Population Viability Analysis/Biology Work Group Meeting

March 29, 2011

Meeting Materials:

Meeting Agenda

Meeting Minutes

PVA Biology Work Group Meeting - Draft Agenda

March 29, 2011; US Bureau of Reclamation
555 Broadway Blvd. NE, Albuquerque, NM 87102
San Juan Conference Room

Actions

- Dr. Goodman will start a list of data for the PVA workgroup to agree on for use in the PVA models.
- Dave Campbell will email a draft memo to communicate the workgroup's next steps to the PVA workgroup for review.
- Stacey Kopitsch (PMT liaison) will invite the Program Manager to attend the joint PHVA/PVA workgroup meeting at the request of PVA.
- PVA members will review the San Acacia Fish Passage Peer Review report to discuss the peer review recommendations at the April 22nd PVA meeting.
- Dr. Goodman will distribute a list of identified "events" of significant population response at certain locations and circulate to PVA members in order to gather information on other activities taking place in proximity. (*Ongoing from 1/28/11*)
- Rich Valdez will provide Dr. Goodman and Dr. Miller with daily drying data for every reach for every year as a file or data set. (*Ongoing; 1/28/11*)

Decision

- The January 28th PVA meeting minutes were approved with no changes.

Meeting Summary

- Dave Campbell brought the meeting to order and introductions were made.
- Meeting attendees performed an action item review. All action items were completed with exception to two ongoing actions.
- The January 28th PVA meeting minutes were approved with no changes.
- Attendees were given a brief update/synopsis of a presentation on the Age and Growth study that was given at the March Science Workgroup (ScW) meeting. The Age and Growth study analyzed the otoliths of wild Rio Grande Silvery Minnow (silvery minnow) of different size classes. A highlight of the presentation was that the otoliths seemed to be more accurate and consistent than size scales in determining silvery minnow age in older fish. It was commented that in several fish species first year annual rings are often not formed and it would be interesting to see if this was also true in silvery minnow as it would affect age determination.
- Attendees then joined the Executive Committee (EC) for a 45-minute session in which they viewed presentations from Dr. Goodman and Dr. Miller on the background and status of the PVA models.
- Attendees were given a report out of the February adaptive management sessions. During the latest session attendees drafted a list of uncertainties and questions for the Program; the hypotheses that had been previously put together by the PVA were incorporated into the list. The next adaptive management session will be April 5th-7th.
- Attendees discussed the need to be able to understand and evaluate the differences between the two PVA models. There was also discussion on the need to have consensus on the data sets and determine the degree to which there is consensus on the analytical processes used. Dr. Goodman will start a list of data for the PVA workgroup to agree on for use in the PVA models. It was suggested that the steps that the PVA is taking to concede on the data and discuss model differences be communicated to the EC. Dave Campbell will email a draft memo to communicate the workgroup's next steps to the PVA workgroup for review.

- Attendees discussed the upcoming PHVA/PVA joint workgroup meeting scheduled for April 22nd, 2011. Frustration was expressed over difficulties in collaboration between the PHVA and PVA workgroups. It is extremely important for this meeting to be productive and have open dialog between both groups. Stacey Kopitsch (PMT liaison) will invite the Program Manager to attend the joint PHVA/PVA workgroup meeting at the request of the PVA workgroup. As the Bureau of Reclamation Biological Assessment has been the main focus of the PHVA, attendees discussed alternate modeling options outside of URGWOM in order to facilitate PVA moving forward. It was proposed that a simple hydrology model using URGWOM rule sets and the historic data be developed for PVA use.
- The CC has requested that the PVA review the recommendations in the San Acacia Fish Passage Peer Review and identify a recommendation to be converted into a future study. PVA members should review the San Acacia Fish Passage Peer Review report to discuss the peer review recommendations at the April 22nd PVA meeting.
- The next PVA meeting will be April 22nd, 2011 with a joint session with PHVA in the morning and PVA business to follow in the afternoon.

PVA Biology Work Group Meeting - Draft Agenda

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Meeting Notes

Introductions, Review Agenda

- Dave Campbell brought the meeting to order and introductions were made.

