Mexican Wolf Recovery Planning Workshop
April 11-15, 2016
Galleria Plaza Reforma, Mexico City, Mexico
DRAFT NOTES – NOT FOR DISTRIBUTION

Attendees: Peter Siminski; Adrian Wydeven; Nalleli Lara (for Carlos Lopez); Enrique Martinez; Roberto Wolf; Monica de la Fuentes Galícia, (Secretariat of Environment and Natural Resources); Jose (Pepe) Bernal and Ismael Cruz (Comísion Natural de Areas Naturales Protegidas); Eric Odell and Craig McLaughlin (Colorado Parks and Wildlife); Jim Heffelfinger, Francisco (Paco) Abarca, and Jim deVos (Arizona Game and Fish Department); Kevin Bunnell and Marty Bushman (Utah Division of Wildlife Resources); Stewart Liley, Matthias Sayers, and Eric Rominger (New Mexico Department of Game and Fish); Tracy Melbihess, Sherry Barrett, Maggie Dwire, Seth Willey, and John Oakleaf (U.S. Fish and Wildlife Service); Phil Miller (Conservation Breeding Specialist Group, facilitator); Tyson Swetnam (guest, University of Arizona); Gerardo Carreon Arroyo (guest, Naturalia); Alejando (Alex) Gonzalez, Julia Veslasco, Lizardo Cruz, Gerardo Suzan, Andres Lopez, Rurik List (guests, Universidad Autonoma Metropolitana); Armando Yáñez Sandoval, Deputy General Director for Border Issues; Liliana Yasmín García Hernández, Deputy Director for Strategy and International Policy; José Miguel Emilio Fragoso Romero, Chief of Department for North Border, (Secretariat of Environment and Natural Resources); Florentino Chillopa Morales (guest, SEMARNAT); Graciela Alvarez (guest, US Embassy)

Monday, April 11, 2016

Introductions and Opening Remarks

The workshop opened with introductions, agencies' welcome to the group, and review of the agenda.

Vortex Updates and Discussion

Ongoing updates to Vortex input data are underway since March to increase model realism with the intention of making predictions about abundance and persistence under different management scenarios for 50-100 year timeframes. The Mexican wolf Vortex model now includes a Mexican Wolf Experimental Population Area (MWEPA) population and a SM OCCID (Sierra Madre Occidental) population. Progress is underway to add the captive population to the model with assistance from Traylor-Holzer at CBSG.

Inbreeding depression – Data analysis is ongoing. Inbreeding was previously expressed through the number of offspring per litter (number of pups declines with increasing relatedness of parents). Group discussed what impact inbreeding depression has on the viability of the population. Miller explained that several colleagues (Asa, Baumann, Fredrickson, Siminski) are conducting analysis to determine what factors (age, inbreeding, breeding history, etc.) are influencing reproductive success. Previous model runs were very sensitive to inbreeding; need to make sure model is incorporating in a realistic manner for Mexican wolves.

Other genetics issues – Miller is inputting a studbook file into Vortex based on end-of-year 2014; will provide genetic relatedness of every wolf in each population. Precise starting point is not hugely important because we are projecting forward for 50 to 100 years; using end of 2014 allows us to be up to date but still have accurate information on pups (which we wouldn't have from a more recent starting point). Concern raised to make sure that adding studbook, which will capture relatedness, doesn't cause double-dipping on top of inbreeding depression function; response was no, it is not double-dipping. Corral issue: how can cross-fostering be simulated to demonstrate how it influences the genetics of the wild population? Scratchpad 4/11 (1).

Catastrophe – Simulation of a catastrophe in the model should be used to mimic an event that is infrequent but has significant impact on survival or reproduction of the population. Past model used a disease regime for catastrophe ("Distemper", based on gray wolves in Greater Yellowstone Area that mostly affects pup survivorship (80% reduction), with some adult mortality (5%). Catastrophe will affect each population individually. Catastrophe regime in the model is currently being modified for application to the drier conditions of the Southwest and Mexico. Including a disease catastrophe is logical for wolves; but need to revise frequency and extent of occurrence of previous settings to more realistically reflect the Mexican wolf. Also exploring a more general catastrophe regime based on mammal meta-analysis (Reed et al.2003) – would result in 50% reduction in abundance of population in a year, every 25 to 30 years, which is equivalent to approximately 14% per generation; for wolves with generation time of 5 years, equivalent to about 3% per generation. Miller discussed with the group that in the absence of strong data related to a specific population in a specific area, using a generic catastrophe regime is currently a scientific norm/standard. Comparative model runs will be used to assess the different impacts of these two catastrophe regimes.

