

ELICITATION RECORD – Part 1

The Workshop Context

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Stygobromus</i> Species Status Assessment
Date	<p>This Expert Knowledge Elicitation (EKE) workshop was held remotely using a series of telephone and video conferencing calls due to the 2019-2020 global health pandemic. A complete list of session dates, times, and formats is provided below:</p> <ul style="list-style-type: none"> • 09 APR 2020 – 1-hour phone call (intro and QoIs) • 30 APR 2020 – 2-hour phone call (spatial scale, threats) • 09 JUN 2020 – 1-hour video call (SHELF training) • 12 JUN 2020 – 2-hour video call (EKE 1st session) • 18 JUN 2020 – 2-hour video call (EKE 2nd session) • 25 JUN 2020 – 2-hour video call (EKE 3rd session) • 02 JUL 2020 – 1-hour video call (EKE 4th session)
Part 1 start time	9 April 2020

Attendance and roles	<p>David Culver, expert panelist Matthew Niemiller, expert panelist Wil Orndorff, expert panelist Daniel Fong, expert panelist Daniel Nolfi, expert panelist Daniel Feller, expert panelist Jeff Hajenga, expert panelist Daniel Fitzgerald, facilitator David Smith, facilitator Barbara Douglas, SSA representative</p>
Purpose of elicitation	<p>The US Fish and Wildlife Service is undertaking a Species Status Assessment (SSA) for <i>Stygobromus cooperi</i>, <i>S. morrisoni</i>, and <i>S. parvus</i> to support Endangered Species Act decision making. Quantifying the probability of persistence for populations of these species is critical to assessing risk of extinction as part of the SSA.</p>
This record	<p>Participants are aware that this elicitation will be conducted using the Sheffield Elicitation Framework, and that this</p>

	document, including attachments, will form a record of the session.
Orientation and training	Experts were sent the SHELF Expert Briefing document (attached) and provided an overview of how elicitation results would be used in the SSA as part of the evidence dossier (attached) and preliminary discussions. Training on the process of making probability judgments was completed using the attached presentation.
Participants' expertise	<p>David Culver - Professor Emeritus of Environmental Science, American University; B.A. in Biology from Grinnell College, Ph.D. from Yale University. Long-term researcher in cave biology. Authored papers on the cave fauna of both Virginia and West Virginia. Extensive research on epikarst.</p> <p>Matt Niemiller – Assistant Professor of Ecology, University of Alabama Huntsville; PhD, University of Tennessee; MS and BS in Biology from Middle Tennessee State University; Researches speciation, biogeography, and ecology of both cave invertebrates (including <i>Stygobromus spp.</i>) and vertebrates throughout the United States.</p> <p>Wil Orndorff – Karst Protection Coordinator, Virginia Department of Conservation and Recreation; Extensive experienced with caves and stygobionts in the region; Published works include The Invertebrate Cave Fauna of Virginia and numerous studies of karst geomorphology and hydrology throughout Virginia and West Virginia.</p> <p>Daniel Fong – Associate Professor of Biology, American University; PhD, Ecology and Evolutionary Biology Northwestern University; MS Zoology University of Oklahoma; researches population dynamics, structure, life history variation, and biogeography of cave and karst biota; published works include lead author on The Invertebrate Cave Fauna of West Virginia. 2nd Edition, as well as numerous studies on the evolutionary ecology of cave amphipods.</p> <p>Daniel Nolfi - Karst Species Expert, U.S. Fish and Wildlife Service, Chubbuck, Idaho; currently facilitates the bull trout 5-year review and is the Idaho species lead for bull trout and all bat species. Served as the Karst Specialist in the Great Smoky Mountains N.P. for 13 years where he worked closely with numerous cave species and their associated threats, specifically <i>Stygobromus spp.</i> Experience with international cave exploration expeditions and assisted with bio-inventories and collection of newly identified species.</p> <p>Dan Feller – Western Regional Ecologist, MD Department of Natural Resources; held position since 1990; MS in Applied Ecology and Conservation, Frostburg State University; researches population ecology and biogeography of rare and threatened species, including aquatic cave invertebrates;</p>

	<p>extensive knowledge of caves in the region and direct experience sampling <i>Stygobromus spp.</i></p> <p>Jeff Hajenga - Wildlife Biologist II, West Virginia Division of Natural Resources; Employed as Wildlife Biologist with West Virginia Division of Natural Resources, Wildlife Diversity Program, since 1996. Bachelors and Master’s Degree in Biology. Currently Cave and Karst Project leader for WV. Assisted with cave invertebrate surveys conducted for Cave Invertebrates of WV second edition book. Extensive experience in cave invert inventories, limited experience in Natural history assessment of cave invertebrate populations.</p>
<p>Declarations of interests</p>	<p>David Culver – I have no personal interest in the outcome of this report.</p> <p>Matt Niemiller – None declared.</p> <p>Wil Orndorff – None declared.</p> <p>Daniel Fong – None declared.</p> <p>Daniel Nolfi – My personal interest in this process for these species is to understand emerging threats to cave obligate species and mechanisms to protect them. Specifically, I am interested in learning the process that is used for information-limited species and how that can guide conservation measures to recover a species or prevent a species from needing protection under ESA.</p> <p>Dan Feller – None declared.</p> <p>Jeff Hajenga - As a wildlife biologist, I want to support the persistence of all species for stability of natural systems. Proper assessment of populations and threats to species and habitats is vital in protecting the populations.</p>
<p>Strengths and weaknesses</p>	<p>This expert panel includes both regional and international experts on <i>Stygobromus spp.</i>, as well as karst geology, hydrology, management, and conservation. Several of the experts (Fong, Culver, Orndorff) are co-authors on the authoritative references on the cave and karst fauna of Virginia and West Virginia. All panellists have extensive experience with cave biota and karst ecosystems in the central Appalachians, and most have direct experience with the specific localities and species considered in this elicitation.</p>
<p>Evidence</p>	<p>The experts received an evidence dossier (attached) summarizing information on the distribution and status of three <i>Stygobromus</i> species (<i>S. parvus</i>, <i>S. morrisoni</i>, and <i>S. cooperi</i>) prior to the workshop. Multiple calls were held to discuss available evidence. Experts had opportunity to provide additional data or confirm they were not aware of missing items.</p>
<p>Structuring</p>	<p>Experts discussed potential QoIs and approaches over multiple</p>

	calls and were most comfortable with eliciting the probability of persistence for a population given a specific threat scenario. Primary threats to cave amphipod persistence were structured in terms of proxy variables based on data availability and expert familiarity.
Definitions	Probability of persistence is defined as the likelihood a meta-population surrounding a specific locality will persist for 4 generations (approximately 10 - 20 years).
Part 1 end time	02 July 2020
Attachments	Evidence dossier; SHELF expert briefing; Training presentation

