mortality rate) needs to be estimated; and the scatter or the over dispersion coefficient for the entire collection has to be estimated.

- Dr. Goodman used a Bayesian fitting to estimate these 3 parameters with a clear indication of the confidence for each.
  - The over dispersion coefficient is somewhat "portable" in that it scales consistently with the mean as was shown in the graph of within-sample-period variance against within-sample-period mean for all months, all reaches, and all years (the respective reaches did not cluster separately in this graph, nor did the fall samples specifically). Therefore estimates of the overdispersion coefficient from large samples can be used as a guide for smaller samples which are insuffient for estimating the overdispersion coefficient on their own. This can now be utilized as a planning tool. For example, hypothetical scenarios and sampling properties for a given mean (ex. 10 fish/100m^2; 20 fish/100m^2; 100 fish/100m^2) with this "patchiness" applied can be tested.
- We now have estimates with confidence intervals for the measure of over dispersion that has some level of portability.

- *Expected Performance of the Criteria:* Dr. Goodman then simulated a future monitoring scenario based on a "best case" situation. 2005 was the best year on record with a mean of 37.3 fish/100m^2 and also had extremely favorable spring flows. In this test scenario, it is assumed that this favorable mean and flow would be available indefinitely but the patchiness would continue to be consistent with the overdispersion coefficient estimated from the 2004 brood in the Angostura reach. Simulating a sampling from the corresponding negative binomial (and its associated uncertainty) obtained from the Bayesian inference, would we be able to satisfy the 5 fish/100m^2 future requirement in a best case situation? The answer is not that encouraging.
  - The probability of 14 or more of the sites yielding minnow densities above 5 fish/100m^2 is 10% (the actual number above threshold in 2005 was 14). However, the probability of all 20 sites being above threshold is very small - around 5 millionths. And the probability of being in attainment 5 years in a row is essentially zero.
  - Based on this analysis, Dr. Goodman encouraged a "rethinking" of the recovery criteria. He also cautioned that these considerations need to be kept in mind when designing the sufficient progress measures.

- At this time, the PVA discussion was switched to the hydrology issues. It was reiterated, from the discussion at the previous PVA meeting,that there is no statistical difference between the no action and proposed action hydrology scenarios that were provided from Bureau of Reclamation's (Reclamation's) Biological Assessment (BA) (at least in terms of the variable used). This means that no matter how sophisticated the PVA models are, they will not show a statistical difference in the biological response as a consequence of scenarios. From a BA/Biological Opinion (BO) process standpoint, the modelers are finding it challenging to evaluate the difference between no action and proposed action runs because no there is no statistical difference in inputs on which to model a fish response.
  - Attendees then discussed the concerns with "stringing" together 5 10-year sequences. There are interdecadal concerns especially when stringing sequences together. It was explained that the processing of the paleo record began with statistical evaluation of the interannual (and up to 5 year variability) to make sure there were no "big jumps." That variability has been accounted for in a statistical way (but not a process way). It is the larger oceanic circulation changes (climate changes) that are not currently addressed.

        - The idea was to capture the "middle majority" of annual average flow at Otowi – so 80% was used. PVA members expressed concern that it is the extreme years (good and bad) that are going to be biologically important and thus need to be included.
        - The development of the hydrologic sequences were selected out of the 1000 100-year scenarios to represent the total 10-year flow across Otowi of 10% exceedance, 30% exceedance, 50% exceedance, etc. With those sequences, a series of "step downs" where various actions (supplemental actions, Heron operations, El Vado operations, etc.) were modeled. The underlying hydrologic setting is the same but modified the management.
    - The PVA work group was updated that a coding issue in URGWOM had been identified and fixed and simplifications are being made to the model. A 50-year run can now be done within 2 to 3 hours. Additionally, the next step is to extend the URGWOM record back to the 1950s. This will capture some of those extreme drought years.
    - It was also shared that there are 112 150-year sequences developed from the Climate Impact Assessment General Circulation Model (GCM) – those are available, processed through URGWOM on a monthly time step. These runs do incorporate the physical earth processes and simulate weather.
        - The GCM model runs are not only indicating a decrease in water availability, it also indicates a change in distribution – the projected future has less water coming from the head waters of the Rio Grande (main stem) and more coming from the San Juans.
        - An argument was made for the PVA to have both the GCM and paleo sequences. The GCM runs capture the trends in terms of temperature/precipitation/evaporation/evapotranspiration/etc. but don't capture the decadal and century-long variability (long-term drivers) that the paleo record does.
        - The PVA made an official request that PHVA provide 5 150-year GCM sequences for both the no action and proposed action.
        - Adjourn for the day.

DAY 2: Tuesday, June 12th

- Dave Gensler brought the meeting to order.
- Meeting attendees discussed how to address the past PVA meeting notes that have not yet been finalized by the work group. Dave Gensler volunteered to review the past meeting notes. Meeting attendees agreed that all of the unapproved past notes will be considered approved after they are reviewed by Dave Gensler; if there are any significant changes or comments to the notes they will be circulated to the work group. The May 14th, 15th, and 16th draft notes were approved with the addition of a correction to information provided at the last PVA meeting: It had been said that Jesse Roach's monthly time step model does not include monthly operations; however it has since been learned that the model does include monthly operation.
- Attendees were reminded that the PHVA will be providing 5 150-year GCM sequences for the proposed action and the PVA work group had also requested that sequences be provided for no action as well. It wasn't known when this data would be received however it's believed that the proposed action output would be received by July or August. Dave Gensler will follow up with the PHVA work group on a timeline for receiving the GCM sequences for the proposed action and no action scenarios.
- Meeting attendees reviewed the May 2012 Action Items. Most of the May action items were completed or are in the process of being completed.
- Dr. Goodman then continued the presentation of his *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report*.

- *Expected Performance of the Criteria (continued):*
  - Dr. Goodman simulated a future monitoring scenario based on indefinitely repeated extremely high population density value to determine how high the true mean would have to be to reliably detect a CPUE above 5 fish/100m^2 in the "October" monitoring with the current design. Based on this analysis the 2005 means of 37.3 fish/100m^2 were not enough and with any realistic mean, attainment cannot be reached with the current design.
- Another subchapter that Dr. Goodman would like to add focuses on detectability to determine the number of samples needed to be convincing that the mean fish density in the river is low. By drawing an inference and calculating the confidence interval it's found that with 6 consistent zero samples the upper 95% confidence tail is 20 fish/100m^2. If there are 6 zero samples in a row there is no confidence that the population is low and at 10 zero samples the upper confidence limit is .2 fish/100m^2. Not only are a large number of samples needed to be confident that the population is "high" but a large number of samples are also needed to be confident that the population is "low".
- *Conclusions:* The analyses of the population monitoring CPUE data indicate that the monitoring-based recovery criteria in the recovery plan are too subject to sampling variation and are too volatile to be used as a long term indicator of the status of the species.

- Meeting attendees then viewed presentations from Dr. Miller and Dr. Goodman on preliminary model test runs.
  - In Dr. Miller's presentation *A preliminary "straw man": integrating spring flow and silvery minnow biology in the middle Rio Grande* he explains how he uses the population monitoring data from 1993 – 2007 to transform flows to fecundity estimates and transform flow estimates to sequences to get trajectories in order to understand the different responses of the population to different flow profiles.
    - Using the formula for deriving CPUE into abundance from the Population Estimation report from ASIR, Dr. Miller was able to transform CPUE data into abundances. The relationship between spring flow and the number of individuals (RAMAS is a female specific model) in the river is used to try to determine the relationship of flow to the number of individuals. From this an expression was derived to find the volume of water from one year to the next that would yield a doubling of the female population abundance in order to get estimates of population abundance for Albuquerque, Isleta, and the San Acacia reaches. For simplicity, it was implied that changes in first year fecundity are fully responsible for corresponding changes in abundance. The abundance relationship is then used to get a proposed relationship between flow and Age-0 fecundity.
    - To develop the hydrology sequences, 10 years of data at 5 exceedance levels were arbitrarily strung together for a proposed action and no action years to compare the two data sets. Log normal distribution was used to identify environmental variability. Though not significantly different, the proposed action scenario does have a lower mean and a slightly larger variance than the no action scenario. Dr. Miller explained that in the PVA he plans take a large number of the flow data over a period of time to define as a statistical distribution to realize different flow sequence over time and generate a distribution of possible outcomes for population.
    - Distributions for fecundity of Age-0 fish for flows were then derived. The difference between the proposed action and no action years is that the mean fecundity is lower for the proposed action years because of a reduced mean spring flow.

- Summary of test model structure:
  - Two age classes for simplicity
  - F_1 scaled within each reach in accordance with the original ratio of 1.229/0.909 = 1.35
  - Environmental variation (SD in mean demographic rates) scaled to that calculated for F_0 (expressed as CV)
  - No complex density dependence yet
  - Initial reach-specific abundances taken from 2007 Population Estimation work – K estimates arbitrarily set for each reach
- The test model structure was used to simulate minnow population trajectory under no action and proposed action scenarios. It was noted that each of the two action scenarios start with an equal number distributed over the reaches based on the 2007 monitoring reports. In the early phases of population growth both populations have the opportunity for substantial growth but the no action scenario has more growth with its higher estimates of spring flows and higher estimates of Age-0 fecundity. The population's individual replicates of these simulations begin to be constrained by approaching carrying capacity and the abundances become attenuated. The model needs more work with regards to the type of the statistical nature of the relationship between flow and abundance and to find a way to statistically define these parameters to be useful to the PVA.
- Dr. Miller will develop a written description of the methodologies used in the preliminary model run to distribute to the PVA work group.

o Dr. Goodman presented several example runs of Bayesian PVA prospective analysis.