Review action items from May PVA meeting

- **Gary Dean and Rich Valdez will continue discussions regarding the updates to the RiverEyes data collection protocols.**
    - It was explained that in the past the RiverEyes data was collected as observational data and Rich has been working with Gary to update collection protocols to collect more quantitative data; for example: "x" amount of river distance is dry on a certain day at a certain time. Gary has been provided with a template that will be useful in making sure that data is collected in the updated format. No formal process has been started to translate past data into the new format but SWCA has been translated the drying data that they collected.
    - Dave Gensler shared that he is making a simple model using a spreadsheet that uses URGWOM output to predict an approximation of drying on a sub reach based on outflow from the preceding sub reach. Dave has completed this process with the 50-year URGWOM run that he received from Nabil Shafiki. His next step is to use URGWOM output from 2009 and 2010 based on flows at Otowi to check the procedure. It was commented that the updated drying data will be useful to determine the precision of the spreadsheet in terms of reality on the river.
- **Tetra Tech will distribute the presentations given in today's meeting**.
    - Complete.
- **Jason Remshardt will correct the augmentation data through September 2010 by adding the "release location by river mile" field back into the spreadsheet and will distribute the updated data to Dr. Goodman and Dr. Miller**.
    - Complete.
- **Dr. Goodman and Jason Remshardt will continue discussions on how to use the Service's monitoring data to emulate ASIR-type data**.
    - Complete.
    - Jason has sent the most updated version of the edited files to Dr. Goodman.
- **Dr. Goodman will distribute a list of identified "events" of significant population response at certain locations and circulate to PVA members in order to gather information on other activities taking place in proximity**.
    - Not complete.

- **Rich Valdez will provide Dr. Goodman with daily drying data for every reach for every year as a file or data set.**
    - Ongoing. The daily drying data will also be provided to Dr. Miller.
- **David Gensler, Rich Valdez, Mick Porter, and Dr. Goodman will represent the PVA work group at the adaptive management work group meeting on February 1st, 2nd, and 3rd and will report back to the PVA work group at the March meeting**.
    - Complete. An update will be given at today's meeting.
- **Dr. Goodman will correct the labeling on Figure 4 – the Isleta graph and San Acacia graph are reversed.**
    - Complete.

Review/Finalize Past Meeting Minutes

Decision: The January 28th PVA meeting minutes were approved with no changes.

- Attendees were given a brief update/synopsis of a presentation on the Age and Growth study that was given at the March Science Workgroup (ScW) meeting.
    - The Age and Growth study analyzed the otoliths of wild Rio Grande Silvery Minnow (silvery minnow) of different size classes. The presentation described their process for the otoliths, scales, and comparisons. The presentation and otolith images will become available once the draft report has been released.
    - It was commented that the study found significantly different standard lengths for the 1874 museum specimen fish than what was recorded for the same fish in a previous study.
    - Two highlights of the study were that otoliths are more accurate and consistent than the size scales in classifying the fish into age classes and that it appears that the fish are laying down their annual rings in the spring.
        - It was commented that Cutthroat trout, and many fish species that spawn in the spring, often miss establishing the first annual ring altogether if spawned out of late spring or summer and it would be interesting to see if this was also true in silvery minnow as it would affect age determination.
        - Because younger fish have a distinctly small size, length is often more reliable than annual rings in determining age but in fish over 60-65 mm predicting age by length is more uncertain.

PVA Models preliminary outputs – presentations to the Executive Committee in the Rio Grande conference room

- The PVA work group joined the executive session and introductions made. Attendees were asked to hold all questions until after the presentations. It was explained that due to time constraints the executives would be given a question priority.
- *FORTRAN Model – Dr. Goodman:* Dr. Goodman is a professor with Montana State University and teaches courses such as PVA. He has been involved in this project for 3 years and has been an active member of the work group for the last 2 years. He explained that the work group has been analyzing data to be used as inputs for the model. Dr. Goodman then briefly ran a demo of the FORTRAN model in order to highlight how quickly it can complete thousands of iterations and produce outputs. In the demo, the model was simulating a population response using 19 rows of parameters over 100 year's prediction time.