ELICITATION RECORD – Part 2

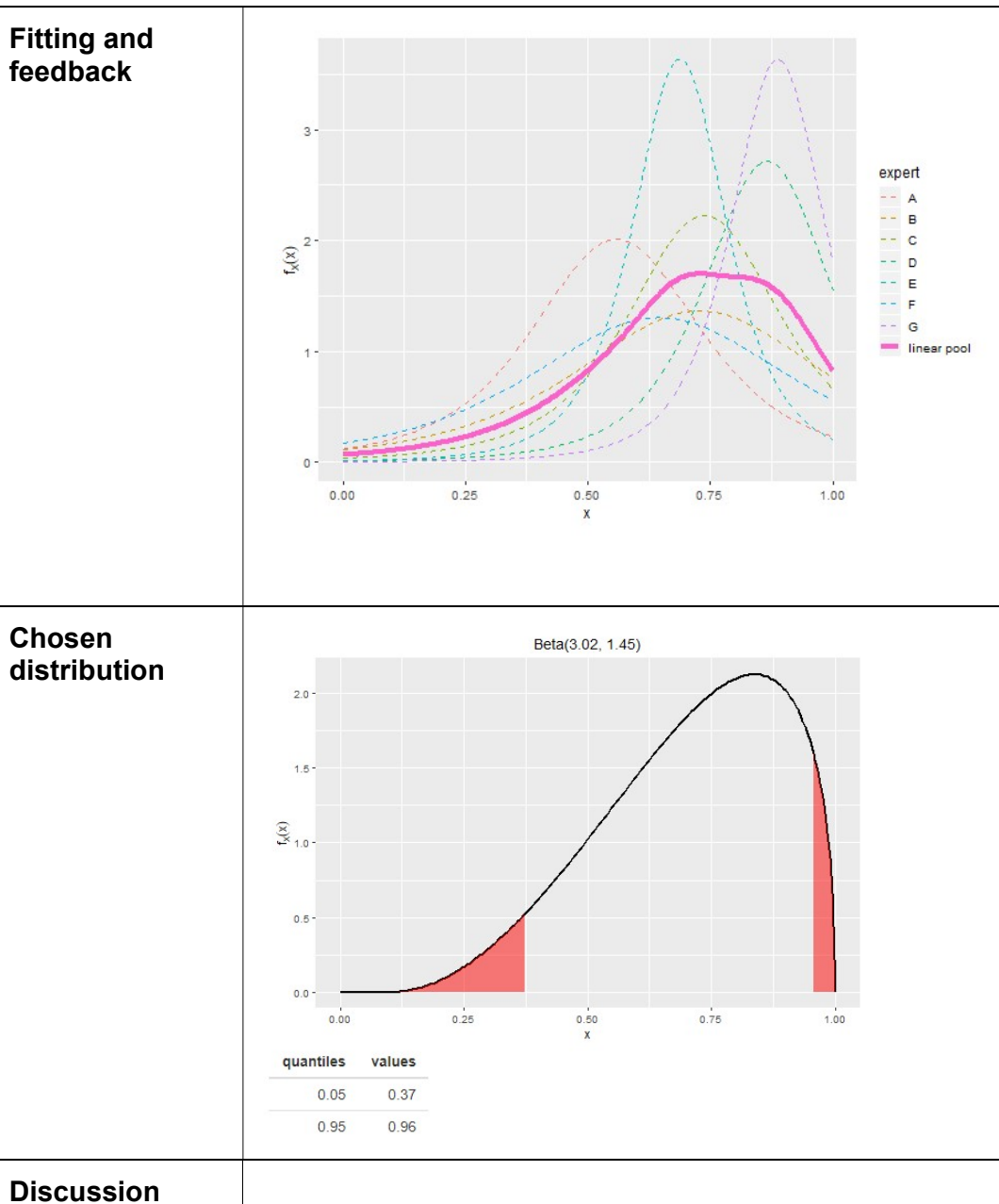
Eliciting a Continuous Distribution

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 1 – Stygobromus parvus</i>
Date	12 June 2020
Quantity	Cassell-Windy Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	10:10 EDT

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z - Observation in 1969, WVDNR ranks element occurrence as historical in natural heritage database, WVDNR visits site irregularly for bat counts, last visit 2007</p> <p>G – portion of Greenbriar River shown on map does not interact with this locality hydrologically (lower third of map). Karst map is not appropriate at this scale, it is based on exposed carbonate rocks, additional karst likely below surface. Entrances to cave are private.</p> <p>Z – karst map is the Weary and Doctor 2014 map by USGS, you should think of it as depicting rock types that have the potential for karst development. It is provided as an approximation only.</p> <p>E – popular recreation cave, but limited to skilled cavers only. Cave generally considered as “open,” minimal contact with owners. 7 miles of mapped cave passages, 140 ft vertical depth. All entrances privately owned. The locality on map is the Windy entrance, the second entrance is to the south in the open field.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

<p>Fitting</p>	
<p>Group discussion</p>	<p>D – tended to be optimistic in judgments because not much change in last 40 years on landscape, doesn't see much projected change. Unexpected threats may arise, but those would be rare.</p> <p>G – slightly less optimistic, but doesn't think threats in Greenbriar River will affect this population. There are uncertainties such as disease or climate change, but thinks QoI lies in the 90% range. Expressed difficulty thinking about personal probabilities of a probability of persistence, which contributed to uncertainty.</p> <p>B – most important aspect is the forest above population, which seems relatively intact. Gave high weight to this, and much less weight to health of the streams. Gave a longer tail to cover unexpected issues. For epikarst systems, what happens to major streams are not as important as effects of forest cover.</p> <p>C – tended to be more pessimistic and provided wider limits due to such limited information. Not sure how to appropriately apply threat information when there is such high uncertainty in current conditions; there is some</p>

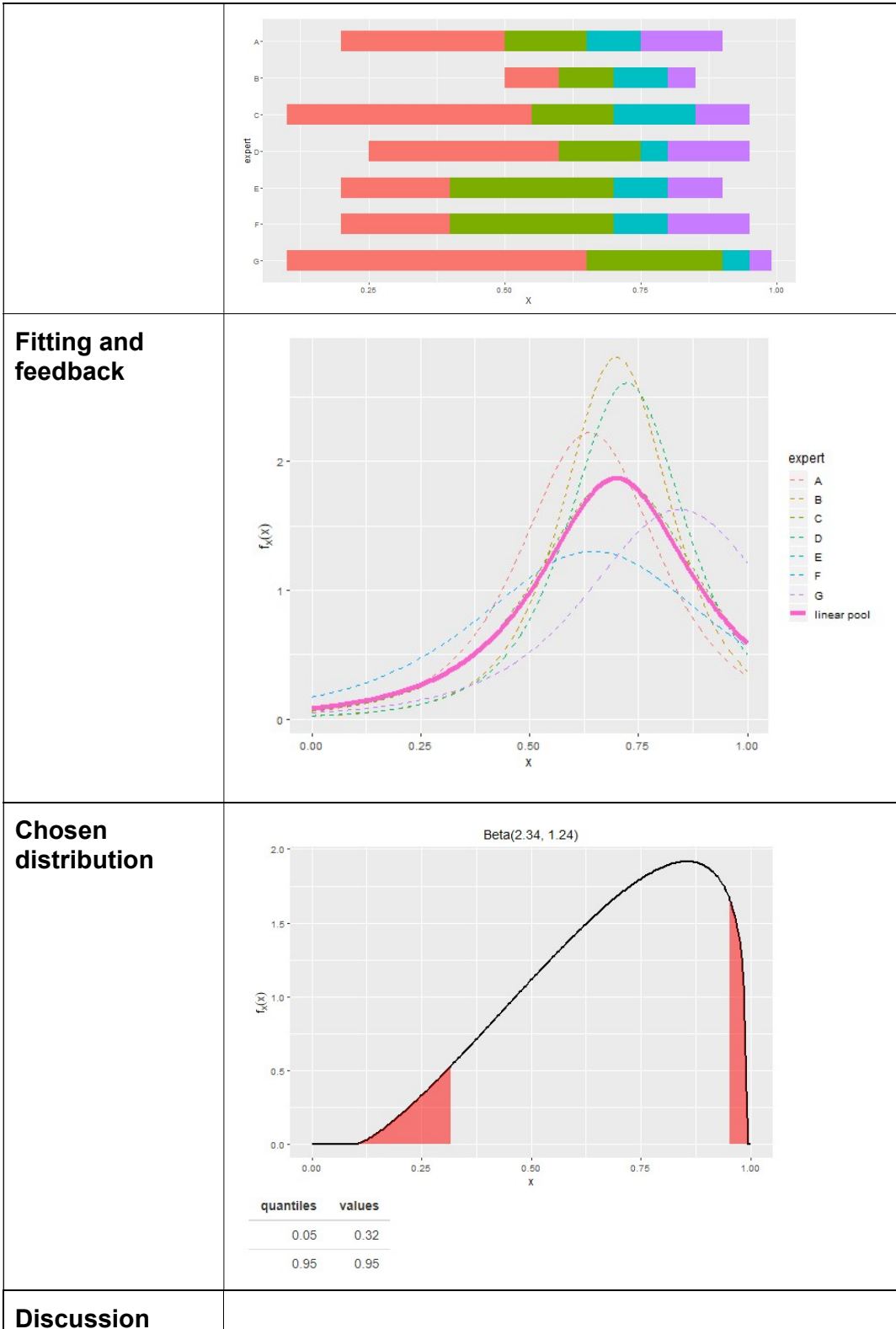
	<p>probability that the population is already extirpated.</p> <p>E – concern about logging was basis for lower probabilities, logging rates fluctuate annually and expects this threat to increase in future. Concerned about push to develop rural areas due to urban flight as result of COVID-19 pandemic. Area around cave fits development profile and is near tourist draws like Cass Railroad and mountain recreation areas. High uncertainty about why adjacent watershed has pH issues, but catchment for this population does not.</p> <p>Z – Not all streams have been assessed for TMDLs or the 303(d) list, so lack of impairment could be due to lack of sampling in that area.</p> <p>G – geologic features not shown on the map represent huge uncertainty. There was much less forest 100 years ago, but these animals have persisted in most places. Sampling difficulty and effort is major uncertainty.</p>
<p>Group plausible range</p>	<p>0.1 – 1.0</p>
<p>Group elicitation</p>	<p>Method: Quartiles</p> <p>Judgements:</p> <p>Q1: 0.58</p> <p>median: 0.73</p> <p>Q2: 0.85</p>



Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 1 – Stygobromus parvus</i>
Date	12 June 2020
Quantity	Crawford Cave No. 2
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	11:00

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z - Nearby mines currently produce crushed stone, past production of limestone. Agriculture is hay, small amounts of corn, sorghum, and soybeans. WVDNR lists locality as historical.</p> <p>E – 370 ft of mapped passage in a small cave. WVDNR bat surveys visit this site, but generally do not look for inverts.</p> <p>B – cave not resampled for 2007 update to cave invertebrates of WV book</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

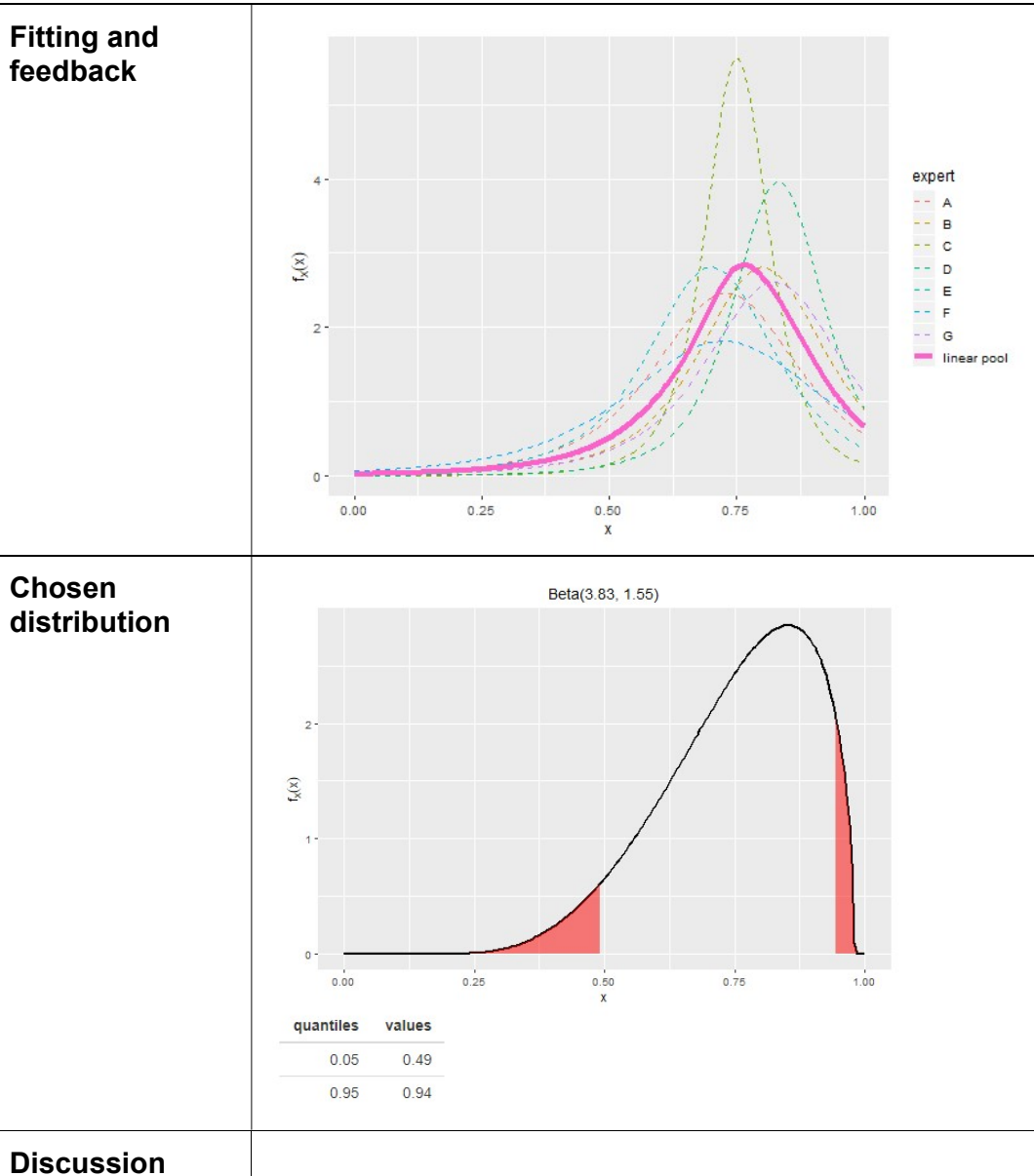
<p>Fitting</p>	
<p>Group discussion</p>	<p>A – lower probabilities in distribution due to concerns over potential future limestone mining, which moves regularly into new areas nearby once current quarry is exhausted. Also due to corn and soybeans being roundup-ready crops.</p> <p>B – lower probabilities reflected mining and agricultural land covering half of catchment, but in general optimistic about persistence</p> <p>G – limestone is not represented by the karst layer in maps, there is more karst habitat in subsurface west of the karst layer shown, and should be more affected by the forested area. Asked about metapopulation location in relation to sampling locality.</p> <p>Z – confirmed we are not assuming metapopulation is centered on locality; locality is an opportunistic sampling point and our assumption for metapopulation distribution is that it could reasonably be distributed throughout a 1km buffer. The specific distribution, number of metapopulations, and dispersal rate are all unknowns.</p>
<p>Group plausible range</p>	<p>0.1 – 0.99</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements:</p> <p>Q1: 0.55</p> <p>Median: 0.71</p> <p>Q2: 0.85</p>



Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 1 – Stygobromus parvus</i>
Date	12 June 2020
Quantity	Izaak Walton Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	11:20