- PVA generates random population trajectories and tallies the fraction that has crossed a predetermined threshold within a specified amount of time. There are 3 reporting parameters in this particular model: 1) the final population size; 2) the first passage time to threshold (how long it took the trajectory to reach the predefined threshold); and 3) diagnostics (an option chosen from different diagnostics).
- Dr. Goodman first ran a calibration scenario of 18 years to see if the model could generate distributions that are similar to what has been seen in the 18 – 19 years of monitoring data. The population threshold was set to a placeholder of 1 unit of CPUE/100m^2. In this scenario survival is different for adults and young of the year.For the first run, a sample size of 1,000 trajectories was used. The diagnostic option that was chosen was the spring flow distribution.
- Results: The mean final population size after 18 years was 8 units of CPUE/100m^2 and standard deviation 6.3; the model could use absolute individuals but this would require looking at the population estimation process. It was noted the distribution of the "time to cross the threshold" was very ragged. It was also noted that the spring flow distribution was very "scratchy". It was explained that the "scratchiness" is an artifact of the sample size of trajectories; if there was a larger sample size the "scratchiness" would not be present and the reproducibility would increase.
- Dr. Goodman then made additional example model runs using 1 million and 5 million trajectories. With this level of sampling the distribution has been resolved enough to begin looking at the fine points in the model results. In the 5 million trajectory model run it was noted that there is large variability in final population size and though some of the population sizes are quite low, which is consistent with what was seen in reality, something is keeping the population from going extinct. Because the model doesn't show in absolute terms how low the population is, it's not

known if the population is low enough for genetics to be a concern. This particular scenario had zero probability of going to extinction and there was little probability of going below the 1 CPUE/100m^2 threshold.

- Meeting attendees reached a resolution on the Consensus Data Set for this iteration of the PVA models. For this iteration of the models, the PVA work group accepts the data that are archived on Dr. Goodman's website as provided by the originators to Dr. Goodman and as reconciled by Dr. Goodman and there is agreement with using these data sets as the consensus data for use in the PVA models for this iteration. The datasets and the pedigree are shown and documented on Dr. Goodman's website. The PVA work group requests the originators of the data review and concur with the validation or reconciliation of the population monitoring data. The egg monitoring data is considered provisional and is not considered appropriate for inclusion in the model at this time.
- The PVA work group discussed how to address the Service's questions regarding the PVA. Attendees were in agreement that because not all of the appropriate information is available many of the questions could only be answered on an abstract level. One suggestion was for the modelers to have face-to-face meeting with the staff members who may be using the PVA in their BA/BO analyses. As part of this meeting the modelers could show the staff what the models will look like and find out what changes could be made to the models based on how they will be used. It is preferred for these discussions to take place during the July PVA work group meeting if possible but the PVA model training workshops are alternate venues for these discussions to take place.
- The PVA work group discussed validating Dr. Goodman's report and potentially considering the report as a possible PVA work group product. There was general agreement that the information in the report is important and once the report is validated and approved by the work group then the report should be referred to the EC. The work group agreed that the report will undergo internal review and cross validation of the processes used before it is referred to the EC. PVA work group members will review and/or cross check Dr. Goodman's report for discussion at the July PVA meeting.

Next Meetings:

- Regular PVA: Monday, July 23rd starting at 10:00am and Tuesday, July 24th; location TBD
    - Tentative Agenda Items: (1) August 15th Service deadline – what can be done? What needs to be supplied to provide PVA information?; (2) Update on RAMAS model (due June 31st) and upcoming deadlines; (3) approval of June PVA meeting notes; (4) "strawman" model runs with the 5 150-year GCM hydrology; (5)
- PVA Training (tentative): Wednesday, August 15th and Thursday, August 16th

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June 11th and 12th, 2012
US Bureau of Reclamation
555 Broadway Blvd. NE, Albuquerque, NM 87102
Rio Grande Conference Room

Meeting Notes

DAY 1: Monday, June 11th, 2012

Introductions, Agenda, Review December 2011 and May 2012 draft notes:

- Dave Gensler brought the meeting to order. Introductions were made. The agenda was reviewed and rearranged to shift the critical discussions to Monday when Reese Fullerton (facilitator) was present. The regular business items (ex. draft note approval) were postponed until Tuesday.

Report Presentation: *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report* dated May 1st, 2012

- Dr. Goodman then presented his *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report dated May 1st, 2012.* In introduction, Dr. Goodman apologized that the document is so daunting. He explained that he started this process over a year ago motivated entirely by his own needs for the PVA and fully expecting to delve into the mathematics. The original intent was to determine how to estimate recruitment and survival from the Catch Per Unit Effort (CPUE) data. However, this "tour" of the population monitoring CPUE data fortuitously bears on questions that have since come up: (1) the Service question regarding the ability of the PVA models to predict the recovery criteria metrics; (2) sufficient progress metrics in the Recovery Implementation Plan (RIP) Action Plan; and (3) commentary on the recovery criteria and use of the recovery criteria (or criteria like them) based on CPUE.

- *Recovery Criteria*
    - Dr. Goodman pointed out that a number of recovery criteria in the recovery plan involve the ASIR sampling protocols (ex. Criterion 1-A-1: prevent extinction mentions the standard sampling protocol (which is the ASIR protocol). However, the criterion for delisting "switches tracks" with the requirement for 3 minnow populations with a probability of extinction less than 10% in 100 years. This is exactly a PVA criterion.
    - The analysis developed here was intended to pursue 4 questions about the demographic criteria that are based on population monitoring metrics: (1) what has been the observed trajectory of those metrics over the past 19 years?; (2) what is the statistical "noise," and therefore, uncertainty, in measuring those metrics?; (3) how much would the population need to change (increase) in order to meet the criteria for those metrics?; and (4) how have those metrics correlated with other PVA-related characteristics of the population over the past 19 years?
        - In general these questions are aimed at determining how close have we may have come, historically, to meeting the criteria and what is the pattern over time.
        - It was cautioned that the "switching tracks" from CPUE monitoring-related criterion to PVA recovery criterion could indicate a disconnect. For example, what if a PVA analysis demonstrates a probability of extinction of less than 10% in 100 years at the same time that the downlisting criterion requiring 5 years of > 5 fish per $100m^2$ at all sites is not met? This may indicate that the recovery criteria need to be revisited for future planning .

- *Historic Record of the Monitoring Metrics*
  - *Completeness of the "October" census*
    - The following analyses are based on data files provided by the Service and ASIR to the Collaborative Program (and can be found on Dr. Goodman's website).
    - The first issue is that the recovery criteria specify that the metrics must be based on population monitoring October results from *at least 20* of the routinely sampled sites. However, there have been 20 sites sampled only about half of the time (historically). Until 2001, there were always quite a bit less than 20 sites – so there has not been many years of sampling to test this portion of the criteria exactly. With the exception of 2 missed sites in 2003 and 1 in 2011, ASIR has been sampling 20 sites in the recent years.
    - There is a range (or spread) of "October" sampling dates - from late September to late October. This is not to the letter of the recovery criteria. There may be good logistical reasons, but those need to be known and properly accounted for. If there is a time trend (i.e., the date matters with regard to how many fish are seen) we will need to correct that trend in order to standardize the results and back calculate to a reference date .

  - *Presence of RGSM at 3/4 of Sites*
    - This "distribution" requirement is focused on minnow detected at ¾ of the sites year by year. Historically, each reach has been in attainment about 2/3 of the time but not always/often simultaneously. This is not that stringent a criterion but the long-term predictive value of this metric is questionable.
      - Whatever this monitoring metric is measuring is volatile (ex. 2003 to 2005) and can change very rapidly one year to next – this indicates that is it not a long-term property. Dr. Goodman explained that this is not reassuring as a real measure of the health of the population.
      - ***Question:*** What extent do you believe that volatility is biologic or statistical phenomenon?
        - ***Response:*** The underlying source of the volatility is real (biologic) but the *extent* of the volatility in any given sample might be statistical since it changes with the sample size.

  - *Presence of YOY at ¾ of Sites*
    - For the YOY requirement, the system has only been in attainment for about ½ time and not in all reaches at the same time. In other words, individual reaches are in attainment about half of the time. There are times when one reach looks good but other reaches are below the threshold. What this metric is measuring is also volatile - from a low fraction of sites with YOY detected to a very high fraction of sites.
      - It was clarified that Recovery Criterion 1-A-2 and Recovery Criterion 2-A-2 has different "time" specifications. One specifies the October sampling and the other is more open to any recruitment indications from July to October. Criterion 1-A-2 is focused on annual reproduction which could be met in June.
      - Dr. Goodman pointed out that the fact that the time indicators (and therefore sample size) are not specified will make it ambiguous to evaluate: the more samples you take (over time) the higher the probability of finding a YOY minnow.

  - *Minnow Density >5 per 100m^2, all sites*
    - This is the downlisting criterion - for every site in all reaches.