- In this example run, the predicted frequency of the simulated population dropping below the 1,000 individuals in 100 years was 0.6%. Other outputs included an average final population size at the end of 100 years of 2 million but numbered up to 8 million in some years.
- Dr. Goodman presented general background information on PVA models and explained that a PVA is a population model that makes future predictions about population response but also tracks and shows the uncertainties and probability distributions. The outputs are thus probability distributions of a predicted population size for any given timeframe. PVA models can also be used to determine critical threshold of extinction (ex. 20 years).
- The "boiler plate" parameters for the FORTRAN model include 3 separate reaches, with specified up/down stream migration, and reach-specific rates based on data indications. There are at least 3 age classes and there is potential for river discharge to affect survival.
- It was emphasized that there is not one universal PVA model and this PVA model has been developed for the specific purpose of modeling the silvery minnow – which can be characterized as having a short life expectancy, volatile population dynamics (ex. 1 female fish can produce over 1,000 eggs so the population can change "over night" by a factor of hundreds), and existing in an unstable environment (making the species vulnerable to environmental change so the population can rapidly decline). The key to long-term survival is how the fish withstands the environmental change.
- For the silvery minnow, withstanding variability means the patterns and correlation structures with lambda (λ) - or the factor of population growth over a year – has to be looked at.
- The work group has spent the last 2 years analyzing data on *relative abundance* from the population monitoring data for the last ~20 years.
    - The monitoring data is reported as catch per unit effort (CPUE), which is the number of fish caught in a seined area equivalent to $100m^2$.
    - It should be acknowledged that the CPUE is an *index* to the population size – there is a small net in a large river with a fast fish.
    - Attendees were shown a graph of population monitoring quarterly summaries from 1993 to 2008. As the CPUE ranges from under one fish per $100m^2$ to several hundred fish depending on the year it can be seen that the relative population fluctuates up and down over the years by a factor of over 100. It can also be seen that the population abundancy estimates are tracking the flow of the river to some extent.
    - The CPUE data was used to generate different graphs for each year to track young of year and compare the relative population abundance to other factors. The survival is represented in the slope of the line. These graphs show the hold-over adults from previous year, and new preproduction or the maternity compared to the flow (hydrograph from Albuquerque gage). This allows yearly reproduction to be estimated and shows the interrelationships of these.
- Through his data analysis, Dr. Goodman concludes that the data are credible for (1) estimating the relative "brood strength" or reproduction by reach and year; (2) estimating the 1^{st} year cohort survival by reach and year; and (3) average in the 2^{nd} year survival rate. Note that the sampling of older fish is "spotty" due to relative lack of numbers caught in sampling.

- All the graphs support the volatile nature of this species. Within a single year the population can explode from 10,000 fish to millions. Each fall census can be used to form a λ ratio year to year. On average, there is no change in the long-term trend but there is a lot of scatter or uncertainty in the long-term λ – this indicated that we cannot confidently say anything about the long-term trend from the estimate of average λs. Remarkably, however, the abundance estimate tracks the spring flow amazingly well. Note that λ does not track flow.
- Based on these observations, Dr. Goodman's perspective is that the Program should be cautious in looking at random λs and trying to estimate patterns to arrive at long-term trends. He suggests that the Program should not set long-term λ as part of the recovery goals. If done in this manner, the predicted time to extinction is very rapid.
- Dr. Goodman then explained his perspective that the data indicate that (1) the minnow population can successfully rebound from extremely low numbers; (2) λ corresponds strongly to carrying capacity (K; or how many fish the river can support this year); (3) the spring flow sets "K" for reproduction; (4) flow does not enhance survival although it influences reproduction; (5) large λ values occur if there was a small population size the year before, but if the population is large then λ is small.
    - The population corresponds to flow but the growth rates do not. The flow can predict the number of offspring produced – low flow there will be small numbers of young of year for low flow and young of year numbers increase with increased (higher) flow. There is no real relationship between the summer survival and summer flow. In fact, years with high summer flow actual show lower survival of fish to the next year – but this not to be misunderstood as justification for decreased flow!
    - The results of the current data inputs into the FORTRAN model indicate that the population is resilient to "normal" range of river flow variations. Of course, there are upper and lower limits to the population but the model (and data) is indicating that the predicted probability of extinction is much lower than originally thought. This means that the optimal management strategies will be very different than originally thought (i.e., rethink long-term λ goal in the recovery plan, etc.)
    - There are critical uncertainties with the minnow resilience: (1) how "small" a number of parents can replenish the population? The species have been able to "bounce back" from the low numbers observed so far.; (2) what are the limits to "normal" summer drying? How "low" of flow is too low?; (3) what minimal habitats provide survival refuge in the summer? Where are the minnow going and how are they surviving the dry spells?; and (4) what are the habitat characteristics? How much of that habitat is needed?
    - The opportunity to use PVA in a jeopardy evaluation will require decisions. The PVA can compare 2 scenarios - a contemplated action (defined as a scenario) against the baseline (or the system in absence of that proposed action). This comparison will indicate the potential impacts (differences) of that contemplated action. The PVA model(s) can also be used to quantify the difference in time to extinction, probability of extinct, time to recovery, etc. with the proposed action.
    - Remember that future conditions needs to include climate (trends), meteorology (weather variability), land use changes (trends), geomorphology changes (trends), habitat interventions, etc.