Definition	Probability that the meta-population surrounding each locality will persist over four generations.																																								
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z – visited regularly for WVDNR bat counts, last visit in 2019, WV natural heritage ranks element occurrence as “extant - viability not assessed”</p> <p>X - Property owner is Izaak Walton league, a hunting and fishing organization. The cave is gated, timber harvest occurs on the property.</p> <p>E – 958 ft of passage, 20 ft depth profile.</p>																																								
Plausible range	See judgments spreadsheet for complete record.																																								
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> <table border="1"> <caption>Approximate Quartile Judgments from Chart</caption> <thead> <tr> <th>Expert</th> <th>Q1 (Red)</th> <th>Q2 (Green)</th> <th>Q3 (Cyan)</th> <th>Q4 (Purple)</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>0.50</td> <td>0.78</td> <td>0.85</td> <td>0.90</td> </tr> <tr> <td>B</td> <td>0.55</td> <td>0.75</td> <td>0.80</td> <td>0.90</td> </tr> <tr> <td>C</td> <td>0.40</td> <td>0.70</td> <td>0.80</td> <td>0.90</td> </tr> <tr> <td>D</td> <td>0.25</td> <td>0.65</td> <td>0.80</td> <td>0.95</td> </tr> <tr> <td>E</td> <td>0.20</td> <td>0.65</td> <td>0.75</td> <td>0.85</td> </tr> <tr> <td>F</td> <td>0.50</td> <td>0.75</td> <td>0.85</td> <td>0.95</td> </tr> <tr> <td>G</td> <td>0.25</td> <td>0.75</td> <td>0.90</td> <td>0.95</td> </tr> </tbody> </table>	Expert	Q1 (Red)	Q2 (Green)	Q3 (Cyan)	Q4 (Purple)	A	0.50	0.78	0.85	0.90	B	0.55	0.75	0.80	0.90	C	0.40	0.70	0.80	0.90	D	0.25	0.65	0.80	0.95	E	0.20	0.65	0.75	0.85	F	0.50	0.75	0.85	0.95	G	0.25	0.75	0.90	0.95
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<p>Fitting</p>	
<p>Group discussion</p>	<p>B – high probability of persistence due to assumption that land would be protected by IW league and logging would be done responsibly. Land is on top of ridge with a small drainage area; that would seem to provide protection.</p> <p>G – The belt of karst up to north probably does not include mines. Seems to be a secure population.</p> <p>A – Iron mines are likely old and abandoned. Does IW league know of amphipods?</p> <p>E – more confidence in persistence due to landowner.</p> <p>X – IW league is aware of cave and gates it, but likely due to concern for bat species</p>
<p>Group plausible range</p>	<p>0.2 – 0.98</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements:</p> <p>Q1: 0.67</p> <p>Median: 0.78</p> <p>Q2: 0.87</p>



Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 1 – Stygobromus parvus</i>
Date	12 June 2020
Quantity	Piddling Pit
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	11:40

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z – There are records of occurrence over several years. Natural heritage program in WV ranks element occurrence as “extant - viability not assessed”</p> <p>B – we observed 4-6 individuals during last sampling in 2005. Individuals were not collected.</p> <p>D – There is almost no visitation to cave due to difficult access</p> <p>X – The property is owned by The Nature Conservancy</p> <p>E – 126000 ft of passage; 94 ft vertical profile</p> <p>G – mines in the broader landscape are disconnected from the local karst and are old abandoned iron mines.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

<p>Fitting</p>	
<p>Group discussion</p>	<p>B – more confidence this site will persist due to ownership by The Nature Conservancy. There are not many threats that appear to affect recharge area of the epikarst in immediate vicinity.</p> <p>D – the site is also extremely remote and isolated, which adds to confidence in persistence. It is difficult to get permission to access this cave, even for sampling. It is hard to think of any known threats occurring here.</p> <p>There was discussion of the likelihood that the property could change ownership in the future. X suggested that this has happened in the past and in other states, where ownership has transferred to the state or Forest Service, while Expert E suggested they had heard of no such plans for this property.</p> <p>Z asked expert F to provide their reasoning for the longer left tail of their distribution. F suggested their lower quartile may have been misjudged and provided reasoning for higher confidence in persistence similar to other experts.</p>
<p>Group plausible range</p>	<p>0.2 – 0.98</p>
<p>Group elicitation</p>	<p>Method: Linear pool of individual judgments.</p> <p>Judgements:</p> <p>Q1: 0.73</p> <p>Median: 0.81</p> <p>Q2: 0.88</p>

<p>Fitting and feedback</p>							
<p>Chosen distribution</p>	<p>Beta(6.24, 2)</p> <table border="1"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.58</td> </tr> <tr> <td>0.95</td> <td>0.94</td> </tr> </tbody> </table>	quantiles	values	0.05	0.58	0.95	0.94
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0.05	0.58						
0.95	0.94						
<p>Discussion</p>							

<p>Day 1 End time</p>	<p>12:00</p>
<p>Attachments</p>	<p>Evidence dossier Site narratives Judgments spreadsheet</p>

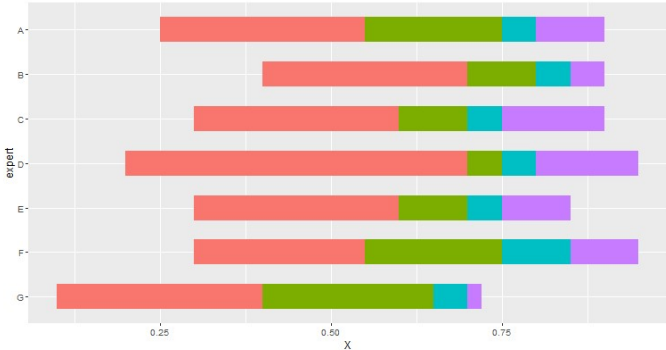
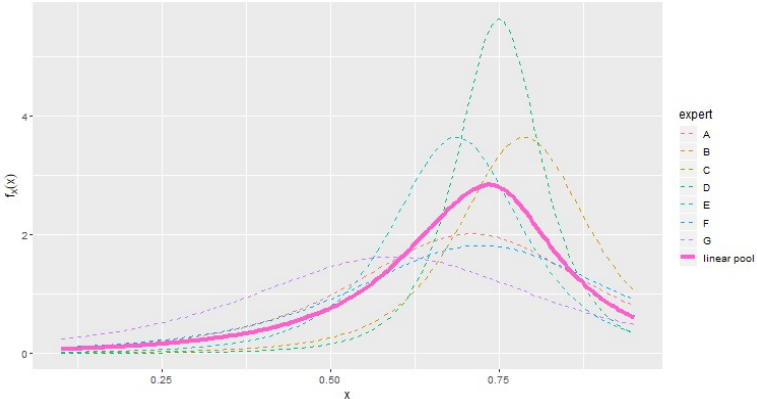
ELICITATION RECORD – Part 2