- This requirement has never been met historically. More than 5 minnows per 100 m^2 overall has never been observed at 100% of sites; in fact, the closest ever attained was less than 75%.
- By reach, there have been a few years when only one reach has been in attainment. The quantitative measure (what fraction is in attainment) is horrendously volatile: dropping to zero and then 2 years later it was almost at the highest ever seen.
- This metric is volatile and shows low prospects for ever being in attainment. For example, 2005 was the best year the system has seen in terms of abundance of minnow and water – but even that year only 70% of the sites show >5 minnow in 100m^2.
    - Dr. Goodman shared the opinion that it is very worrisome that the downlisting criterion can't be met (or close to met) even in the best year on record. This best water scenario cannot be replicated by management; it will only occur when Mother Nature provides it.
- The discomfort with the quantitative criterion of >5 fish per 100m^2 prompted Dr. Goodman to question the noise - site by site and sample by sample - as a function of the mean for that year. How do we roughly characterize the range of values by site by reach and within each year?
    - Graphing the range of minnow densities over the sites in October (sample spread on log scale), we see that in every year, except years of almost no minnow, there is huge variability. One site might have 50 fish but another site in same reach in that same year might only have 1 fish. The bottom line is that there is a huge spatial variability at any given time in all the reaches in all years.
    - ***Question***: If the frequency of CPUE value pattern were to be plotted on each of those lines, would it show a non-normal pattern on a log-transform scale?
        - ***Response***: Correct. ASIR has used log regressions and the suspicion is that the normality required for least squares regression wasn't achieved even by log transformation. This variability is so severe that even log-transformation won't normalize it.

- *Correlations*
    - How do the 3 criteria (1. sites with minnow present; 2. sites with YOY present; and 3. sites with minnow density >5 fish per 100m^2) correlate?
    - These 3 metrics are essentially all "telling the same story" and indicating the same thing. They are all "funny" ways of re-expressing the mean density of fish that year (which is highly correlated to the mean flow in May-July).
        - This explains the volatility: dry spring = low numbers; and wet spring = high numbers. There is no predictive ability year to year.
        - Does this mean the CPUE numbers are so statistically "flaky" that they are not usable at all? The answer is no. The CPUE numbers are very useful when used appropriately.
    - However, this high correlation between the mean density and the fraction of sites above the 5 fish per 100m^2 threshold saturates at about 15 fish per 100m^2. As the mean density goes up so does the fraction of sites above the 5 fish per 100m^2 threshold but this stops at about 15 fish per 100m^2. This means that even if there are more fish in the system, there will not be more sites above the 5 fish per 100 m^2. This is indicating some "perverseness" of the patchiness of minnow abundance and distribution.
        - Possible explanation/theories:
            - 1. There may be sites that are just not chosen by the fish.

- 2. This is telling us something about how the patchiness of fish numbers is scaling with the mean density – more fish in the river and the presence actually becomes patchier.
- 3. The fish school and the schools are coherent but they move around, maybe at higher fish numbers the schools become larger and more coherent..
- 4. Some implication of habitat saturation – the habitat saturation isn't overcoming the habitat avoidance. There are just some places that "just don't look right to the fish" at a given time
- However, there are not yet an adequate number of samples to get to the reasons. We still need the by-mesohabitat data in order to do a more habitat-stratified analysis .

- ***Question:*** To what degree do the Angostura data influence the reach attainment of the high density data for 1995 and 2005?
  - ***Response***: Angostura was "low ball" in those years but that is not necessarily the case in other years. By and large, the scatter looks the same. Appreciation for the extreme scatter indicates we have to get formal with the statistics.

- ***Question***: Are there any sites in Angostura that consistently fall out?
  - ***Response***: In any given year, there are sites that have been avoided during the October sampling. Is that consistent year to year? The answer is no. We do not see any site that stands out as a really good or bad site over all years. The patchiness either has to do with microhabitat variability (which is not stable over time) or the schooling of the fish.
  - The system has extreme variability but it cannot be simply written off as a static site property. We see it over all sites in all reaches in all years.

- *Estimating the Noise in the Metrics*
  - How do we characterize this high variability in the by-sample numbers where the mean doesn't represent the values? There are a number of statistical distributions that can be used. Counts are frequency represented as a Poisson distribution, but we will see in a minute that the Poisson will not do for the RGSM data.
  - It was pointed out that the ASIR sampling tends to happen over several days and then there will be a span of time (several weeks or months) before sampling occurs again. The group of samples (sample events) taking place within a few days within a reach constitute a sample period. This means we can calculate the mean and variance of the samples within the sample period.
    - Figure 10 shows the estimate of the within-sample-period-variance in minnow density among sample events plotted against the sample period mean minnow density, for the September to November sampling for all years and reaches.
    - Dr. Goodman explained that the black line is where variance would be equal to the mean. It is interesting to note that the variance is consistently higher than the mean and increases as the mean increases. Therefore we can't use the Poisson distribution. But this is very consistent with what is called "overdispersion." The negative binomial is a statistical distribution that explains and quantifies this kind of variability pattern.
      - Now that we know the appropriate distribution, we can begin power analyses; and we can begin to design sampling to get a specified precision.

- *Variance Along a Cohort Trajectory*
  - Here we consider a way to look at all the sample events, within a reach, for a single cohort-- all the fish hatched in the same year. The rationale is that the subsequent trajectory of this single batch of fish will reflect a history that they all have in common, so a common statistical model may plausibly be fit to the entire set of observations.
  - Dr. Goodman then plotted all the individual sampling events (200+ on specific dates) for the 2004 brood of fish in the Angostura reach. (The brood starts with the YOY in 2004 and follows into 2005 as the Age 1 fish). The 2004 brood was selected as the first exploration because it had a lot of data points and the numbers were relatively high so there were fewer issues with "zeros."
    - The biological hypothesis is that there needs to be some underlying cause for the pattern since this is the same group of fish.
    - Referring to Figure 12, Dr. Goodman explained that the heavy black line is the result of doing the regression which is following the mean value of the negative binomial on that day (or the center of gravity of the negative binomial mean regression). The slope of the black line represents a mortality rate. The scatter about the regression line is the expression of the overdispersion. We now have a way to estimate the overdispersion for cases where we don't have as many samples.

  - *Bayesian Fitting*
    - To characterize Figure 13 we need to: (1) estimate the size of the brood on May 1st as the intersect value; (2) estimate the slope or rate of exponential decay (mortality rate); and (3) determine what is the scatter or the common overdispersion coefficient for the entire collection of samples for that brood.
    - To estimate these 3 parameters, the model was fit by Bayesian inference. This exercise provides us with a quantified measure of confidence in each estimate.
    - The lower left graph is the overdispersion coefficient. The over dispersion coefficient is somewhat "portable" in that it scales consistently with the mean as was shown in the graph of the within-sample-period variance against within-sample-period mean for all months, all reaches, and all years (the respective reaches did not cluster separately in this graph, nor did the fall samples specifically). Therefore estimates of the overdispersion coefficient from large samples of sample events can be used as a guide for smaller samples which are insufficient for estimating the overdispersion coefficient on their own . This can now be utilized as a planning tool. For example, hypothetical scenarios and sampling properties for a given mean (ex. 10 fish/100m^2; 20 fish/100m^2; 100 fish/100m^2) with this "patchiness" applied can be tested.
      - ***Question:*** What do you think about partition of variance in any one year and any one reach? How much is demographic variance and how much is sampling variance? How will that be addressed in the derivation of the model variance?
        - ***Response:*** Application of this gives us the ability to describe the variance that each individual sample will "dip into." How much could have just been noise in the estimates? The answer is pretty small. It is apparent that the estimates, at least for 2004, gave good numbers. The May 1 density was between 15 and 55; so we can do the equivalent

of a t-test in comparing to the estimate for other years since we know the variances.

- Dr. Goodman then used the regression procedure to interpolate the October values and the confidence interval on the new estimate of the October values. This technology gives us the ability to calculate a better October density than the October sampling is providing by itself because the regression follows across the entire cohort of 200+ sample events. We already have a suggestion that there is a need for a more stable metric (than the >5 fish per $100m^2$) but at least we now have a "tighter" way to estimate the October values.
- To test the partition of the variance (and gage the realism of the estimates), Dr. Goodman took the parameter estimates and synthesized data through a random number generator to get simulated data that impressionistically looks like real data, and compared it to the actual data and the regression on the real data. To the eye, the simulated data had the same sort of scatter and fit the regression as well as the real data . This is a first step in getting intuitively comfortable with a level of internal consistency in the method.
- ***Comment***: It should be pointed out that some significant numbers of fish may be lost after each spawning event. This is a biological factor. It is thus cautioned that there could be a real "dip" in mortality associated with the spawning (or in other words, a differential mortality). Dr. Goodman said that the negative binomial regression method should be used to test whether this hypothesized "extra" mortality associated with spawning can be detected in the data.

- After a lunch break, Dr. Goodman returned to the report presentation. He pointed out that the PVA work group will need to have discussions on the appropriate steps for internal validation from the group so that the Program isn't "just taking his word for it" - especially since a formal peer review could take years.
  - *Expected Performance of the Criteria*
    - We now have estimates with confidence intervals for the measure of overdispersion that has some level of portability.
    - Dr. Goodman then simulated a future monitoring scenario based on a "best case" situation. 2005 was the best year on record with a mean of 37.3 fish per $100m^2$ and also had extremely favorable spring flows. In this test scenario, it is assumed that this favorable mean and flow would be available indefinitely but the patchiness would continue to be consistent with the overdispersion coefficient estimated from the 2004 brood in the Angostura reach. Simulating a sampling from the corresponding negative binomial (and its associated uncertainty) obtained from the Bayesian inference, would we be able to satisfy the 5 fish per $100m^2$ future requirement in a best case situation? The answer is not that encouraging.
      - The probability of 14 or more of the sites yielding minnow densities above 5 fish per $100m^2$ is 10% (the actual number above threshold in 2005 was 14). However, the probability of all 20 sites being above threshold is very small - around 5 millionths. And the probability of being in attainment 5 years in a row is essentially zero.