Mortality – Mexican wolf Vortex model is using a density dependent mortality rate. Previous input data for model was from Yellowstone gray wolf population. We are updating it with Mexican wolf data from MWEPA population. Mortality input will be specific to each population in the model. Need more information to be able to set hypotheses/scenarios for Sierrra Madre Occidental or another Mexico population; mortality may be higher at the beginning of population establishment due to human-caused mortality or dispersal mortality, etc. Rominger questioned whether we are going to incorporate different survival rates for wolves when they move from captivity to the wild; Miller responded that it would be feasible to do so in Vortex.

Habitat Analysis

We want to identify specific areas in Mexico that have certain biological/ecological characteristics suitable for Mexican wolf reintroduction. Relevant information may include: roads, human population density, land ownership, slope, ungulate biomass, vegetation type, livestock density, geographic barriers. Some information is available in global data that is uniform between US and Mexico. Group needs to discuss what data layers should be used, are available, criteria for selection, and ranking.

Technique: Swetnam reviewed Cyverse Wiki, which can use global data sets. Would develop a table that provides road types, land use, etc. with a weighting scheme. Vector data would be converted to raster data.

Swetnam described Jet Steam, a newly launched National Science Foundation cloud source that can be used to compile and store data, and allow multiple users on a virtual machine. Need someone to put in a proposal for a start-up allocation, which would provide access to 40,000 hours of computer time.

Meyer brought up a question raised by some workshop participants over email after the Wickenberg workshop of whether niche modeling is appropriate for a generalist species. He agrees that niche modeling for the gray wolf species may have shortcomings, but thinks it is appropriate for the Mexican wolf subspecies, which has more specific historical habitat associations.

Meyer presentation: Toward a range wide habitat model of the Mexican wolf (available on Sharepoint)

Meyer and colleagues' objectives for the meeting are to: agree on the overall approach for the analyses, especially on the geographic area to be analyzed; select data layers; agree on criteria/rankings for data layers (e.g., characterizing road density by high/medium/low). Primary challenges include defining the area of the analysis and dealing with lack of information or poor quality information, especially data mismatch across the border.

What is area of analysis?

Group reviewed historical range maps from the scientific literature to inform a decision on the geographic area for habitat analysis: Young and Goldman 1944, Hall and Kelson 1959, Nowak 1995, Parsons 1996, Chambers 2002 draft, etc. The habitat analysis will not use one of these maps verbatim as the area of analysis, but rather will use it as a basis to develop a climatic envelope; group clarified that this portion of the assessment will not result in a habitat suitability map for the Mexican wolf but rather will result in a map of climatic suitability. The climatic polygon will provide the base layer upon which other layers will be added to develop a suitability map. Meyer pointed out that the historical range maps in the literature were lines drawn by hand. The group discussed the taxonomic history of the Mexican wolf, related to the treatment of gray wolf subspecies that occurred in the Southwest and Mexico historically (*baileyi, mogollonensis, monstrabilis*) by various authors. In the US, FWS has relied on the historical range as defined by Parsons, which included a 200 mile extension of Nowak 1995, with *mogollonensis* and *monstrabilis* subsumed with *baileyi*. See FR 80 2488, January 15, 2016, available on Service's Mexican Wolf Recovery Program website: http://www.fws.gov/southwest/es/mexicanwolf/