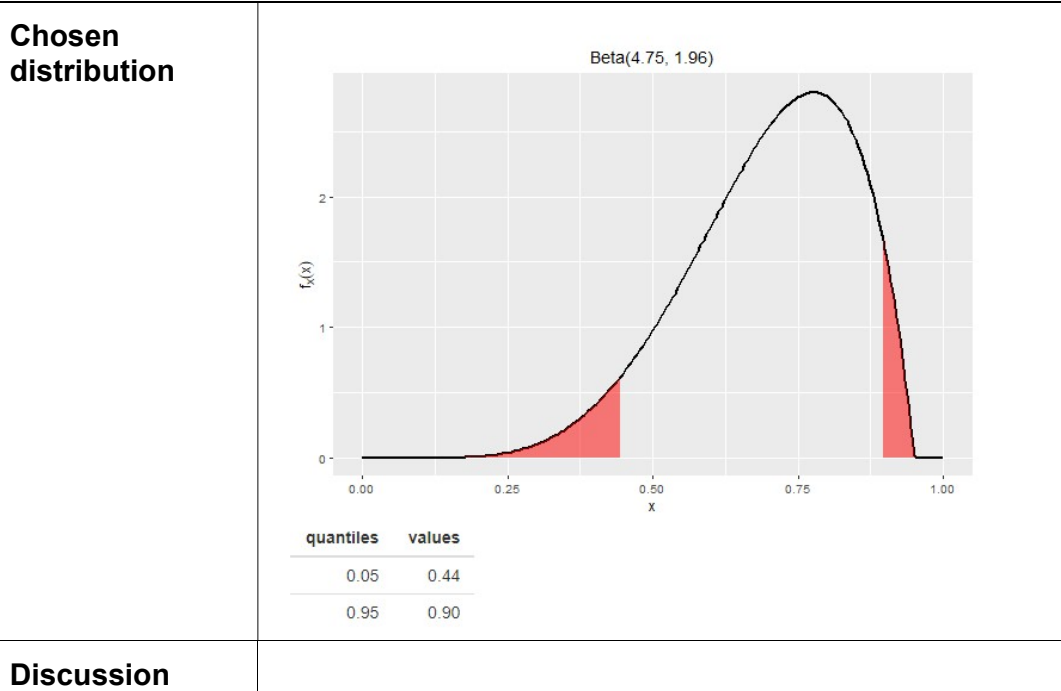
Eliciting a Continuous Distribution

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 2 - Stygobromus parvus and Stygobromus cooperi</i>
Date	18 June 2020
Quantity	Bonner Mountain and Bonner Pit Caves
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:07 EDT

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narratives.</p> <p>The experts considered the probability of persistence for both localities simultaneously due to the similar threats, overlapping upstream watersheds, and contiguous region of karst connecting localities.</p> <p>Z – WVDNR provided data that lists the element occurrence as “extant – viability not assessed.”</p> <p>E – 437 ft of cave passage in Bonner Mountain Cave. Cave information not available for Bonner Pit; Asked if this is Bonner Pit 1 or 2.</p> <p>A – believes it is Bonner Pit 1, but has not personally visited the cave.</p> <p>No experts on the panel have personally sampled these sites.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

<p>Fitting</p>	
<p>Group discussion</p>	<p>Z – asked the three experts who gave wider distributions to discuss their reasoning, particularly for the lower plausible limit.</p> <p>A – both caves are largely covered by agricultural land use, and there is risk of pesticide and herbicide application that could impact the population</p> <p>G – agreed with A</p> <p>B – was more optimistic about persistence because agricultural land use has been occurring in the region for a long time and these animals have persisted. Doesn't see much projected change over next 20 years.</p> <p>Z – asked if there were concerns over not knowing the year species were observed for Bonner Mountain Cave. Is there risk the species is already locally extirpated?</p> <p>G – the sampling is always sporadic so the lack of data isn't concerning. Assumes species is extant in the absence of disturbance. Tends to weigh the agricultural impacts heavier than others might because the agricultural land use of today is much different and more intensive than historical agriculture. <i>E.g.</i>, VA farmers are sometimes paid to apply animal waste as fertilizer. It is also easier to convert agricultural land into more developed land use through, <i>e.g.</i>, rural housing developments.</p>

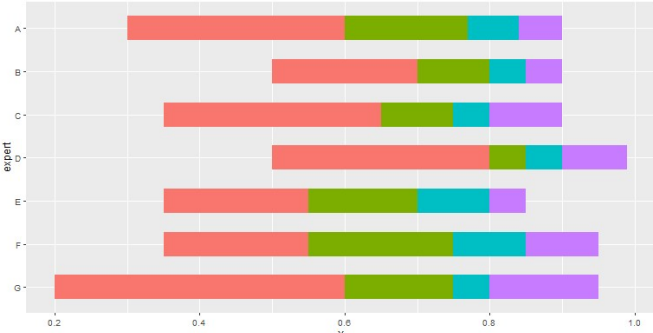
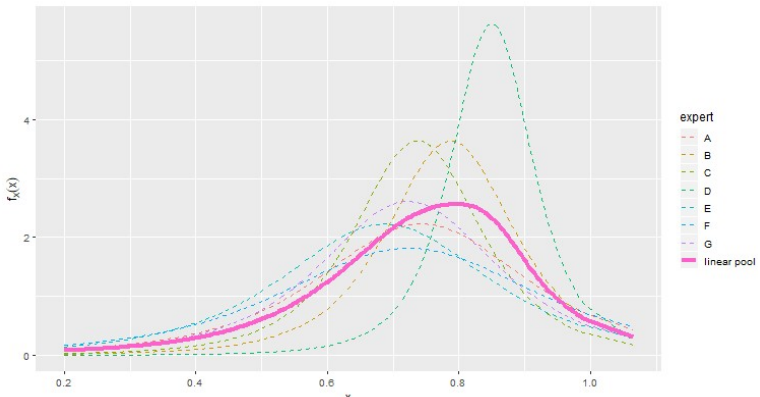
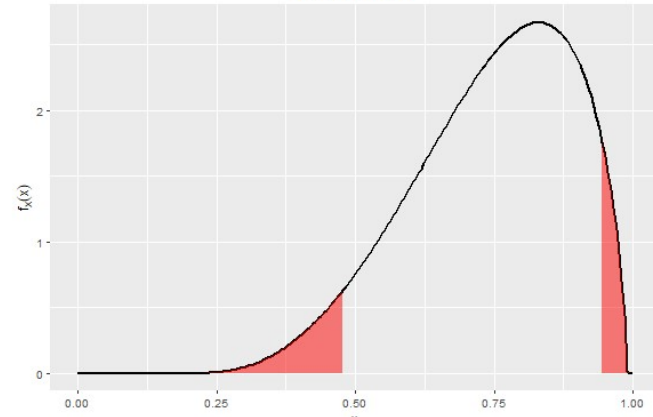
	<p>A – confirmed poultry farm effects on local watersheds</p> <p>Y – asked experts for other points of view supporting optimistic probabilities that haven't been expressed yet</p> <p>B – expressed that 4 generations is not much time, should be stable over that time frame.</p> <p>C – less confident due to presence of agriculture, but levels seem low and this disturbance is historical. Uncertain about chemical applications, but remains optimistic about persistence.</p>
<p>Group plausible range</p>	<p>0.1 – 0.95</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements:</p> <p>Q1: 0.61</p> <p>Median: 0.72</p> <p>Q2: 0.81</p> 
<p>Fitting and feedback</p>	



Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 2 - Stygobromus parvus and Stygobromus cooperi</i>
Date	18 June 2020
Quantity	Bonner Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:35

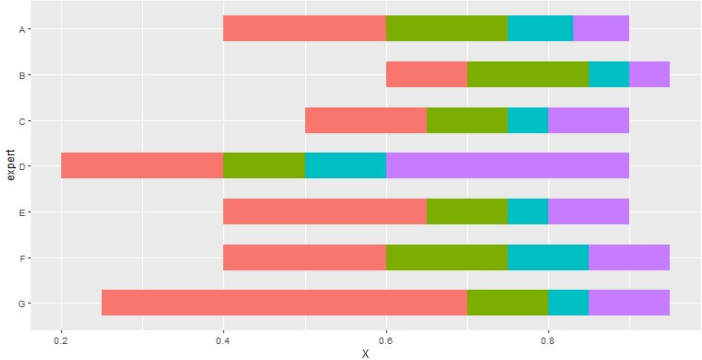
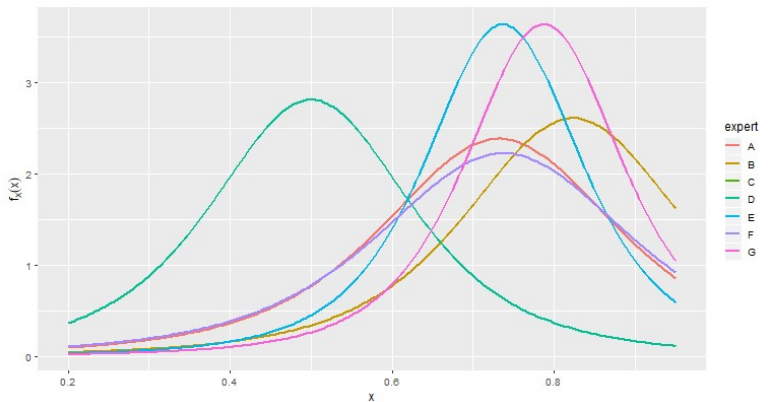
Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z – WVDNR ranks element occurrence as good, but cave not visited regularly.</p> <p>E – 2100 ft of cave passage, entrance through sink hole, passage up to Northeast, cave is not very maze-like</p> <p>G – asked for clarification on type of local mining</p> <p>Z – Mining to North is crushed stone quarry and past limestone and sand and gravel mines</p> <p>C – asked for clarity on impaired stream and direction of flow</p> <p>Z – stream in watershed listed as impaired for pH/acidity and impaired benthic macroinvertebrates. Streams to north, outside of watershed listed as impaired due to iron, aluminium, and dissolved oxygen. Reviewed flow direction on map.</p> <p>G – suggested impaired streams north of the ridge will likely not influence this site based on local geology.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