- Based on this analysis, Dr. Goodman encouraged a "rethinking" of the recovery criteria. He also cautioned that these considerations need to be kept in mind when designing the sufficient progress measures.
- ***Question***: How different would the 2 "simulated future" graphs look if a different year was used?
    - ***Response:*** Quantitatively, that answer is not available yet. But Dr. Goodman explained that he is currently having the same analysis applied to all years and reaches. Qualitatively, the data shows the same "triangular" pattern (abundance against time) for each brood even though there are less data points. In the early 1990s there were a few years where the numbers of fish were not dramatically different and there were fewer zeros in the early sampling for the brood, but there was still some level of patchiness. This raises the question if something has happened in the system (geomorphology) that has exacerbated the patchiness. If yes, can it be controlled and managed to get fewer of these "0" samples?
    - It is very rare that all 20 sites will be above the 5 fish per $100m^2$ threshold in any given year; but to get 5 consecutive years of that threshold looks essentially impossible.
    - Dr. Goodman then cautioned that while it would be very tempting to treat the overdispersion parameter as having a "life of its own" for each brood in each reach, and possibly for each seson, but because of the flakiness (high sampling variability) of the variance of the negative binomial, the overdispersion coefficient parameter is very hard to estimate unless you have a large sample size.
    - Due to time constraints, the PVA discussion was switched to the hydrology issues at this time. Dagmar Llewellyn and Amy Louise joined the group for this discussion.

Report back on status of PHVA URGWOM runs, additional PHVA products requested by PVA (Gensler/Llewellyn)

- David Gensler provided a brief update on the hydrology request from the last meeting. David explained that after the June meeting he talked with Dagmar and Warren Sharp about the possibility of additional URGWOM model runs specifically targeting years on either side of the exceedances that were selected.
- Dagmar shared that her understanding was that the last data projection transmission from the PHVA was is enough for the modelers to get started on some run but that there were concerns about variability and cyclic patterns. She suggested that the PVA use what had been provided to run basic scenarios, calibrations, etc. and once that has been completed, then the group can begin to look at options for longer times.
    - In response, Dr. Miller explained that he has been working through the no action and proposed action hydrology runs from URGROM to try to develop a sample protocol and example of how they could be employed/applied. He shared that there is no option at this point other than stringing the 5 10-year sequences together but he was ultimately looking to generate a distribution of a range of hydrology variations.
        - While the 5 10-years sequences could probably be a statistically appropriately place to start, the concern over the transitions between the years remains.
        - These models typically address the possible outcomes given any number of possible situations by running 1,000 replication of a 100-year fish model – to get to average and unusual (both positive and negative) fish population response projections. The purpose is to provide a distribution of outcomes given a suite of situations.

- The results are largely "predetermined" when there is only one hydrologic sequence.

- Dr. Miller also explained that the PVA work group realize in May (and he has since verified in the data) is that there is no statistical difference between the proposed action and no action, at least in terms of the variable used. This means that the PVA models, no matter how sophisticated, will not show a statistical difference in the biological response as a consequence of scenarios. From a BA/BO process standpoint, the modelers are finding it challenging to evaluate the difference between no action and proposed action runs because no there is no statistical difference in inputs on which to model a fish response.
- Dagmar acknowledged that there are interdecadal concerns especially when stringing together the sequences, but the processing of the paleo record began with statistical evaluation of the interannual (and up to 5 year variability) to make sure there were no "big jumps." That variability has been accounted for in a statistical way (but not a process way). It is the larger oceanic circulation changes (climate changes) that are not currently addressed. From this paleo record analysis, 1,000 100-year sequences were developed.
    - The idea was to capture the "middle majority" of annual average flow at Otowi – so 80% was used. PVA members expressed concern that it is the extreme years (good and bad) that are going to be biologically important and thus need to be included.
    - The development of the hydrologic sequences were selected out of the 1000 100-year scenarios to represent the total 10-year flow across Otowi of 10% exceedance, 30% exceedance, 50% exceedance, etc. With those sequences, a series of "step downs" where various actions (supplemental actions, Heron operations, El Vado operations, etc.) were modeled. The underlying hydrologic setting is the same but modified the management.
    - Dr. Miller clarified that the RAMAS model runs on an annual time step but can use monthly data but daily data is preferable.

- Dagmar then informed the work group that there are 112 150-year sequences developed from the Climate Impact Assessment General Circulation Model (GCM) – those are available, processed through URGWOM on a monthly time step. These runs do incorporate the physical earth processes and simulate weather.
    - The GCM model runs are not only indicating a decrease in water availability, it also indicates a change in distribution – the projected future has less water coming from the head waters of the Rio Grande (main stem) and more coming from the San Juans.
- The PVA work group was updated that a coding issue in URGWOM had been identified and fixed and simplifications are being made to the model. A 50 year run can now be done within 2 to 3 hours. Additionally, the next step is to extend the URGWOM record back to the 1950s. This will capture some of those extreme drought years.
- At the May meeting, the PVA work group requested additional URGWOM runs (5 for each exceedance) in order to determine possible range of flows and the "noise" or error. However, the selection of these additional sequences was questioned – what is the right way to pick or select a truly representative sample? After a brief discussion, members then cautioned against using predetermined sequences with no variation.
    - The PVA models are being asked to evaluate/provide guidance on things like the likelihood of 3 really bad years in a row and population response. The work group wants/needs to be able to generate a series of different hydrologic parameters for those types of situations.
        - Even within the dry sequences there can be hugely wet years and the wettest sequences have multiple drought years.

- It was pointed out that while spring runoff is an important driver, there is the potential for something else in late summer that needs to be evaluated.
- Dagmar shared that technically the PHVA could do the URGWOM runs, but this does not mean there will be the time or money. She suggested the PVA models could provide a real contribution with modeling the habitat – connectivity to the floodplain; before/after habitat restoration in terms of effectiveness; etc.
    - In order to do this, there has to be some measure of habitat availability at different flows. PVA members explained that while there has been some preliminary work towards this, it is not available yet.

- Attendees briefly discussed any options to develop their own hydrologic scenarios or "numbers" in order to be unconstrained from a particular scenario. As long as there is confidence in the relationship between the hydrology and the demographic response of the fish, it could be possible to come up with a variety of scenarios to determine what has to happen in order to maintain a level of fish population response.
    - Dudley and Platania did some work on the number of days above x flow threshold. This could be built on to get a ruleset on the relationship between past observed flow and past CPUE. But this is assuming a static geomorphic system.
        - It was pointed out that the system has pretty much been in equilibrium based on the 2002/2003 HECRAS modeling.
        - Dr. Goodman then asked if the PHVA could answer other specific questions, such as: during the summer, the difference between the proposed action/no action is a certain number of extra days or miles of drying? Could PHVA provide those generalizations?
            - It was responded that because of issues with the balance of ET and groundwater inflows, the portrayal of drying in URGWOM is not believed to be accurate or reflective of reality. However, David Gensler has developed a spreadsheet-based model on just the MRG that addresses the days and numbers on drying.

- If there is opportunity to get some 100-year sequences in the works, what data (paleo or GCM) and number of sequences would the PVA like?
    - PVA members discussed that there is argument for both: the GCM runs capture the trends in terms of temperature/precipitation/evaporation/evapotranspiration/etc. but don't capture the decadal and century-long variability (long-term drivers) that the paleo record does.
    - The PVA made an official request that PHVA provide 5 150-year GCM sequences for both the no action and proposed action.

- ***Question***: Is the Cochiti deviation built into the proposed action or no action?
    - ***Response:*** It is included in both. It is an existing action now so it is included for the first 2 years of the no action and it is a proposed action as well.
    - The current definition of "proposed action" does not include conservation measures.
- ***Question:*** I'm puzzled at the level of hysteria over short-term deadlines if the scenarios analyzed for the BA (both no action and proposed action) do not contain any conservation measures. If the outcome is that there is some effect(s), won't all this work have to be redone with the conservation measures included for a BO?
    - ***Response:*** As of today, the analysis only contains the proposed action/no action scenarios. But by the time the Draft BA is finalized, it should include conservation measures as well. But yes, the current scenarios in the Draft BA do not contain conservation measures– so these would have to be rerun in order to evaluate.
    - It already does include ongoing MRGCD ongoing conservation measures.

- It was pointed out that everyone involved understands that the submitting a BA to get to a BO is not the "end of the story." The idea behind the consultation process is that a lot of things still have to be worked out through PVA modeling, development and implementation of the RIP, URGWOM modeling, etc.

DAY 2: Tuesday, June 12th, 2012

Opening and Introductions

- Dave Gensler brought the meeting to order.

Review/Approve Past Outstanding PVA notes, May 2012 Action Item Review and Update

- Meeting attendees discussed how to address the past PVA meeting notes that have not yet been finalized by the work group.
  - Dave Gensler volunteered to review the past meeting notes to see if there are any issues.
  - Meeting attendees agreed that all of the unapproved past notes will be considered approved after they are reviewed by Dave; if there are any significant changes or comments to the notes they will be circulated to the work group.
- The May 14th, 15th, and 16th draft notes were approved with the addition of a correction to information provided at the last PVA meeting; it had been said that Jesse Roach's monthly time step model does not include monthly operations, however it has been learned that the model does include monthly operation.
- Attendees were reminded that the PHVA work group will be providing 5 150-year GCM sequences for the proposed action and the PVA work group has also requested that sequences be provided for no action as well so that the PVA can compare the two sets sequences.
  - It wasn't known when this data will be received; however, it's believed that the proposed action sequences will be available by July or August 2012.