Meyer reviewed historical Mexican wolf occurrence data (high reliability = validated with a specimen; lower reliability = anecdotal information); this analysis only uses high reliability data points. Most of the reliable data points in Mexico were from predator control, deposited in scientific collections during the 1940s-80s; Siminski raised concern that these data points may be biased toward areas that are poor habitat for wolves. Initial results show a climatic break above the general area of I-40. Meyer doesn't know why the climatic break is occurring, but hypothesizes it is due to temperature and precipitation. Developed similarity analysis of niche comparisons between subspecies to look at climatic similarity of occurrence between *baileyi, monstrabilis, nubilis*, *mogollonensis*. Group discussed which author's historical range polygon to use (Nowak, Parson, etc.) Heffelfinger raised concern that if we use data points that weren't

Mexican wolves, such as northern wolves from the Mogollon Rim included in Parsons, the model will be trained for northern wolves/climate; Liley stated the Parsons extension of 200 miles was too arbitrary for a basis for this habitat assessment. Barrett expressed concern that if the recent BRWRA data points were not used, the model would be biased against habitat that is currently occupied by Mexican wolves. deVos agreed that the BRWRA data should be used.

Group discussed the inclusion of data points from Hendricks et al. 2016 paper, specimens that had Mexican wolf genetic material but may not have been Mexican wolves. The group recognized that the choice of polygon matters significantly for Mexico due to the inclusion/exclusion of the Sierra Madre Oriental (SMO). Mexico (CONANP and several independent scientists from Mexico) indicated an interest in selecting a polygon that allows for analysis of SMO.

To alleviate concerns over training the model for more mesic habitat that would emphasize areas above I-40, the group agreed to cap the model at I-40 for geopolitical reasons. The Service's policy stance is to first focus on assessing the feasibility of a recovery implementation strategy in historical range before looking in areas north of the general I-40 area. The group agreed to use the Parsons 1996 historical range polygon and the recent BRWRA data points, minus a data point in the Dallas, TX area, which was an extreme outlier.

What data layers are needed?
Group discussed whether slope is an important feature of habitat suitability and agreed it is not important over a broad landscape and therefore should not be included as a habitat layer.

Forest Cover: Scratchpad 4/11 (4) Consensus land cover. Need to use broad classification – forest, shrub, etc., rather than very specific classes: there may be differences in classification between countries, e.g., vegetation classification in Araiza is different than how we name vegetation in US. Habitat group will continue to work through this using MWEPA data, data from Mexico reintroduction, Araiza et al. 2012 paper, etc., to inform decisions on wolf use of various vegetation classes.

Road data: Scratchpad 4/11(5)
Data layers to consider include distance to roads and density of roads. Literature related to gray wolf suitability more typically uses road density, which can correlate to human density. Is there a way to differentiate between public and private land roads (private land could have roads but very few people have access to it)? Wydeven provided a definition based on Mladenoff et al. 1995. Group discussed that different road types may be associated with different mortality issues (vehicular mortality vs illegal killing access).

Group decided to use road density/wolf probability from Mladenoff et al. 1995 (Table 3), with possible exception to combine lowest road density categories, as road density is higher in Mexico and therefore there may not be any areas in Mexico that contain the lowest category densities:

Road density	Probability class (p)
0-0.25km/km^2	>/95% p
0.25-0.38	0.75-0.94 p

0.38-0.45	0.5-0.74 p
0.45-0.53	0.25-0.49 p
0.53- 0.60	.10-0.24 p
> 0.6	< 10% p

Tuesday, April 12, 2016

Habitat Analysis (cont. from 4/11/16)

What data layers are needed?

Human density Scratchpad 4/12(1)-(2)
Group discussed whether both human density and distance to settlements are relevant defining habitat features for Mexican wolves. Swetnam and Heffelfinger described the night lights data layer as a possible surrogate for human density. Mexico colleagues explained that in Mexico, census population data is more accurate than night lights because many rural areas do not have electricity. Group discussed using census data or Land Scan as possible data layers, or a combination; determined that LandScan data would provide highest quality comparable data between the two countries.

Meyer described the methods used in Araiza et al. 2012 to buffer human densities based on three scenarios (optimistic, medium, and pessimistic). Group discussed that we need to remember that we are looking for general habitat suitability, not specific reintroduction sites where lowest human density would be most important.