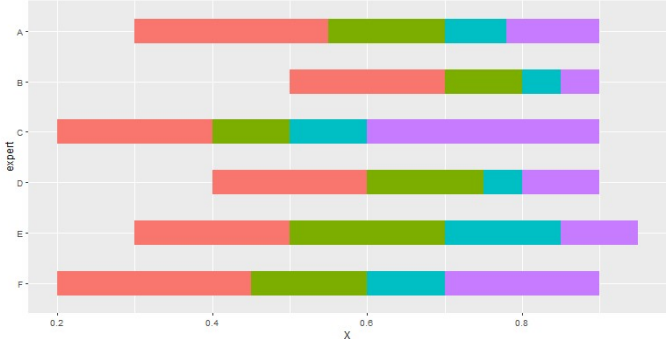
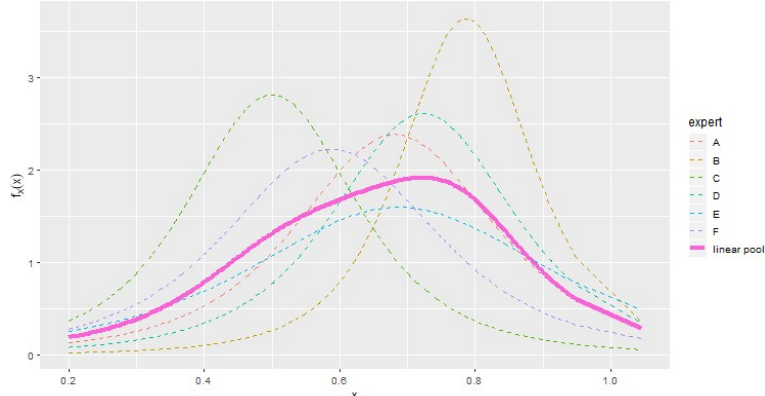
<p>Fitting</p>	
<p>Group discussion</p>	<p>Z – asked about the wide left tail and lower plausible limit in G’s judgments.</p> <p>G – the belt of karst in this area has a lot of agriculture. The probability of persistence is likely fairly high, but wanted to express less confidence in the probability given the uncertainty in the exact location of the meta-population around the sample point and proximity to the agriculture</p> <p>C – agrees, we need to consider that some karst development is taking place below the surface in the belt of agriculture and the meta-population may be extending into that area.</p> <p>Z – asked for the experts that provided a narrower range of probabilities to provide their reasoning.</p> <p>D – agreed with G’s reasoning and suggested they might have underestimated the uncertainty for this population.</p>
<p>Group plausible range</p>	<p>0.2 – 0.99</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record</p>

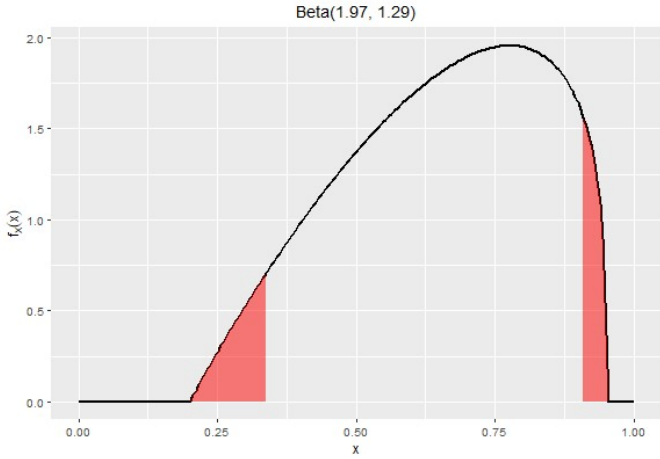
	<p>Q1: 0.65 Median: 0.76 Q2: 0.86</p> 						
<p>Fitting and feedback</p>							
<p>Chosen distribution</p>	<p>Beta(3.74, 1.69)</p>  <table border="1" data-bbox="560 1648 738 1743"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.48</td> </tr> <tr> <td>0.95</td> <td>0.94</td> </tr> </tbody> </table>	quantiles	values	0.05	0.48	0.95	0.94
quantiles	values						
0.05	0.48						
0.95	0.94						
<p>Discussion</p>							

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 2 - Stygobromus parvus and Stygobromus cooperi</i>
Date	18 June 2020
Quantity	Shreve-Howell Pit
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:57

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>E – 1,000 ft of passage, 150 ft deep, entrance on eastern slope of ridge is terraced/offset</p> <p>A – This cave requires a long rappel to access, personally involved in collection. At time of sampling, land was owned by Westvaco paper mill. Cave visitation is not the issue at this site; difficult access and entry.</p> <p>X – Most Westvaco land has been sold to timber harvest companies. Developed area to North is the town of Elkins, and agricultural band is roughly following highway 219 South.</p> <p>E – You can see harvesting in different lots in the closeup image of locality. Z confirmed that imagery is from 2019 USDA NAIP.</p> <p>B - asked A whether they had to enter the cave after the deep rappel to access ceiling drips to sample. Expert A confirmed that amphipods were collected in drip pools 100 m into cave, roughly 140 ft below the surface. There is a steep slope.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

	
<p>Fitting</p>	
<p>Group discussion</p>	<p>Z – asked expert D to provide their reasoning for lower interquartile range.</p> <p>D – gave median of 0.5 because area appears largely owned by logging interests, imagery shows evidence of clearcutting, and due to proximity to town of Elkins.</p> <p>G – agreed with D; would be likely to shift their individual median to a lower value due to logging in area. Appalachia was logged in the past, but considers recent practices a “scorched-earth” approach.</p> <p>B – Logging has been around in this area for a long time, and these animals have persisted here until at least 2001. Logging appears to be the only major threat in this locality. There is a relatively thick overburden (thickness of epikarst), which might provide some buffer for this population through a deep reservoir of epikarstic water.</p> <p>Z – It doesn’t seem that anyone is giving a high relative weight to the impacts of the impaired surface streams, but in our earlier conversations there was concern about the uncertainty of underground movement of water and pollutants through karst.</p> <p>D – these are not stream species, the water mostly comes from precipitation over the drainage area of a drip, the quality of forest is more important. It may be more helpful to think of them as forest species.</p>

	<p>E – the geology of the area will provide a buffer from some of the surface impacts on other side of the ridge.</p> <p>A – those stream impairments are classic coal mining issues, which occur in a different geology than karst. Thinks logging can impact the epikarst species more than we are suggesting with these distributions, there is large uncertainty in how logging can affect the species because cave is on steep slope and logging has caused landslides in other caves. Need to keep in mind that these species are not listed at a state level, so no protections are in place.</p>
<p>Group plausible range</p>	<p>0.2 – 0.95</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record</p> <p>Q1: 0.52</p> <p>Median: 0.67</p> <p>Q2: 0.8</p> 
<p>Fitting and feedback</p>	