        - Water management also needs to be considered in terms of water availability, storage and transfers, diversions and withdrawals, low-flow channel operations, pumping, etc. To evaluate a water management strategy, if/then rule sets can be used to test the "future world" and simulate applying the rule set using the PVA model. The results can be "scored" with the PVA and the scores for different strategies can be compared.
    - Next steps for PVA work group include: (1) consolidating and creating a consensus data set; (2) then performing a consensus data analysis; and (3) if consensus cannot be achieved then explain and document the differences. Agencies within the work group need to define what the "baseline" and "actions" scenarios are and define the metric(s) for evaluation.

- *Questions*
    - ***Question:*** Given all the variables and information, how much is the water quality issue (diversions, inflows, etc.) included into the model? ***Response***: Water quality is not factored into model *per se*, but it is included in the data analysis. When analyzed by reach and by year, it turns out that the San Acacia Reach has the "happiest minnows" even though it has the worst water quality. Given the range of water quality seen, water quality issues are not seemingly having a detrimental affect on the fish.
    - ***Question:*** But are these the same fish over time? ***Response***: There is no evidence in a differential population between the reaches. The genetic analysis implies a single population. The involvement of the minnow in the ecosystem and food chain are incorporated into the "thinking" in a big way. The fish does "evolve" and this fish has evolved and adapted high tolerance to harsh conditions (ex. high temperatures, low oxygen, etc.). Also, there is no evidence of reach-wide [water quality] problems but there may be localized issues. However, the data indicates the fish can tolerate the current range of "normal" to "poor" conditions.
    - ***Question:*** What are the indicated impacts of the channelization – meaning faster flows – on the minnow? ***Response***: The tendency of the river to incise will have to be counteracted. Dr. Goodman strongly encouraged the Program to look closely at investing more into habitat modification experiments and projects. Based on his analysis, it is time to "scale up" the habitat projects to a larger scale as to be obviously detectable on the fish population. Dr. Goodman's perspective was that this would be a very promising intervention.
    - ***Question:*** Can you speak more about the climate change issue and incorporation into the PVA? ***Response***: The most responsible thing to do is to use the best climate predications that are available – there are predicted warming trends. But the predictions for precipitation are much more uncertain. Management strategies need to be designed with enough flexibility to allow the appropriate agencies to respond to those changes that materialize (i.e., options need to be build in so response can be quick).
    - ***Comment***: The HR work group co-chair thanked Dr. Goodman for his perspective on the importance of habitat restoration research and projects. It was shared that the HR work group needs this type of information in order to effectively determine projects and paths forward. ***Response:*** Dr. Goodman responded that the estimates of inundated area(s) are credible and can be used confidently and if habitat modifications change inundated are than this needs to be incorporated into the model.