Group discussed literature pertaining to the relationship between human density and wolf occupancy from the Western Great Lakes and Northern Rocky Mountains in the US. Wydeven suggested his data from Western Great Lakes may be a good starting point as an estimate of human density/wolf use, but would be conservative, as the data is from the 1980s -- over time the landscape filled in with higher human densities and road densities and wolves began using places with higher human densities.

Wolf habitat use and human density:

	Use	Non-use
WI	<1.52(SD=1.61)	>5.16(SD=3.48) (Mladenoff et al. 1995)
NRM	<0.43(SE=0.07)	>2.41(SE=078) (Oakleaf et al. 2006)

Oakleaf could analyze human density/wolf use for the MWEPA.

Group agreed on human density relative ranking scheme of:
<1.52 = good quality
1.52 to 4.74 = medium (2 SDs)
>4.74 = poor

Land Ownership:

Group discussed what land ownership characteristics are important for wolf habitat and whether that significance is the same in both countries. Group agreed that land ownerships may not be directly comparable between US and Mexico in some cases, such as specific definitions of wilderness areas or ejidos. Colleagues from Mexico clarified that there are some natural protected areas that have ejidos within them, which would require two layers of data. Group discussed an option of not including land ownership as a feature of suitability because it incorporates biases that may not be appropriate for both countries (US bias toward public land over private land may not be appropriate for Mexico.) Instead, all other data layers would be combined to determine suitability, and then land classification could be overlaid and would be used to develop implementation strategies specific to ownership opportunities/challenges. Sayer raised the question of how the Service would view Mexico's ability to contribute to recovery if most of suitable habitat occurs on private land. Service responded that federal agencies in Mexico would need to assess both the biological and sociopolitical potential of Mexico for the Service to understand the degree to which Mexico can contribute to recovery.

Group agreed to use land ownership as a data layer to assess implementation strategies rather than as a building block of habitat suitability. Defer continued discussion on land ownership issue until initial habitat assessment results are availble.

Prey density/biomass availability: Scratchpad 4/12(5)-(6)
Group discussed whether prey density or biomass should be used to define Mexican wolf habitat suitability. Meyer and Heffelfinger explained that density data on mule deer, white-tailed deer, and elk for each GMU below I-40 in AZ is available and can be converted to an ungulate biomass index using the Fuller et al. 2003 regression. Liley reiterated that GMU data for NM is also available in the 2014 EIS. Swetnam re-described (from Wickenberg discussion) that various greenness indices can be assessed to determine which ones best represent ungulate data; that remote sensing layer can then be used as a binational surrogate for ungulates in the habitat assessment.

In Mexico some white-tailed deer density is available via UMA monitoring data. However, rigorous quality control on UMA deer data does not occur consistently compared with ungulate monitoring data in the US. Servin looked at monitoring data from northern UMAs in Sonora, Durango, Chihuahua and Sinaloa, which generally used the same monitoring methodology from 1997-2010. Servin presentation on Sharepoint. Servin's synthesis of data shows 7.5 deer/km^2 average for all UMAs in Sonora and Durango in the Sierra Madre Occidental. Group discussed that it may be valuable to use field data (to be provided by Lopez and Lara) from Durango and Chihuahua to assess the reliability of the UMA data. Group discussed whether it would be to extrapolate UMA data across a larger region, with participants expressing support for or concern with this approach. Meyer explained that their methods would result in a separate map for each prey species, which could then be combined into an overall prey biomass map.

Swetnam questioned data accessibility of the habitat data layers for the general public. Generally the group is comfortable with public data accessibility, especially when the draft recovery plan is released, given that most layers are public already and those that aren't would be modified versions of public data.

Group reviewed overall approach to habitat assessment: Scratchpad 4/12(7)

- We have 3 sources of data for prey density: UMAs, field work in Mexico and surveys, US GMUs
- TBD, how to calibrate UMA data on prey density based on Lopez and Lara data
- At this point, standardized UMA and GMU data on prey density would be available
- Then, test 2 different methods to determine which is preferable:
  1) Random forest approach using satellite products looking for relationship between satellite data and prey data, or
  2) Niche centroid approach (explained in Wickenberg), may use some of same layers but different approach (split data into calibration data and validation data; not separating US and Mexico data but will choose a random sample from each and see how validation performs; concern about elk overwhelming the data).
- Assess results and select methodology with better results.