Action: Dave Gensler will follow up with the PHVA work group on a timeline for receiving the GCM sequences for the proposed action and no action scenarios.

- It's believed that the proposed action sequences include the supplemental water and the non-federal actions by MRGCD. The conservation measures are also included in the proposed action sequences. It's not known if the conservation measures can be separated out and there are conservation measures that are still in development and have not yet been included.
  - It was one opinion that the proposed action sequences shouldn't include any conservation measures. The proposed action sequences should include only the proposed actions without any specific actions for the minnow; in order to evaluate the impact the conservation measures and supplemental water need to be segregated from the proposed actions.
    - Another issue with including the conservation measures in the proposed action sequences is that they have not been finalized.
  - The supplemental water can be turned off and on.
  - It was shared that Reclamation has been working on different ways to understand the impacts of the conservation measures and it has been found that the URGWOM model may not be the best tool for that; Reclamation is also utilizing spreadsheets to evaluate the conservation measures.
  - It was pointed out that given the timeframe for the BO; the conservation measures may not be plugged into the model and tested before the BA deadline.

- Jason Remshardt updated meeting attendees that the applications for the LCC funding opportunities are due on June 28th.

May 2012 Action Item Review:

- **Yvette Paroz will determine if the ASIR population monitoring data provided already includes depth/velocity/temperature/etc. information. (*from 05/16/12);***
    - Complete. Yvette updated meeting attendees that the ASIR population monitoring data does not include depth or velocity measurements. The monitoring data does include temperature data but temperature is only measured at a single point on each site and is not measured in each habitat type.
- **Yvette Paroz will check the ASIR data to determine if the mesohabitat/surficial area is in GIS or electronic file formats. (*from 05/16/12)***
    - Ongoing; Yvette is working with the contractor to obtain the GIS layers.
- **Jason Remshardt will email the FWS Population Monitoring data with mesohabitat/depth/velocity/substrate information (1999 to 2001; 2002-2012) to Dr. Goodman and copy Yvette Paroz for posting to the Program's website. (*from 05/16/12)***
    - Ongoing; Jason will be working with Dr. Goodman via email to determine which of these data are needed.
    - Dr. Goodman will also be working with Jason to reconcile some inconsistencies within the data.
- **Yvette Paroz will provide Dr. Goodman with Reclamation's Fish Datasets that include information on depth/velocity/substrate; these datasets will also be posted to the Program's website. (*from 05/16/12)***
    - Incomplete. The data sets have not yet been sent to Dr. Goodman. The data sets are similar to the Service's population monitoring data but the Reclamation data sets are smaller. Yvette will be working with Dr. Goodman to see what parts of the data will be useful to the PVA.
- **Dr. Goodman will compare the Program website to his for discrepancies and will email any missing files (ex. the Dudley data file) to Yvette Paroz for posting to the Program website. (*from 05/16/12)***
    - There are still files on Dr. Goodman's website that are not included on the Program website. Dr. Goodman will be providing the files to Yvette.
- **Yvette Paroz will provide ASIR's Population Monitoring and Population Estimation presentation to the ScW work group to Tetra Tech to distribute to the PVA work group. (*from 05/16/12; TT emailed to Ali to post on 05/22/12)***
    - Complete.
- **Peter Wilkinson will follow up with Grace Haggerty on her action (from December 2011) to forward the Doug Wolf "I-40 to Central Inundation" Presentation to Mick Porter. (*from 05/16/12)***
    - The status of this action item was not reported on.
- **Rich Valdez will send his temperature/minnow length (hatch & growth rate) work to Mick Porter. (*from 05/16/12)***
    - Ongoing. Rich updated meeting attendees that he is working on a temperature correction; his model works but the predictions are a little "off". Rich will be sending Mick the work that he has done so far so that they can work to get the temperature corrected. The model works well to predict the hatching date of the fish. Because the model corresponds to peaks of egg drift it's suggested that it be used for the Cochiti Deviation Analysis to help determine when the minnow hatched. The main stem temperature information that was provided by Mick is used as the input to the model.
- **Comments, considerations, suggestions, and other feedback on the Corps' Cochiti Deviation Analysis should be emailed directly to Mick Porter as soon (and as often) as possible. (*from 05/16/12)***

  - Complete. Comments were received from Dr. Goodman. There will be a shift in the general process of the Corps' Cochiti Deviation Analysis that will help help tie the analysis to the PVA.
- **PVA work group members will review the datasets on Dr. Goodman's website to prepare discussion points, questions, and identification of anything that needs validation or review in preparation for the Consensus Dataset decision at the June 11th meeting. Feedback should be emailed to David Gensler and Dr. Goodman no later than May 31st, 2012 in order for a simple yes/no decision to occur at the June meeting. If no comment is received by then, members risk losing their ability to provide input into the process. (*from 05/16/12)***
  - Complete.

Continuation of Report Presentation: *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report* dated May 1st, 2012

- The modelers were asked if they knew how they would be using the current hydrologic sequences in their models.
  - During the preliminary model run presentations the modelers will be describing how they are able to use the current hydrologic sequences and if there are any shortcomings. Dr. Goodman explained that his presentation will consist mainly of diagnosing and demonstrating the effects of inadequate sample size of hydrologic sequences as this affects the sample size of trajectories. Though there is not much that can be done about sample size of hydrologic sequences during this PVA iteration (this is out of PVAs hands, and PHVA does not seem to be promising many more runs) some amount of information can be obtained and the limited results may help impress on others the limits of using a small sample size (and therefore the importance of obtaining a larger sample).
  - If the sequences from the paleo reconstruction and the forward climate modeling are generally representative then the modelers could extract the serial correction from those sequences and generate millions more sequences. To do this the modelers would need to know what the difference in spring flows are between the proposed action and no action sequences.
    - It was commented that it would be interesting to know what's going on with respect to the summer and spring that creates the different flows within an agency's settings.
  - The PVA work group still needs to have discussions to determine how to tie drying to minnow observations. The notion of drying days is hard to link to survival with the present data.
    - It's difficult to use the number of river miles that are dry as an indicator because it's not know what it means for a river mile to dry. When a mile is considered dry does this mean that it is completely dry or are there pools? Also, does a mile being dry mean the river mile is dry over three days or three hours?
  - Dr. Miller was asked how he is dealing with dry periods in the RAMAS model.
    - Dr. Miller explained that he is taking the 50 spring flow data points from the 5 10-year sequences to create a statistical distribution. The sequences are being treated as independent flow.

- Dr. Goodman then continued the presentation of his *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report*.

- *Expected performance of the criteria (continued)*:

  - ***Question*:** The true mean in the simulation is the mean across what spatial area?
    - ***Response:*** In the simulation the entire river is sampled.

- ***Question:*** What is the highest density sample after recruits show up in the summer?
  - ***Response:*** The sample densities go into the 100s. Not counting pools, the highest sample density is about 500 fish. There was one sample in the population monitoring data from a pool below Isleta Diversion Dam that was outrageously higher than the other samples. The sample was not taken in the late summer but the record was not clear s to whether drying was occurring and if the sample should be treated as an isolated pool or not.

- An additional subchapter that Dr. Goodman would like to add focuses on detectability to determine the number of samples needed to be convincing that the mean density in the river is low. Zero samples (samples with zero fish) can be common, but how many zero samples are needed to determine that the mean density in the river is low?
  - Dr. Goodman graphed the number of samples that are exclusively zero samples against the upper confidence limit on the estimate of the true mean. The coefficient of over dispersion which governs the true variance is treated as portable. By drawing an inference and calculating the confidence interval it's found that with 6 consistent zero samples the upper 95% confidence tail is 20 fish/100m^2. If there are 6 zero samples in a row there is no confidence that the population is low and at 10 zero samples, the upper confidence limit is .2 fish/100m^2.
  - This means that not only are a large number of samples needed to be confident that the population is high but a large number of samples are also needed to be confident that the population is low. This is true across the whole river or across single reaches.
  - ***Comment:*** So much of the foregoing conclusions are highly dependent on the nature of the over dispersion coefficient and portability. A skeptic may ask what happens if the over dispersion coefficient is not portable. How can the skeptics be convinced?
    - ***Response:*** A natural second phase to discussions on this report could include discussion on the discomforts with the report and what can be done to allay the discomforts. The glib answer is to ask why 2004 would have been exceptional; it happened there when the scatter of points was not visually different than scatter in other years or other reaches. In more depth, of course, we can look at estimates of the overdispersion coefficient in other reaches and other years as long as the number of sample events for those broods are large enough.

- *Conclusions:*
  - The analyses of the population monitoring CPUE data indicate that the monitoring-based recovery criteria in the recovery plan are too subject to sampling variation because the measurements are a snapshot in time and instantaneous. Also, because the CPUE seems to be driven by spring flow, CPUE data is too volatile to be used as a long term indicator of the status of the species. Even if there is unlimited sampling, the data for each year is simply an indicator of the status of the species for that particular year.
  - These analyses set the stage for a "rethinking" of the recovery criteria. The only criteria that are left standing after this critique are the PVA-type criteria. The PVA-type criteria are used in the delisting criteria and should be integrated into the downlist and prevent extinction criteria. The PVA-type criteria could also be integrated into the sufficient progress metrics, the RIP, and adaptive management.
    - ***Comment:*** Using PVA-type criteria as recovery criteria and sufficient progress metrics would require the the PVA to be a more absolute predictor of population performance than many PVAs would responsibly to claim to be. The PVA work

group has only been discussing utilization of the PVA for more relative predictions; for example, there is a 50% greater risk of extinction with scenario "a" as compared to scenario "b".