- ***Question:*** Is the rescue/salvage data being incorporated into the trend analysis? And if so, how much impact is there? ***Response:*** The record for *how many* minnow were rescued/salvaged is fairly good – and great in some years. But unfortunately, not a lot is known about release locations and the subsequent survival and where released. Dr. Goodman encouraged the Program to get estimates of how effective salvage is in terms of survival and to consider ways to capture release location information.
- ***Question:*** With the data (and model) that we have now, is it possible to determine the minimal flow summer requirements are now? ***Response:*** There is probably enough data to be able to pursue this question. The model is capable of predicting the frequency of low flow years and the population response. However, it is recommended that this question be first run through the work group to attempt to arrive at consensus before a blanket number (with no context or caveats) be supplied. It has been observed that even in extraordinarily dry years there is still some reproduction – this can be quantified. The data indicates that there is a 1,000/1,500 cfs flow threshold – below which reproduction is significantly reduced but does still occur. It needs to be determined if that 1,000 cfs is enough to keep the population going. The question is answerable but a specific response cannot be given today.
- ***Question:*** Can the minimal summer flow requirement question be answered in time for consideration in the new Biological Opinion (BiOp)? ***Response:*** Yes; there is no foreseen reason why not.
- ***Question:*** There is a lot of uncertainty that is not captured in the model - what will it take to address this and improve the model? ***Response:*** The uncertainty is captured as the back ground noise; the trends in the noise are all the "other" variables. To gather more specifics on the "noise" and uncertainties, it will require funds and commitments from everyone to pursue.

- *RAMAS Model – Dr. Miller*: Dr. Miller presented on the RAMAS baseline model input summary. Dr. Miller thanked the EC for their continued support of this project and explained that the information presented today will demonstrate the evolution of the "thinking" and analysis as the work group moves closers to useful analytical tools. The background PVA information was not repeated – instead, the focus was on the demographic RAMAS model he is constructing.
  - There is considerable uncertainty and variability (manifested as the fluctuations in natural system) with the hydrology and biology in the Middle Rio Grande (MRG) system. This uncertainty makes it difficult to have confident, detailed interpretations of available data. To address this, Dr. Miller is creating a model that mimics the general trends in the population abundance and demographic dynamics observed through historic population monitoring efforts. Dr. Miller's perspective is that there is merit to looking at the long-term population behavior; this does not mean that it is possible to predict how many fish will be in any one place at any point in time. Dr. Miller emphasized the comparative approach to interpreting the quantitative outputs across scenarios.
  - The RAMAS model uses an age-based life table that contains up to 5 age classes (Age 0 through Age 4). *Note: Earlier versions only had 2 or 3 age classes but there is some evidence to suggest the existence of small numbers of the older individuals so placeholders are being built into this iteration.* Age 0 ranges from birth to 11.99 months; Age 1 ranges from 12 months to 23.99 months, etc. The RAMAS model is based on a pre-breeding census; in other words, the census is taken just before reproduction.

        - Fecundity is a combination of maternity (egg production) and the survivorship of those hatched individuals to the next census. The model takes the number of individuals this year and using a growth rate and mathematical calculation predicts the population numbers for the next year.