Group discussed whether incorporating small mammals or birds into prey data is feasible but most agreed that it is not. Group also discussed whether the presence of other predators on the landscape, such as mountain lions, interferes with our ability to accurately describe the relationship between prey density and wolf density. Several participants suggested that the Fuller et al. 2003 data includes wolf populations in geographic areas that had multiple predators.

Group discussed how we would rank prey densities in terms of habitat suitability for Mexican wolves. Oakleaf noted the small size of white-tailed deer in Mexico and that they should account for 0.5 in biomass estimates. Several participants suggested we develop thresholds from Fuller, but others stated concern that Fuller uses North American areas not Northern Sierra Madres. Group considered an approach where anything below "1" is not suitable and everything else on the scale of 1 to 10 is just a continuum. Group deferred continued discussion.

Cattle density: Scratchpad 4/12(8)
Both US and Mexico have county level cattle density data. Group decided to look at density without ranch classification (feed lot, slaughterhouse, etc). US classification data is available through National Agricultural Statistical Service (see 2014 EIS), but classification is not likely available for Mexico. Participant mentioned Guillermo Ponce Campos, University of Arizona Postdoc, working on "cattle predation risk" study.

Elevation:
We have elevation data. No further discussion.

Climate:
We have climate data. No further discussion.

Landscape Metrics (shape and connectivity of patches): This will be an informative layer to look at in second stage of modeling (after other layers have been combined and polygons of suitable habitat are evident) to help assess connectivity for dispersal between high quality patches of habitat. Group also mentioned Carroll et al. 2011 Conservation Biology paper and

Jimenez paper under review with NRM dispersal data as additional sources of information related to connectivity potential between patches of suitable habitat.

How should we incorporate changing climate in the habitat or Vortex modeling? Swetnam suggested the group pick two contrasting climate models (liberal and conservative change) to use in comparative Vortex simulations. Group discussed another approach as identifying input variables in Vortex that may change due to changing climate and assess viability of populations under those conditions. Meyer commented that niche model can assess which geographic areas may be more vulnerable to climate change. Group questioned whether climate change is important for Mexican wolf recovery in elk systems, given that elk are generalists and are not predicted to be severely impacted by it. FWS stated that climate change was not identified as a threat in the 2015 listing rule and would need to be considered within the five factor analysis in the recovery plan/species status assessment.

How should layers be categorized/ranked? Scratchpad 4/12(10)

Layers: Road density, human population density, forest cover, land cover, prey density, livestock density. Do we want to weight these layers to provide relative contribution of each layer to providing suitable habitat? Options: 1) Give all layers the same weight; give all layers the same dark to light color gradation (e.g., light is worse condition, dark is better consdition) so that overlaid color gradations of the layers collectively show better or worse areas; 2) Give layers different weights. Group agreed that it is hard to weight all of them because we have different levels of uncertainty on each of them, e.g., prey is very important but we have very high uncertainty in some areas.

Group shared general discomfort with the idea of ranking. Participant suggested a canonical logistical regression. A related but different issue is that some layers will be numerical (e.g., low to high human population density) but some are categorical (e.g., forest cover); how do we address this?

Group discussed whether/how the habitat model can be validated. Participants questioned whether we could not include MWEPA data in historical point data and then use it to validate the model.

Group discussed the timeframe for habitat analysis and the interdependence of Vortex and the habitat assessment. Habitat model would provide us with polygons that can contribute to recovery of Mexican wolves; Miller would incorporate a carrying capacity for each polygon in the model and would need to be able to estimate expected connectivity. Miller estimated that Vortex work will take three months after habitat info is available.

Wednesday, April 13, 2016

Updated agenda:

- UMA discussion
- Potential habitat discussion
- Vortex update

- group work

UMA Discussion

Florentino Chillopa Morales, Subdirector of sustainable use of free ranging wildlife, SEMARNAT, Guest, presentation on Sharepoint.