- **Response:** Recovery Criterion 3-A-2 is already an absolute PVA-type criterion in the recovery plan ("Three populations of Rio Grande Silvery minnow, in the historical range of the species, each of which demonstrates a probability of extinction in the wild of less than 10% within 100 years"). With a definitive PVA if the probability is 11% the criteria is not met and if the probability is 9% the criteria is met, so the use of PVA-type criteria would mean the scientific rigor bar would go up as would the need for scientific consensus. Using PVA-type criteria would only work smoothly institutionally if there is agreement on the PVA that is being used and on the appropriate standards for PVA input.

- Questions/Discussion
  - ***Comment:*** The report brings up 3 issues: 1) the use of the CPUE data for demographic recovery information; 2) the utility of the CPUE data for PVA; and 3) the traditional use of the CPUE data for monitoring the minnow, which was the original intent of the Program. The analyses show the limitations for applying CPUE data in making the determination that the population has improved just because the metric has gone up from one year to the next. The information from the CPUE data does have value in calculating survival rate. Originally, the CPUE data was intended to be used as a point metric for where the RGSM population is at compared to the last year to try to get a better understanding of what that information means.
  - Dr. Goodman emphasized that when the information in the report is communicated to the EC that the clarification should be made that the issues are not with the quality of the population monitoring data but with the use of the data.
  - ***Comment*:** There is a strong correlation between CPUE and the spring runoff that accounts for part of the volatility of the CPUE data but there may also be life history aspects, like early recruitment variation, that account for the volatility as well.
    - Even in a stable environment minnow are an r-selected species and their population numbers would fluctuate; however the addition of an unstable environment enhances the volatility.
  - ***Question:*** If the PVA changes from being relative to more specific, is the confidence in the PVA enhanced by the correlation of the uncertainties in the inputs so that the results in a presentation of the uncertainty of the results reflect the uncertainties of the relationships that serve as inputs?
    - ***Response:*** Broadly, yes, but there are a lot of details. If the PVA is being used in a more demanding role for absolute predictions, users need to be cognizant of their own uncertainty of the relationships that they have wired into the model. There is some literature and controversy over the right technique for doing this. We will need to discuss this in more detail within the PVA workgroup when the time comes.
    - It was explained that, traditionally, PVAs use several years of prior data to build an understanding of the relationships for a species in that environment to build demographic descriptions and make forward projects based on the prior information. More sophisticated PVA techniques are being developed to have a better understanding of prior data and make better forward projects. PVAs have assumed that the data that was collected will project into the future however that's not very realistic. There are two sets of difficulties in using PVAs as a predictor: 1) how to understand the past data; and 2) how relationships will be derived among the variables in a different environmental back drop moving

forward. Additional assumptions will need to be made to start using the PVA for making decisions and predicting forward from 2013to 2113. For example, if climate change is ignored then the PVA will be making incorrect and relatively more uninformed absolute predictions.

- ***Question:*** Are the life history relationships of the minnow hard wired into the model?
  - ***Response:*** This will depend on the relationships and the model; the life relationships may be a "dial" or the model may require recompiling to adjust a relationship.
  - ***Question:*** Are the hydrologic scenarios considered as input for the model?
    - ***Response:*** In terms of information content and influence on the outcome, there is no fundamental difference between a "dial", an input file that the program reads, and a parameter with different values hardwired, as all of these factors influence the outcome. Because all of these factors influence the outcome, all of these factors should be supported by data and an uncertainty in any of these factors will be important to the outcome. The PVA work group will not know everything about the future and there are a lot of things that can happen that might affect the species that are outside of the scope of the Endangered Species Act and the PVA (i.e. nuclear war). If there is no fine print of what will be included in the model, the best available science becomes the default and it is the responsibility of the institution to use the best science to update the PVA. The recovery plan team could specify what is inside and outside of the scope of the PVA which they propose to use for specific purposes.
- ***Comment:*** In lieu of a year-to-year body count of fish it may be more appropriate for a PVA to provide a yearly accounting of the health of the population. One of the challenges is whether or not the two principal resource agencies will agree to this. Even if there are no issues with the utility or value of the population monitoring data, there may be issues with the use of the data. A workshop is being proposed to the EC to discuss the use of CPUE data for population monitoring.
  - It was pointed out that it will be hard for the EC and agencies to agree to expand the use of PVA in the sufficient progress metrics or as recovery criteria until the PVA work group completes the initial work that that they were tasked with. It might be more appropriate to show what the PVA can do before proposing that it be used to replace recovery criteria or be used as a sufficient progress metric.
  - The PVA should be used as an annual assessment within the Program. In addition to providing an annual assessment of health, completing a PVA every year will ensure that new information from adaptive management is utilized as there is the potential that the new information could substantially change the understanding of the status of the population.
    - An assessment would also be useful in making recommendations to modify the monitoring protocol to ensure that the appropriate data is being collected to get more confident estimates of recruitment and survivorship.
- There was concern that the EC may see the PVA as a tool to evaluate an action; the PVA work group sees the PVA as a tool for assessing the health of the population.
  - It was shared that the EC was told by the Service that the PVA would be a highly useful tool for informing the EC on the "weights" that should be assigned to the categories of the sufficient progress metrics. This was in reference to a table of sufficient progress "factors" in various categories (flows, demographics, genetics, etc.) that the Service had distributed to the EC.

- The modelers had heard some discussion on the PVAs use for this but they are still unsure of the relationship of the PVA to the sufficient progress metrics.
- Dr. Goodman shared that, from his experience, the use of the word "weight" would require careful scrutiny. The word "weight" often gets used in situations (such as a "weight of evidence" evaluation) where the agencies are granting themselves broad discretionary power. By contrast, ESA factual determinations of whether recovery criteria have been met are "determinative" (this is a legal term) in the sense that the scientific facts speak for themselves in determining the decision. Thus, for example, use of a PVA to determine whether the delisting recovery criterion (3-A-2) has been satisfied is not a matter of "weight"; the PVA result is the PVA result, and as long as that PVA result meets the "best science" standard that should be the end of story.

▪ It was asked if the RIP would have its own set of recovery criteria.

- The RIP will determine its own metrics to measure sufficient progress and the Service will use those metrics to make an annual sufficient progress determination to see if the conservation measures are sufficient to maintaining ESA compliance. Ideally the sufficient progress metrics would be in line with the recovery criteria.
- It was shared that there has been some discussion within the EC on what the level of overlap between the metrics and the recovery plan needs to be as well as discussion on how the conservation measure should relate to the recovery plan. The EC has also had discussion on the role that demographic criteria will play in the metrics.

- Attendees then briefly discussed validation of the report, how to pass the information in the report to the EC, and whether or not the work group should make any recommendations to the EC regarding the recovery criteria.
  - Dr. Goodman was asked if he would feel comfortable recommending an alternative or range of alternatives for the recovery criteria.
    - Based on his report, Dr. Goodman recommends replacing the current recovery criteria for the "prevent extinction" and "downlisting" with criteria that are framed in terms similar to the "delisting" criteria which are based on PVA.
    - It was pointed out that though the recovery criteria are important their revision is not in people's short term window of tasks that need to be immediately accomplished.
    - There was agreement from several work group members that it would be premature for the PVA work group to make a recommendation that the recovery criteria need to be revised. In the context of properly defining the role of the PVA in the RIP, the work group could say that the report indicates the PVA needs to be used in developing the sufficient progress metrics.
  - Attendees agreed to revisit discussion on validating the report at a later time in today's meeting.
  - It was commented that these types of sensitivity analyses will be helpful in trying to inform adaptive management and may also be useful in developing the sufficient progress metrics. Given that it may take a number of years to complete, the analyses one of the sufficient progress metrics could be compiling the data sets needed to perform the analysis. This would show that steps are being taken and the burden of obtaining the data would be on the RIP and not just the PVA work group.

Model Test Runs ("quasi-strawman")

- Attendees viewed Dr. Miller's presentation *A preliminary "straw man": integrating spring flow and silvery minnow biology in the middle Rio Grande* on preliminary model test runs.

    - Dr. Miller first explained that the bulk of the methodology used in his analysis was developed 3 ½ years ago and not many changes have been made since that time. Now that there is hydrologic data there is the opportunity to test out the preliminary tools. The presentation is based on simple analyses and ways to transform hydrologic data into data that can be used in the PVA. The analyses are preliminary and changes can be made.

    - *Flow and CPUE*
        - Dr. Miller used the original population monitoring data from 1993 – 2007 to transform flows to fecundity estimates. For this preliminary analysis Dr. Miller used total acre-ft across Albuquerque in May and June as the spring flow metric. It was noted that the relationship between flow and CPUE becomes stronger and more positive from Albuquerque Reach to San Acacia Reach.

    - *Flow and Transformed Abundance*
        - Using the formula for deriving CPUE into abundances from the Population Estimation report from ASIR, Dr. Miller was able to transform CPUE data into abundances. The relationship between spring flow and the number of individuals (RAMAS is a female specific model) in the river is used to try to determine the relationship of flow to the number of individuals. From this an expression was derived to find the volume of water from one year to the next that would yield a doubling of the female population abundance in order to get estimates of population abundance for Albuquerque, Isleta, and the San Acacia reaches.
        - Based on the initial relationship it is expected that there will be a more facilitated doubling of population size downstream for a given amount of flow increase. In Albuquerque reach this relationship is weaker compared to San Acacia reach. This is why there is a smaller doubling value in San Acacia reach compared to Albuquerque reach.
        - ***Question:*** What ratio was used to extract females from the CPUE?
            - ***Response:*** An equal sex ratio.