- This is a female-only model and the data on maternity is based on the study published by Platania and Altenbach in 1996. The regression analysis was extended to derive the anticipated maternity estimates for the older age classes; maternity is increased for each of the older age classes. As more information is provided for age and growth the numbers will be refined.
- For the RAMAS model, a reference value for survivorship (that is tied to a long-term growth rate) needs to be established. This is not saying that the population is restricted to that growth rate but we need to understand how the growth rate is affected by other variables. Quarterly CPUE values can be used and regressed to the previous quarter CPUE to derive a survivorship value for that quarter. Assuming a long-term population growth rate of 1.0 (to initiate the analysis), the reference value of age specific survivorship (spawned this spring and survive to next spring) is developed at 0.0016.
    - The survivorship values for older age classes were derived from the modal progression analysis by Rich Valdez. It is assumed, in the absence of actual data, that the survivorship rates of older individuals will be the same as the Age 1 fish.
- Please note that the fecundity and survivorship rates in the MRG are not static – this is driven by environmental variation (EV) which is typically expressed as statistical variability or standard deviation around mean rates. It is very difficult to make accurate assessments of EV due to the complexity associated with using CPUE data for estimating age-specific survivorship and coarse estimates for mean demographic rates. To simulate the observed annual variations in CPUE, Dr. Miller has expressed annual EV as a coefficient of variation around the mean demographic rates. The current range of variation around fecundity and survivorship is between 20% and 40%. This allows the impact of the EV on the long-term predictions about the population abundance to be explored.
- Dr. Miller then shared that to initiate simulations, the initial reach-specific population size needs to be input; these "seed" the model as a starting point for the comparison of population responses predicted. This should be thought of as an "abundance index" and how the index changes over time instead of actually taking the specific run numbers. Using 2009 data, it is estimated that there are 1,048,598 minnow in Angostura; 1,602,348 in Isleta; and 923,352 in San Acacia.
- There has to be some ecologically based limit to the number of individuals that can be supported by the river and habitat. This term, carrying capacity (K), is notoriously difficult to characterize and quantify. K is an expression of density dependence; in other words, the population is regulated in abundance as the population approaches the maximum resource base. Dr. Miller's opinion is that the relationship between density dependence and the risk of population decline given different hydrological scenarios is not clear.
    - Assuming a gross but acceptable correlation between CPUE and an index of abundance, Dr. Miller has computed that the assumed K is about 2.5 times the 2009 population abundance. In other words, based on historic population abundances, the MRG system is capable of supporting more than double the 2009 population numbers (Angostura K – 2,600,000; Isleta K – 4,000,000; and

San Acacia K – 2,300,000 for a total capacity of 8,900,000). Attendees were reminded that this starting point allows for exploring the simulated population responses. K is not a static variable but will be tied closely to the spring flow.

- Dr. Miller cautioned that the risk of extinction should neither be over or under estimated. The density dependence initiated at low population abundance will affect the predictions on how the population can or will rebound. The intensity of density dependence at low population numbers is still not clear. A population "ceiling" that limits the population growth at high densities is one mechanism that can be employed to address K. This ceiling or cap at high populations is a "brute force" way to enforce the density dependence. Low density dependence is not currently included in the RAMAS model.

- Dr. Miller next discussed survivorship. The May-July survivorship is tied to the magnitude of the spawning flow and the August-October survivorship is tied to the extent of summery drying. The relationship between flows and long-term demographics can be explored once the spawning flows are derived from the hydrologic models (such as URGWOM). The flows can be translated and tied to the survivorship values of newly spawned individuals. This will allow for directly exploring the impact of flow - including the impacts of repeated years below a certain threshold (ex. 3 or 4 dry years in a row).

  - Unfortunately, there is still much uncertainty and doubt on the nature and intensity of the relationship between the extent of drying and summer survivorship. In order to incorporate the summer drying into a PVA, the functional relationship (between drying and survivorship) is important (linear? thresholds? etc.)

- Because this is a reach-specific model with reach-specific demographics, the down (and possibly up) stream dispersal needs to be understood. There is some information available but it is not definitive. This means that a range will have to be used to explore the necessary level of dispersal to maintain the metapopulation structure.

- The augmentation program data is being taken into account in the RAMAS model. The total number of individuals added each year can be extrapolated with the survival to assume the approximate numbers of fish available each year in the spawn.

- Dr. Miller concluded by showing example graphs of model outputs showing how the example iterations describe what is actually seen on the river and in the population. The K and density dependence processes at high density still need to be addressed.

- *Questions:*

  - ***Question:*** Is there any ways to improve the hydrologic (ex. URGWOM) models as well? ***Response:*** Dr. Miller expressed that he is not an URGWOM expert so it would not be responsible for him to give advice on the model construction. The integration of the hydrologic scenarios into the PVA models remains unresolved. One issue is that URGWOM is being used to look at much short time horizon (5 to 10 years) in the future for a very detailed look at river operations and responses; but the PVA needs to look much further into the future for the longer-term horizons. The PVA is still trying to determine how to create longer hydrologic sequences.

  - ***Question:*** Can you provide clarification to the reference value? ***Response:*** Dr. Miller wants to be able speak to "a particular increase in spring flow will relate to a particular response in output" – in order to do this, it requires a reference value for comparison

purposes. It is unknown if Dr. Goodman is adopting the same approach to relate the hydrology to biology.