<p>Chosen distribution</p>	 <table border="1" data-bbox="574 667 738 766"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.34</td> </tr> <tr> <td>0.95</td> <td>0.91</td> </tr> </tbody> </table>	quantiles	values	0.05	0.34	0.95	0.91
quantiles	values						
0.05	0.34						
0.95	0.91						
<p>Discussion</p>	<p><i>One expert (C in previous Qols) dropped off the video call after the personal judgment round due to connectivity issues, resulting in one less distribution in the group judgment round. This expert was given a chance to review the workshop notes and chosen distribution afterwards. They stated the chosen distribution looked reasonable, and had no additional discussion points to add.</i></p> <p><i>E – suggested that parcel size and more details about the landowners would be useful information to have in this kind of exercise.</i></p> <p><i>A - asked for clarification on how the decision makers will interpret these results.</i></p> <p><i>Z – we will encourage the decision makers to consider these results as predominately capturing the relative uncertainty in persistence among localities.</i></p>						

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 2 - Stygobromus parvus and Stygobromus cooperi</i>
Date	18 June 2020
Quantity	Siler's Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	14:38

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>B – in addition to information in evidence dossier, 1 individual was collected in 2006 as part of the 2007 book update and was confirmed by J. Holsinger.</p> <p>G – this property was recently purchased by a caver, and is being managed by the Mid-Atlantic Karst Conservancy. This will likely result in more visitation in the future. The cave entrance was recently uncovered after being bulldozed shut shortly after the last collection.</p> <p>E – the cave was reopened in 2019 after the landowner changed.</p> <p>Z – the cave entrance is currently gated with a metal, bat-friendly gate (open slats).</p> <p>G – This karst region is limited in extent; only about 10 mi by 1.5 mi of exposed karst and is isolated from other karst formations. The site is close to several urban areas (Hagerstown, Frederick, Martinsburg, Winchester, etc.).</p> <p>B – Emphasized this is a single location endemic in a restricted area of karst with encroachment by development.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

<p>Fitting</p>	
<p>Group discussion</p>	<p>B – The projected land use in the site narrative is not realistic for this area.</p> <p>Several experts described personal experience with increasing development in the region.</p> <p>Z – clarified that projected land use statistics show projections within the watershed draining to a 1km buffer around sampling point. These numbers do not include projected increased development around the urban areas mentioned. The projections for the immediate regions of agricultural-forest matrix do not indicate large changes, but urban areas are projected to increase.</p> <p>A – provided a lower plausible limit near zero due to large number of developed areas within a short drive, projected increase in usage due to recent change in property ownership, and because this is the only known occurrence. There is little chance for areas outside of this locality to contain this species.</p> <p>E and G confirmed.</p> <p>F (distribution E in above graph) – based upper plausible limit on experience from other caves where stressors have impacted a wide range of aquatic cave species, but they consistently find epikarst <i>Stygobromus</i>. They seem to be one of the last groups to persist. This site definitely has a</p>

	<p>lower probability of persistence relative to the other sites we've reviewed.</p> <p>B – there is a high risk of stochastic events due to restricted expanse of karst.</p> <p>E – there is only a single, limited pocket of karst in this region.</p> <p>Z – we want to be careful to focus on the probability of persistence for this meta-population, and not bring in other elements of species-level risk related to the number of populations. Think about how you would judge the probability for another species occurring in this location.</p> <p>G – Confirmed that it is the meta-population here that has a real limit. There is an increased risk due to the fact that the karst restricts the scope of where the meta-population could occur. Even if we think about other co-occurring species, this site has a much greater risk of extirpation.</p>																																			
<p>Group plausible range</p>	<p>0.05 – 0.9</p>																																			
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> <p>Q1: 0.35</p> <p>Median: 0.48</p> <p>Q2: 0.62</p> <table border="1"> <caption>Approximate Quartile Data from Chart</caption> <thead> <tr> <th>Expert</th> <th>Q1 (Red)</th> <th>Median (Green)</th> <th>Q2 (Cyan)</th> <th>Q3 (Purple)</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>0.15</td> <td>0.45</td> <td>0.55</td> <td>0.85</td> </tr> <tr> <td>B</td> <td>0.35</td> <td>0.55</td> <td>0.75</td> <td>0.90</td> </tr> <tr> <td>C</td> <td>0.15</td> <td>0.45</td> <td>0.60</td> <td>0.85</td> </tr> <tr> <td>D</td> <td>0.25</td> <td>0.45</td> <td>0.55</td> <td>0.75</td> </tr> <tr> <td>E</td> <td>0.20</td> <td>0.55</td> <td>0.75</td> <td>0.95</td> </tr> <tr> <td>F</td> <td>0.15</td> <td>0.45</td> <td>0.60</td> <td>0.85</td> </tr> </tbody> </table>	Expert	Q1 (Red)	Median (Green)	Q2 (Cyan)	Q3 (Purple)	A	0.15	0.45	0.55	0.85	B	0.35	0.55	0.75	0.90	C	0.15	0.45	0.60	0.85	D	0.25	0.45	0.55	0.75	E	0.20	0.55	0.75	0.95	F	0.15	0.45	0.60	0.85
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<p>Fitting and feedback</p>							
<p>Chosen distribution</p>	<p style="text-align: center;">Beta(2.41, 2.33)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.19</td> </tr> <tr> <td>0.95</td> <td>0.77</td> </tr> </tbody> </table>	quantiles	values	0.05	0.19	0.95	0.77
quantiles	values						
0.05	0.19						
0.95	0.77						
<p>Discussion</p>	<p><i>Y – Summarizing the resulting distribution, the expectation is for higher development than projections, population is highly susceptible to concentrated and stochastic threats, but there is large uncertainty in probability of persistence as evidenced by other areas where other epikarst <i>Stygobromus</i> spp. have persisted amidst high levels of threats.</i></p> <p><i>B – that captures it. The chances of collecting this species have always been lower. On each collection, we may only encounter 1 or 2 individuals, whereas for other species it may be around 10 or so. It seems likely cooperi exists at low densities. Any threats in this region of karst could have severe impacts.</i></p> <p><i>Z – What is the likelihood that cooperi occurs outside of this isolated band of karst?</i></p> <p><i>A – it is highly unlikely it occurs to the North in Maryland. We don't find it in any caves we sample.</i></p> <p><i>B – Cricket maze cave has been suggested as another</i></p>						