    - *Population Abundance and Age 0 Fecundity*
        - For simplicity it was implied that changes in first year fecundity are fully responsible for corresponding changes in abundance.
            - Sensitivity elasticity analysis throughout the original PVA process (2008) indicated that the fecundity of the 12-month individuals accounts for 80% - 90% of the total age-specific projection matrix elasticity. So therefore, a doubling in population abundance in a given year can be achieved with something approaching a 2x increase in fecundity of Age-0 individuals over that same time interval. Though other age classes contribute to fecundity, for this "straw man" it is assumed that Age-0 individuals are fully responsible for the corresponding changes in abundance.
        - An analysis was then performed to determine the relationship that relates a double of abundance to a corresponding increase in the value of F_0s.

- *Spring Flow and Age-0 Fecundity: Assumptions*
  - For this "straw man" it's assumed that there is a long-term population growth rate that is neither growing nor reducing over time.
  - The observed mean from May – June at Albuquerque gauge is 309,920 acre-feet.
  - Given $F_1 = 1.229$ and $S_1 = 0.0796$, mean F_0 set to 0.909 for lambda = 1.0 over period of observation
  - Single flow – fecundity data point provides anchor for derivation of full relationship across spectrum of predicted spring flow measures.
  - If particular population trajectories are assumed the population growth matrix can be setting using theses parameters and this fecundity value can be tied to the total May – June volume.

- *Proposed Relationship Between Flow and Age-0 Fecundity*
  - The abundance relationship was used to get a simple expression for how fecundity is related to the May – June total volume. A comparison across the reaches shows that the higher end of spring flows get a greater response downstream compared to upstream which is analogous to what Robert Dudley showed when he looked at May – June volume and October CPUE. This analysis is reflecting that observation but trying to reflect in population demographics that can be put into a PVA. If the May – June total volume is believed the volumes can be described statistically and the Age-0 fecundity that is related to the May – June volume can be obtained.

- *Bureau of Reclamation Water Management Scenarios*
  - To compare the proposed action and no action scenarios 10 years of data at 5 exceedence levels were arbitrarily strung together. The two data sets are pretty similar but there are higher levels of variance with the proposed action years as opposed to the no action years and in many situations there are lower flows in the proposed action scenario as compared to the corresponding flows for the no action scenario.
  - Log normal distributions were used to identify environmental variability.
    - In the no action scenario, given the dispersion of the data there is a high level of variability in the flows over time.
    - The proposed action scenario is not significantly different from the proposed action scenario but it does have a lower mean and a slightly larger variance; this is also seen in the CPUE data.
    - Dr. Miller explained that, in the PVA, he plans to take a large number of flow data over a period of time and define it as a statistical distribution to realize different flow sequences over time and generate a distribution of possible outcomes for the population as opposed to using a string of flows as the flow sequence.

- The presentation showed distribution for Age-0 fecundity for Albuquerque, Isleta, and San Acacia reaches for the no action and proposed action scenarios. These data were added to the preliminary PVA model run. Under the given flow distribution a set of fecundity values according to that mean and standard deviation can be derived and drawn over time to get outcomes for the no action and proposed action scenarios. Because of the reduced mean spring flow, the mean fecundity for the proposed action scenario is lower than the mean fecundity for the no action scenario.

- Summary of test model structure:
  - Two age classes for simplicity; the number of age classes will be changed as judged appropriately by the PVA work group.
  - F_1 scaled within each reach in accordance with the original ratio of 1.229/0.909 = 1.35
  - Environmental variation (SD in mean demographic rates) scaled to that calculated for F_0 (expressed as CV)
  - No complex density dependence yet; the PVA work group is still exploring complex density dependence and look at Berverton-Holt model of density dependency. A simple carrying capacity ceiling was used for this "straw man".
  - Initial reach-specific abundances taken from 2007 Population Estimation work – K estimates arbitrarily set for each reach

- *Results*
  - The test model structure was used to simulate 50-year minnow population trajectories under no action and proposed action scenarios.
  - It was noted that each of the two scenarios starts with an equal number distributed over the reaches based on the 2007 monitoring reports. In the early phases of the population growth both populations have the opportunity for substantial growth but the no action scenario has more growth with its higher estimates of spring flows and higher estimates of Age-0 fecundity. The populations in the individual replicates of these simulations begin to be constrained by approaching carrying capacity and abundances become attenuated.
  - The preliminary model run shows that flow estimates in any form can be transformed to statistical distributions and then trajectories to understand the different responses of these populations to different flow profiles. The model needs more work with regards to the type of the statistical nature of the relationship between flow and abundance and in finding a way to statistically define these parameters to be useful to the PVA.
  - The magnitude and volatility in these flow parameters confers volatility in the corresponding demographic parameters.

Action: Dr. Miller will develop a written description of the methodologies used in preliminary model run to distribute to the PVA work group.

- *Questions/Discussion*
  - In response to a question on the difference between the proposed action scenario and the no action scenario it was explained the no action scenario includes flood control and Colorado operations but does not include water storage for the District nor water release for the District or at District structures. The proposed action scenario allows normal function for storage, release, and diversion for the District. The effects may be different if the scenarios were looked at during a drying time period or if the model looked at a bigger action (i.e. action for a reservoir on the main stem).
  - ***Comment:*** The variability in the volumes seems dampened in the population predictions and is smoother than expected.
    - ***Response:*** This is the mean and standard deviation over a large number of runs (100,000 replicates). For every year of the simulation a fecundity estimate for F_0 for each reach is taken. So for Albuquerque Reach, under the proposed action, F_0 for Age-0 fish is derived.

Fecundity can be anywhere from 0.4 to 3 or 4. There is considerable variability in the population. This simple model is looking at carrying capacity as being a hard ceiling.

- ***Comment:*** The populations grow then settle into a slow decline.
  - ***Response:*** This simulation is for the entire Rio Grande with no connectivity between the reaches. If there is enough variability in demographic rates its possible for San Acacia reach to decline and go to extinction. In his report, Dr. Miller plans to look at reach trajectories to get an understanding of how each reach contributes to the overall population trajectory. The PVA work group will need to determine how to deal with carrying capacity. The maximum population size that is achieved in any iteration can also be pulled out.
- ***Comment:*** The 2007 population estimation results were in pilot phase and have since been discounted by ASIR so those results may not be the best to use. However, it's believed that ASIR felt fairly comfortable with the last 2 -3 years of the study so it may be more appropriate to use the methods from 2008.

- Dr. Goodman then presented several example model runs of Bayesian PVA prospective analysis.
  - Dr. Goodman first explained that the PVA generates random population trajectories. Some of the trajectories keep going and some hit the x-axis or some predetermined threshold and the population is extinct. The PVA counts the fractions that have crossed that threshold in the specified amount of time.

  - Dr. Goodman walked meeting attendees through a demonstration scenario.
    - The model has 3 reporting parameters:
      - 1) Final population size
      - 2) First passage time to threshold (How long did it take the trajectory to reach the predefined threshold?). If there are multiple trajectories this report shows the probability distribution of those times.
      - 3) Diagnostics. This is an option that is chosen from different diagnostics.
    - Dr. Goodman first ran a calibration scenario of 18 years to see if the model could generate distributions that were similar to what has been seen in the 18 – 19 years of monitoring data.
    - The population threshold was set to a placeholder of 1 unit of CPUE/100m^2 and the model was set to tally the number of times the population size goes below 1 unit of CPUE/100m^2.
    - . If the work group would like to use units of absolute individuals the work group will have to consider the population estimation process.
      - ***Question:*** The model treats the initial population size as an absolute value?
        - ***Response:*** Not as an absolute value in number of fish, but a number specified in CPUE, fish/100m^2, as would be measured by the monitoring. The model sees the initial population size, and does all its calculations in the same units.
    - The model includes flow distribution in terms of mean and a standard deviation. There is a mean and standard deviation for survival. For this scenario survival is different for adults and young of the year.
    - For this scenario the diagnostic option that was chosen was the distribution of spring flows.

- The seed is used by the random number generator and allows the user to either absolutely duplicate a run by using the same seed or to try a replication by using a different seed.
- For the first run sample size of 1,000 trajectories was used.
- Results:
  - The mean final population size after 18 years was 8 units of CPUE/100m^2 and standard deviation 6.3. It was noted that the distribution was not symmetrical; it had a long tail and a "teeth of a comb" effect.
  - It was noted that the distribution of the "time to cross threshold" was ragged.
  - The high flow in the spring flow distribution was 5,000 cfs. It was noted that the spring flow distribution was very "scratchy". It was explained that the "scratchiness" is an artifact of the small sample size of trajectories. The "scratchiness" indicates that a sample size of 1000 trajectories is not large enough; if there was a larger sample size the "scratchiness" would not be present and the reproducibility would increase. If the seed were changed and this scenario was run again, with the too small sample of trajectories, the distribution wouldn't be the same; the new distribution would have the same general shape but would have different peaks.
  - It was emphasized that because a large sample of trajectories is needed it doesn't make sense to have many thousands of trajectories developed from the same hydrograph.

- Dr. Goodman then ran another sample model run using a sample size of 1,000,000 trajectories. With this level of sampling the distribution has been resolved enough to begin looking at the fine points in the model results. The output distribution of final population size can be looked at on a closer scale to see if the population really is going to extinction at the low points. While the population gets near 0 CPUE, it never actually goes to zero, and instead increases again after these low points. This means that a near 0 CPUE doesn't necessarily mean that the population is near extinction.