- ***Question:*** What is meant by carrying capacity? ***Response:*** Carrying capacity is simply the number of individuals that a habitat can support in an equilibrium sense in the long-term; it is related to the amount of resources the habitat has and the degree to which they can be replenished as the population utilizes those resources. As a starting point in the RAMAS model, K is 8.9 million. How the fish responds to reduced habitat during summer drying still needs to be explored. There is the potential for the population to increase larger than 8.9 million in any particular year depending on the flow but that large a population couldn't be sustained.
- ***Comment:*** Regarding the risk of extinction, in the examples graphs shown there are cases when the population "bumps along" the extinction line but never seems to cross. ***Response:*** Remember, a large number of replicate runs have to be summarized in order to look at the probability that the population will go below a specified threshold. There are high levels of variability and Dr. Miller reiterated that he is not comfortable with how the K is currently being expressed. The model can generate thousands of runs to express the probability that the population goes below a specified threshold (1 individual; 10,000 individuals; etc.) or quasi-extinction level for management purposes.
- ***Question:*** These are sample runs - where in process is the final product? ***Response:*** One important component in the development of final model is the incorporation of hydrologic sequence data. That hasn't yet occurred. There needs to be more face to face discussions and meetings with the PHVA work group to actually gather those scenarios and provide the specific results. Also, there are other data analysis issues that need to be explored (discussions began at the last meeting) and the development of a consensus data set (for confidence).
    - ***Response:*** The FORTRAN model could be implemented now, but it is not recommended. Dr. Goodman reiterated that the PVA work group has been assembling data and analyzing data. They are just to the point of designating a consensus data set. Consensus on the analysis/conclusions drawn also needs to be attempted. Dr. Miller's presentation highlighted some of the differences that have not yet been agreed on, such as density dependence. These topics need to be discussed at the technical work group first.
    - Dr. Miller shared his opinion that these models are not supposed to be exactly the same and he doesn't want to delay the delivery of a functional product because there are arguments about the differences between the two models. His opinion is that the models can still be complementary even with differences. Dr. Goodman disagreed with this position and shared that his perspective is that the Program could be ill served if there are two models producing very different results but no clear context justifying the divergence.
- ***Question:*** Is there consensus on the variables that are going into the models? Hydrology? Biology? Habitat? Habitat size? etc. Where is the work group in terms in confidence on the variables that are being considered? ***Response:*** The variables that have data have been considered, analyzed, and incorporated to the models to the best of the work group's ability. There are specific variables that the work group would like to be able to include but unfortunately, the quantitative nature of the relationships with those variables is unknown – making inclusion difficult. To address this, the work group is developing a philosophy on how to explore those terms. The consensus data set has not been officially agreed to yet.

- ***Question:*** The Program is currently working on developing AM and the LTP. Can these models be relied on for the management recommendations and water decisions? ***Response:*** Yes, once the PVA models are functional and scientifically credible. The PVA can be use to generate hypotheses that guide the AM by providing high probability "if/then" scenarios. The AM response is to "bet" on the high probability actions but have flexible plans in place for quick response if the monitoring indicates the hypothesis was wrong. There is no right or correct answer; the PVA will run scenarios that will subsequently need to be tested over time. The models will be continually be refined as more data is collected. The value of the models come with the on-the-ground testing in AM.

Report out on February adaptive management sessions

- The first day of the February adaptive management sessions began with a description of how the contractor envisions the adaptive management plan to be. During the second day of the session attendees drafted a list of uncertainties and questions for the Program; the hypotheses that had been previously put together by the PVA were incorporated into the list.
    - The need for formation of an official workgroup for adaptive management with a charter and note takers was also discussed during the adaptive management sessions.
    - Attendees were updated that in concurrence with a previous EC decision from their last retreat the EC has decided to approve the CC recommendation to not form an official adaptive management work group until after the BO process has been completed. Currently the COTR distributes meeting agendas and puts documents on the website.
    - It was commented that it would be good to have EC support for a strong interface between PVA and adaptive management.
- Several attendees verified that they would be attending the upcoming adaptive management session on April 5^{th} – 7^{th}; copies of the agenda were distributed.