Overview of UMAs: There are 12,500 UMAs registered in Mexico, most in the northern part of Mexico. Most represented vegetation is scrub. 32,000,000 ha of land covered by UMAs, 7500 UMAs (23,000,000 ha) are managed for free ranging wildlife but are not necessarily working at full capacity; the remaining UMAs manage captive animals. Conservation of habitat is 90% of UMA activity for harvest/sport hunting. The 2000 ley general de wildlife establishes process and permits for managing species on UMAs. Permit conditions include: 1) current valid registration of UMA; 2) species for harvest has approved management plan; 3) current on annual reporting for conservation of the species; 4) file request for permit for harvest, published in daily government register, has to include polygon/transects plan for surveying for the species; 5) results of monitoring must be submitted to agency. Permit provides authority to hunt specific species on the UMA. Some UMAs request to harvest females or other small animals for reintroduction, but most of permits are for trophy males.

Number of UMAs has increased rapidly in recent years but is expected to level out now. Federal government has begun compiling UMA information in electronic/GIS systems but the process is far from complete; in addition, the six border states collect their own data and SEMARNAT is not sure whether their data is electronically available.

Group questioned how confident SEMARNAT is on monitoring information that is reported by the landowners, e.g., reports of 5-7 deer per km^2 in the northern UMAs. UMA oversight typically confirms what is reported on UMAs but sometimes results in change to number of animals permit allows to be harvested if land owner has inflated their reported data; UMA reports that seem inaccurate are subjected to additional oversight. Group recognized that the presence of a predator could decrease the value of an UMA that is permitted for deer hunting and questioned what could be expected to happen with wolf presence on UMAs in terms of the likelihood of illegal killing of Mexican wolves. Morales responded that UMA participants should be included in the wolf program; UMA permittees have already shown they are conscious about conservation and Morales thinks they would be more likely to complain about poaching than to have an actual problem with the wolf. Morales suggested that it might be good if the federal government (General Wildlife Office) could formalize an agreement or relationship with the UMA landowners. However, General Wildlife Office needs the information from our process first so they know where to focus their efforts; they need internal organization and a specific objective to pursue UMA participation in wolf recovery efforts.

Group reviewed polygons from Araiza et al. 2012 publication previously discussed in depth during Wickenberg workshop (March 2016). Mexico colleagues stated their opinion that the Araiza polygons are still the best areas for wolves but re-emphasized that the polygon borders are not barriers to wolf movement, they were just expert opinion to identify the best areas for reintroduction efforts. List stated that central and southern Chihuahua polygons are likely the

best quality habitat but there is heavy drug cartel activity in this area and fewer UMAs. Mexico selected the northernmost polygon as the site to initiate reintroductions.

Gonzalez commented that connectivity between S.M. Occidental and Oriental will be difficult. But there is evidence that a black bear dispersed between the areas over a 7 month period.

Scratchpad 4/13(1)
List stated his view that Mexico needs to define what their goal is for Mexican wolf recovery – is it a certain population number or distribution, or returning an ecological function to the landscape? The Service discussed recovery under the ESA – including the requirement to set objective and measurable criteria that alleviate threats. Group agreed that it would be helpful to have a comparison of US and Mexico endangered species laws. Wolf and Siminski drafted a document similar to this during previous (2003) recovery plan effort that could be updated.

Action Item: Melbihess will work with Wolf and others to draft an informal working document that compares the two laws.

Demographic Modeling Discussions, cont.
Mortality
Oakleaf mortality summary page distributed to participants and methodology discussed.
Survivorship of pups for year 1 is approximately 46%, which is a mortality rate of almost twice what was in the model previously based on Yellowstone data (there data was ~76%).
Model will incorporate different sources of mortality (natural, human caused, cryptic, removal rate).

Catastrophe
Participants still support approach discussed in Wickenberg of two kinds of catastrophe, Reed et al. and reworked disease catastrophe.

Slope of inbreeding coefficient: Miller will use Fredrickson data for now for the purpose of running exploratory Vortex sims, but recognizes Fredrickson et al. 2007 (4.88) data isn't consistent with current MWEPA data.