- Dr. Goodman ran an additional model run in which he changed the histogram bins from 100 to 50 bins between 0 and 1 CPUE for reporting the distribution of final population size, and used a sample size of 5,000,000 trajectories.
  - Dr. Goodman noted that a change in inputs results in a change in the outputs. Since the inputs can be changed, if a PVA is to be taken seriously there has to be real evidence for the numbers that are provided as inputs. The PVA work group has not had enough sound scientific discussions on the input numbers that will be used so there is apprehension to release concrete results prematurely.
  - Results:
    - By looking closely at the region between 0 and 1 unit of CPUE/100m^2 it can be seen that the population was never at 0 CPUE/100m^2. It was noted that there is large variability shown in the distribution of finalpopulation sizes and though there are some population sizes that are quite low, which is consistent with what is seen in reality, the population does not go extinct in these model runs. Because the model doesn't show in absolute terms how low the population is, it's not known if the population is low enough for genetics to be a concern. In this model extinction is actually the last individual but there is the option for setting

a "quasi extinction" or a threshold where if the population goes below that number it is considered extinct for genetic (or other) reasons.
- In this scenario the population not only had zero probability of reaching extinction but there was little probability of the population going below the 1 CPUE/100m^2 threshold.
- This is the platform that Dr. Goodman will be using to develop the PVA.

- *Questions/discussion*

  - ***Question:*** Will you be defining hydrology in terms of statistical distributions?
    - ***Response:*** Yes.
    - Dr. Goodman explained that he wants to sample the 600 year paleo data to get his distributions. Ideally, the PHVA would provide generalizations of the URGWOM rule sets for water management and the climate projection model to explain to the PVA modelers how each year should be tweaked in order to get the sequences that are wanted for the PVA. For example, if the PVA work group wants to predict next year's flows they should take the paleo data andsee what kind of water year tends to follow water years like the present, adjusting for any long term trends; or if they want to model proposed action and no action years, this is how each year should be tweaked.
    - The paleo data would not translate to the baseline but would need to be run through a filter (URGWOM) to convert the sequences to the proposed action and no action scenarios. It would be helpful to have a faster, more statistical filter that would expand each paleo year to a real year of the proposed action or no action scenarios.
    - It was pointed out that the paleo data will first need to be translated.
      - The PHVA work group has an algorithm for matching up existing years with the paleo data. When the existing years are matched to the paleo, the index that is used to carry out the match is the total volume at Otowi gage using the real year's day-to-day record as the expansion. When a matching year is found, for example 1953, it can be explained how the 1953 water management corresponds to what is now being called proposed action and no action. If this process can be done with enough years to get a regression curve then Dr. Goodman can generate the rest of the sequences that are needed.

  - The preliminary model runs show that the amount of water in the system will make a difference in the number of fish but that within the range of variability modeled (and observed recently) the amount of water doesn't make any difference in the probability of extinction. If you want to look at the long-term probability of extinction you shouldn't get too preoccupied with October CPUE in a given year as it is only indicating if there is a wet or dry year.

  - ***Question:*** How many additional hydrographs are desirable for the RIP?
    - ***Response:*** There is not enough of an understanding of what the RIP discussions are right now. If I had hydrologic sequences for 50 proposed action years and 50 no action years that would be enough for a regression or a pattern analysis to indicate how to turn a historic year into a proposed action or no action year. Each year would have a hydrograph that was run through URGWOM twice; once for proposed

action and once for no action. To do the regression, information on how water is carried over from one year to the next will be needed.

- It was commented that one of the issues with letting the PVA generate its own hydrology is that the effects that sequencing has on water management are lost.
- The modelers will need to know how wet year "t" has to be to have carry over water in year "t+1". The modelers will also need to know how the carry over water is spent. This information is available because it is already programmed into URGWOM. Doing this type of exercise will help to get away from the 10-year sequence issue.
- Dr. Goodman has done this with the 18 years of monitoring data and found that there was a uniform distribution of spring flow with definite cutoffs at the high and low extremes.
    - It was explained that the uniform distribution is likely a result of the caps that management places on the water; water does not go below a certain level or over a certain level. There is a management floor and ceiling before the water even gets to the fish.
- Dr. Goodman asked for an explanation of the supplemental water and how it applies.
    - It was explained that the supplemental water is tied more to politics than to water production. It can be assumed that a certain amount of water will be produced for supplemental water and the amount of water depends on the water that is available for lease. The supplemental water is water that is stored one year to be used in the following years and can be used for multiple reasons.

- ***Question:*** Are you using the actual gage data from Otowi?
    - ***Response:*** The model sampled the distribution; however this is not entirely realistic in this scenario because the distribution was log normal, not uniform (which is what was observed). Using the actual gage data will be an important part of validating the model.

Resolution of Consensus Data Set

- Meeting attendees discussed the language suggested at the last PVA meeting for accepting the data posted on Dr. Goodman's website as the Consensus Data Set.
    - A meeting attendee voiced that it was important that the statement include that there is agreement that the data would be used for this iteration of the PVA.
    - Attendees also felt that it was important to acknowledge that the request was made for the originators of the data to review the validation and reconciliation of the population monitoring data. The dates that the requests were made should be included in parentheses in the statement.
        - Attendees discussed that even if the originators do not review the data the data would still be included in the PVA.
    - There was hesitancy to include the egg monitoring data that was translated from the report in the PVA until the actual data has been received. Attendees agreed that the egg monitoring data should not be included in this iteration of the PVA.
    - After some revision the work group agreed to the following statement: *"For this iteration of the models, the PVA work group accepts the data that are archived on Dr. Goodman's website as provided by the originators to Dr. Goodman and as reconciled by*

Dr. Goodman and there is agreement with using these data sets as the consensus data for use in the PVA models for this iteration. The datasets and the pedigree are shown and documented on Dr. Goodman's website. The PVA work group requests the originators of the data review and concur with the validation or reconciliation of the population monitoring data. The egg monitoring data is considered provisional and is not considered appropriate for inclusion in the model at this time."

Update: Modelers responses to Service's questions (including information/data needed and estimated timelines for answers) (Valdez?)

- Meeting attendees briefly discussed the Population Estimation data. Yvette Paroz (project Contracting Officer's Technical Representative) updated meeting attendees that she is working the with contractor to determine what the data submission will look like to ensure that the Program will be getting the data that they have requested. She is also looking through the past contracts to see how much can be provided.
    - Dr. Goodman voiced that he does not have the population estimation depletion sampling. The data sets he has include population monitoring and a small number of population estimation flagged samples with no explanation of what the flag means.
        - The depletions sampling should be included in regular data submissions; however, a certain number of minnow need to be caught in order to do depletion sampling.
        - Attendees discussed making another request to ASIR for the data and also request that ASIR give an explanation of the flags and the population estimation procedure.
            - Requests for the data and participation from ASIR should be sent through Yvette Paroz. All requests are constrained by what was included in the past contracts.
    - Jason Remshardt shared that he was able to find the site occupancy data on the Program website.

- Meeting attendees then discussed how to address the Service's questions regarding the PVA.
    - Attendees were reminded that the questions in regard to critical habitat were deferred as the information is not available to answer those types of questions.
    - Because not all of the appropriate information is available many of the questions can only be answered on an abstract level. The work group will need to determine at what level they are comfortable answering these questions.
    - It was suggested that the modelers have a face-to-face meeting with the staff members who will be using the PVA in their BA/BO analyses. As part of this meeting the modelers could show the staff what the models will look like and find out what changes could be made to the models based on how they will be used. This will also provide the modelers the opportunity to tell the staff members what additional information is needed in order to make the models useful to the BA/BO process. It is preferred for these discussions to take place during the July PVA work group meeting if possible but the PVA model training workshops are alternate venues for these discussions to take place.
    - It was commented that answering some the Service's questions is contingent on the hydrology. One of the questions asked of the PVA models is to evaluate base flows under the 2003 BO for continuous and proposed actions and then spring flows. Some of the questions can be answered by the hydrology; however, some of the questions seem to be a misunderstanding of what the PVA will do.

Follow-up discussion: Dr. Goodman's *RGSM 2010 Revised Recovery Criteria in Relation to Population Monitoring Draft Report* dated May 1st, 2012

- Meeting attendees then continued discussions on the process for validating Dr. Goodman's report and potentially considering the report as a possible PVA work group product to show what the group has been working on.
    - There was general agreement that the information in the report is important and once the report is validated and approved by the work group then the report should be referred to the EC. The work group agreed that the report will undergo internal review and cross validation of the processes used. Cross validation could include replication of the process and reverse engineering.
    - Dr. Goodman then led the work group through some exercises in R to demonstrate methods that could be used to cross check his work.

Action: PVA work group members will review and/or cross check Dr. Goodman's report for discussion at the July PVA meeting.

Next Meetings:

- Regular PVA: Monday, July 23rd starting at 10:00am and Tuesday, July 24th; location TBD
    - Tentative Agenda Items: (1) August 15th Service deadline – what can be done? What needs to be supplied to provide PVA information?; (2) Update on RAMAS model (due June 31st) and upcoming deadlines; (3) approval of June PVA meeting notes; (4) "strawman" model runs with the 5 150-year GCM hydrology; (5) planning for the August training
- PVA Training (tentative): Wednesday, August 15th and Thursday, August 16th

PVA Meeting Attendees
June 11th and 12th, 2012

NAME	AFFILIATION	PHONE NUMBER	EMAIL ADDRESS	Date	
				06/11	06/12
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