PVA Models: Follow up discussion by PVA workgroup

- Attendees discussed the need to be able to understand and evaluate the differences between the two PVA models. It's believed that the EC does anticipate the likelihood of differences in the models and will be interested in knowing the differences in order to have a better understanding.
- There was also discussion on the need to have consensus on the data sets and determine the degree to which there is consensus on the analytical processes used.
    - Most of the data sets are available on Dr. Goodman's website and it's believed that the workgroup is close to consensus on the data that will be used; however there are also data sets that are not ready for use (i.e. river drying data). The work group can make a list of all data sets and indicate the status of each data set (i.e. approved, pending).

Action: Dr. Goodman will start a list of data for the PVA workgroup to agree on for use in the PVA models.

- It was suggested that a metafile be provided for each dataset that documents information about the data such as who collected it, a brief description of the methodology, and how the data is being used in the models.

- It's expected that the PHVA/PVA integration data will be an important part of the consensus data as a large number of flow scenarios will be needed for the models.

- It was suggested that the steps that the PVA is taking to concede on the data and discuss model differences be communicated to the EC.

Action: Dave Campbell will email a draft memo to communicate the workgroup's next steps to the PVA workgroup for review.

- Attendees discussed the upcoming PHVA/PVA joint workgroup meeting scheduled for April 22nd, 2011.
  - Frustration was expressed over difficulties in collaboration between the PHVA and PVA workgroups. It is extremely important for this meeting to be productive and have open dialog between both groups. Meeting attendees were encouraged to talk to their EC and PHVA members. Stacey Kopitsch (PMT liaison) will invite the Program Manager to attend the joint PHVA/PVA workgroup meeting at the request of the PVA work group.
  - As the Bureau of Reclamation Biological Assessment has been the main focus of the PHVA, attendees discussed alternate modeling options outside of URGWOM in order to facilitate PVA moving forward. It was proposed that a simple hydrology model using URGWOM rule sets and the historic data be developed for PVA use.
  - There has been indication from a PHVA member that the workgroup is moving towards generating a 50 year sequence. This would require taking the model to Jesse Roach at Sandia Labs where they will have sufficient computer power.
    - Attendees briefly discussed a 50-year sequence that was provided to Dr. Goodman and Dr. Miller by Nabil Shafike (URGWOM tech team) that was constructed from 5 10-year sequences. The rules are the same for each of the 10-year sequences and the output for each of the sequences is the input for the next sequence. The sequences can be arranged in any order.
  - Attendees discussed that many iterations of flow scenarios will be needed and though the URGWOM model is amazing the need for more computer power indicates that it may restrict the number runs that can be provided. If the PVA is closely involved with adaptive management a model that is fast and flexible will be needed in testing management rule sets. Having a smaller model will also be useful in quickly running new ideas during brainstorming sessions for the RPA process.
  - Since its unknown if future hydrology will be similar to past hydrology it was suggested that the PVA look at how the system can be managed in dry, average, and wet periods instead of looking at it in terms of 50-year sequences. Instead of taking scenarios from URGWOM a range of plausible sequences can be created and if there is a scenario that is determined to be important then it can be run through URGWOM.
    - The URGWOM rule sets and historic data will be needed to model the river system. The plan for creation of a simple model will be presented at the joint meeting.
    - It would be beneficial to discuss how to approach characterization because the monsoonal rain affect in this system is different than a traditional snow run off system in which you usually get a fairly good characterization by looking at an exceedance type of relationship. A suggested way to characterize is to use historical data to draw criteria for the characteristic flows in dry, average, and wet years.

Discussion of San Acacia Fish Passage Peer Review recommendations

- The CC has requested that the PVA review the recommendations in the San Acacia Fish Passage Peer Review and identify a recommendation to be converted into a future study.

Action: PVA members will review the San Acacia Fish Passage Peer Review report to discuss the peer review recommendations at the April 22nd PVA meeting.

Next meeting:

- The next PVA meeting will be April 22nd, 2011 with a joint session with PHVA in the morning and PVA business to follow in the afternoon.

PVA Meeting Attendees
March 29, 2011

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