Thursday, April 14 – Agencies only meeting

Barrett asked colleagues from SEMARNAT and CONANP if they could recommend a process for formally discussing a binational recovery effort with Mexico. Is there a desire to sign a binational plan, or a letter of intent or MOU? SEMARNAT responded that they will need a lot of internal discussion on this issue.

Sandoval recognizes there are two processes that need to move forward on parallel tracks, the biological work, and policy collaboration/communication. He referred to the February 2015 MOU between US Department of Interior and SEMARNAT as a good platform for collaboration. Mexican wolf could be used as an example of the binational tenet of the MOU.

deVos emphasized other binational species conservation efforts such as pronghorn and thick-billed parrot, as well as existing state of Arizona MOU with SEMARNAT. Sandoval also mentioned a project in Big Bend National Park that has binational support from Secretary Jewel and Subsecretario Pacchiano.

Sandoval emphasized that Mexico will need the information from the workshops as a foundation for their internal discussions, as well as to communicate with the public to address social issues. He recommended the information from the group be used as a tool to reach out to the Trilateral Committee. This group needs to provide a clear recommendation of what is needed for Mexican wolf recovery. Various approaches were discussed related to the Executives Table or Shared Species Table; Mexican wolf has not been accepted at the Executives Table this year. Barrett reiterated that the first step is for this group to explore the biological capacity of Mexico for Mexican wolves. Then, Mexico's agencies will need to discuss socio-political capacity for wolves. The Service will then have a good understanding of how much Mexico can contribute to range-wide recovery of the Mexican wolf.

Action Item: Abarca will explore several options for Trilateral involvement in exploring options for binational collaboration on Mexican wolf recovery for Barrett and deVos to discuss with their agencies.

Action Item: FWS (Barrett/Melbihess, in coordination with International Affairs Division and Region 2), will explore options for creating an annex/appendix to the DOI MOU for binational support for Mexican wolf recovery planning. Kemps Ridley sea turtle may be a good binational recovery plan example to emulate.

Agency meeting adjourn; full workshop resumed.

Miller reviewed several Vortex runs to explore the behavior of the MWEPA and Sierra Madre Occidental populations with different mortality, catastrophe, and inbreeding settings for illustrative purposes (the model is not yet calibrated to run sims for results).

Run 1 (inbreeding, Oakleaf pup mortality):

- kept inbreeding provided by Rich;
- baseline mortality information coming from John's analysis (e.g, 50% pup mortality (from pup survivorship from Oakleaf on Wednesday (0.534 for first 6 mon; 0.865 for second six months) with 20% coefficient of variation for environmental variation; 32.7 for first year mortality rate; density dependent maintained);
- same rates/input for MWEPA and Sierra Madre Occidental;
- catastrophes removed;
- initial population sizes taken from studbook from end of 2014
- K=set as they were from last meeting; buffer around target rate of 325 for both populations (set at 433);
- No dispersal between populations;
- genetics – restrictions set on various breeding to functionally minimize rate of inbreeding;
- 25 replicate runs;

- 100 year timeframe

Population goes to 0 in 76 years for MWEPA and in 35 years for Mexico population. What feature in model is driving the population in the model in a way that isn't representing what the population has been doing over time recently. Explored changing mortality and inbreeding.

Run 2 (inbreeding, less pup mortality):
- lessened pup mortality rate (1/2 of Oakleaf), set closer to original Fredrickson estimate
- maintained inbreeding from Fredrickson

Now MWEPA population shoots up to between 400-425 in about 20 years and Mexico population goes up to around 50 wolves in about 20 years. Question – how many packs are producing pups? (important in WI – they had 70% pup mortality but had enough packs breeding to offset mortality). Clearly model is sensitive to pup mortality.

Run 3 (no inbreeding):
- Get rid of inbreeding relationship
- Oakleaf mortality rates
- mean pups produced 4.65 SD 1.8.

MWEPA goes to k within 30 years – very similar trajectory as 2nd run. Miller asked which parameter set are we more confident in based on what we've seen the population do? Graphs showing inbreeding accumulation over time show rapid accumulation to high level (0.4). - but simulation is assuming no additional releases.

Liley stated his opinion that Oakleaf mortality data takes into account inbreeding depression and therefore adding inbreeding is overemphasizing inbreeding in the model. Group discussed the possibility that inbreeding is operating on first six weeks (den emergence) of survival not on litter size. Miller explained that one of the standard ways of incorporating inbreeding depression in Vortex is a reduction in pup survival, where we would input lethal equivalents (which acts on pup survival), which we would have to calculate from the pedigree.

Group got into a general discussion over concerns on how to address inbreeding in the model. Heffelfinger stated that he wants to see evidence of inbreeding before we add it to the model. Liley is concerned it is already incorporated in pup production and survival. Look at literature of mean pups produced across gray wolf taxa. Barrett is concerned that we think about the future in terms of what may happen due to inbreeding and consider the precautionary principle – we know we are dealing with limited genetics due to the bottleneck of the captive population during its inception and effects will occur over time. Heffelfinger asked the group what data it deemed appropriate to use, e.g., the last five years of population growth are not indicative of inbreeding depression acting on litter size (i.e., we should see 3 or fewer pups per litter, but that isn't what we are seeing in the wild). Dwire questioned the formula used by Fredrickson, which indicates that even with a kinship of 0, litter size would never be above 4.8, but average captive litter size with zero inbreeding is 7.2.

Action Item: Oakleaf agreed to provide additional June litter counts from 2009-2014 with information on supplemental feeding, which may be artificially increasing pup survival.

As a solution, Liley suggested a trigger in the recovery plan that says if we see pup production drop below a certain level we will implement management changes instead of dealing with it in the model. Group agreed to table the discussion for the time being until new inbreeding data analysis is available.

Run 4 (modified Fredrickson catastrophe):

- no Fredrickson inbreeding, 4.65 litter size,
- modified Fredrickson distemper scenario (reduced frequency slightly; severity of survivorship was modified 0.5 to 0.6 compared to Fredrickson's 0.2.) – less frequent but more severe.

Comparison between original Fredrickson catastrophe setting to Reed et al. to modified Fredrickson; original Fredrickson was highest; modified Fredrickson uses MWEPA data (Oakleaf mortality level for non-catastrophe year and average of Almberg et al. 2010 Ecological Applications for the catastrophe years) and is a little lower; Reed et al. over time may be more severe due to demographic impact. Miller told the group that reproductive rates will be revised in Vortex based on captive data which may address some of these issues.

Miller's To-Do list for Vortex Scratchpad 4/13 (2)

- Refine mortality rates
- Inbreeding depression- revised analysis
- Captive population component / explore capacity of captive population for contributing to establishing new populations and augmenting existing
- Sierra Madre model component
- Risk thresholds (generic populations)
- Crank up recovery target/k per discussions at Wickenberg workshop
- Dispersal dynamics

Group discussed the lack of a genetic goal for the MWEPA. Cross fostering will be easier to simulate if we understand the goal and can assess what actions will achieve it. Issue will be revisited after Fredrickson reanalysis of inbreeding in captive population has been completed. Siminski explained that a genetic goal was established for the captive population by the Species Survival Plan; suggested that wild populations should strive to achieve a reasonably close goal. Group acknowledged that related genetic metrics may be more feasible to measure in the wild and should be taken into account when setting a genetic goal.

Future meetings:

- Mid-August in coordination with review and comment on habitat model (week of August 22) Monday-Tuesday. Draft habitat analysis will be completed July 31; comments from group on draft due to Enrique on draft by August 10.

- Early November in coordination with Vortex results (first week of November, travel Tuesday, meet Wednesday/Thursday); draft Vortex results due October 15; comments on draft due to Miller by October 25.

- MX folks need invitation letter 2 months ahead of time.

Group acknowledged issue with UMA data availability as it relates to timely completion of habitat assessment – only two years of data are available electronically, the rest is on paper and would be prohibitively time consuming to utilize. Options may be to select a subset of UMAs within the historical range and take a random sample; start from 2015 data and work backwards within time constraints; start with Chihuahua for samples/advice; or look at variability within current data and take subsample to determine whether it is within variation. Colleagues working on habitat assessment will explore this issue further and communicate back to the group.

Meeting Adjourned