	<p><i>potential place to survey for cooperi.</i></p> <p><i>G – cricket maze cave is on the same outcrop of karst, so any individuals there could even be part of the same meta-population as Siler’s Cave. Caves in the WV panhandle area are few and far between; it would be worth sampling in other karst areas nearby without accessible caves, but the distribution of this species is undoubtedly very limited</i></p> <p><i>D – we don’t have enough molecular data to differentiate many species. It is more likely that with morrisoni, e.g., we are dealing with multiple species, rather than the chance that cooperi has a larger range than this single locality.</i></p> <p><i>One expert (C in previous Qols) who experienced connectivity issues was still unable to rejoin the call for this locality. This expert was given a chance to review the workshop notes and chosen distribution afterwards. They stated the chosen distribution looked reasonable, and had no additional discussion points to add.</i></p>
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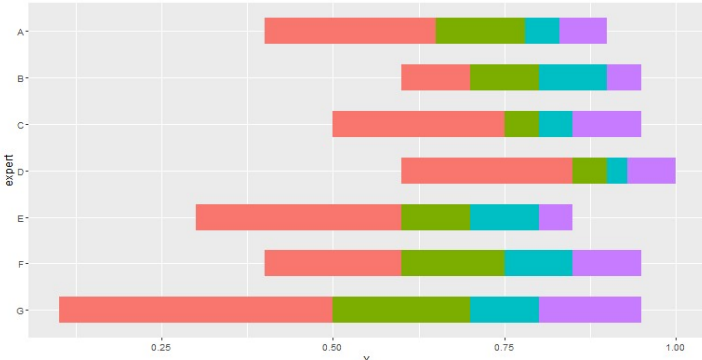
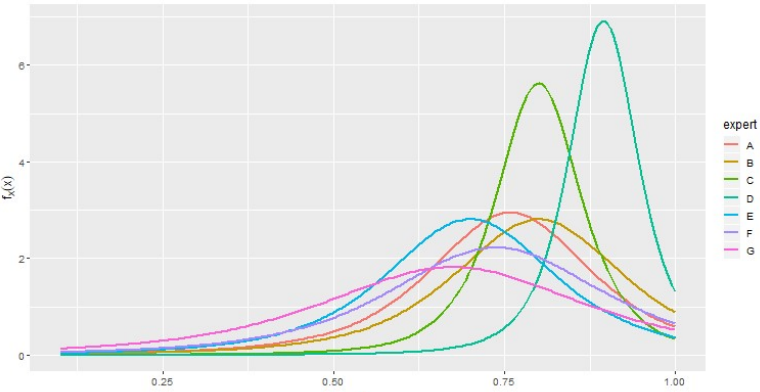
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Attachments	Evidence dossier Site narratives Judgments spreadsheet

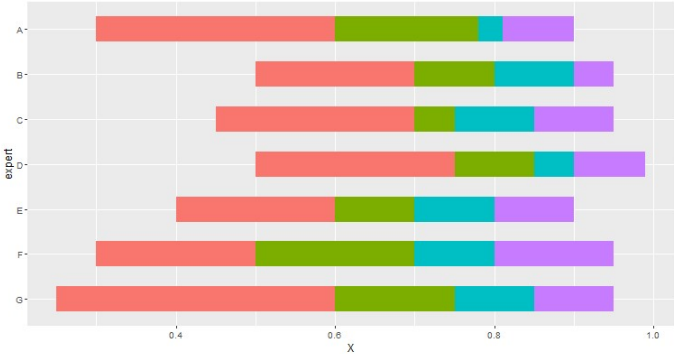
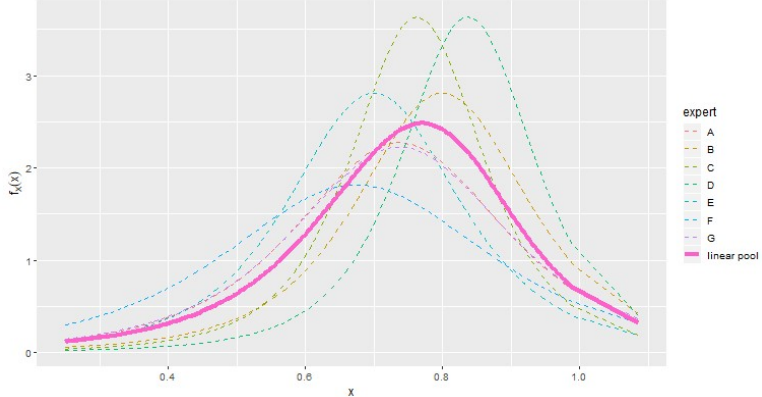
ELICITATION RECORD – Part 2

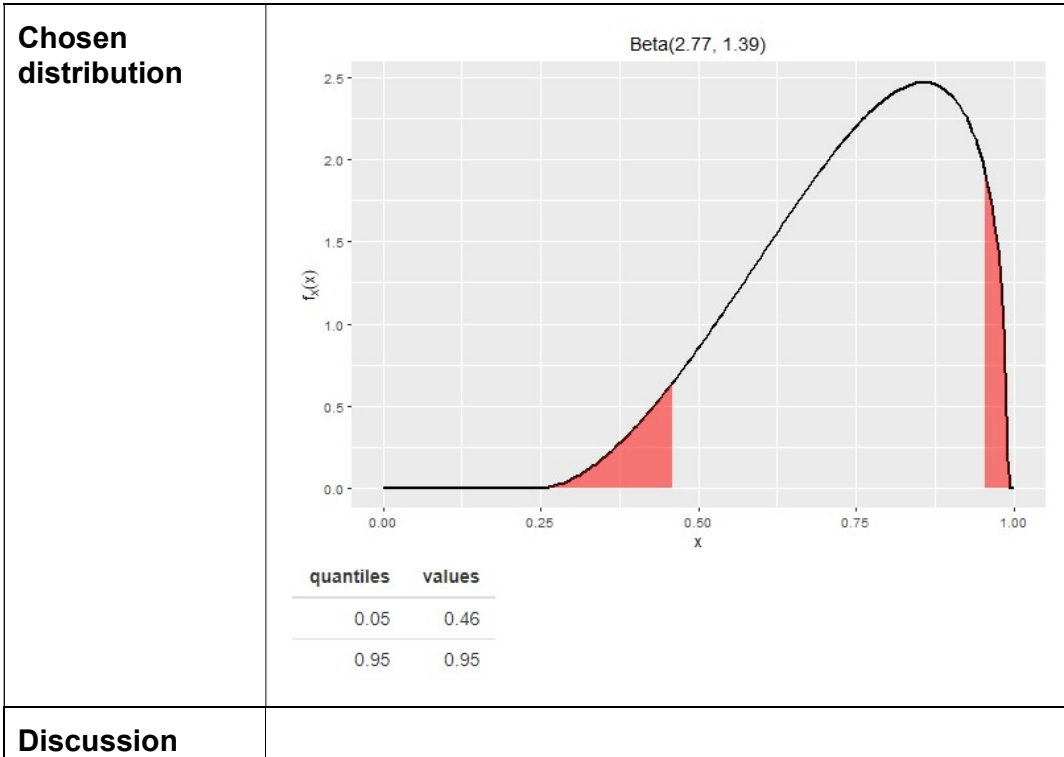
Eliciting a Continuous Distribution

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	Day 3 – <i>Stygobromus morrisoni</i>
Date	25 June 2020
Quantity	Witheros Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:08

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z introduced maps for <i>S. morrisoni</i> conservation areas provided by G. G clarified that areas are based on a Natural Heritage protocol initially developed as a screening tool for plant conservation but believed to be applicable to other taxa. G provided overview of karst features as they relate to <i>S. morrisoni</i> localities. There are three major belts of Siluro-Devonian karst that are well defined. G is uncertain why the species has crossed the belts. The western and central belts connect north of Kenny Simmons; the eastern belt, which includes Witheros Cave, is disconnected.</p> <p>Z – cave is closed SEP-MAY due to Indiana Bat habitat. Agriculture in upstream watershed is largely hay, corn, alfalfa.</p> <p>G - Collected 15-20 individuals for genetic work in 2014, could have collected more; species was abundant.</p> <p>B – asked if we are considering <i>morrisoni</i> as a vadose stream species (vadose ~ free flowing water above water table). Specifically, in Witheros, are most of the streams fed by drips?</p> <p>D - yes</p> <p>G – Not sure. There is no dye tracing available for this site; it was attempted but wasn't successful. There is certainly some epikarstic source water, and possibly input from sinking streams. The stream does not precipitate calcite. Individuals collected in pools and streams.</p>

	Thought property was under conservation easement (VA perennial outdoors agreement) but could not confirm.
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> 
Fitting	
Group discussion	<p>Z – asked for reasoning around G’s lower plausible limit.</p> <p>G – lower limit due to lack of conservation easement. The current owners are dedicated to conservation of the property, but ownership could change. Timber activity is present nearby, cave passages may occur below river grade. The meta-population could exist well beyond outcrop areas, but if it corresponds to outcrop persistence is less likely. The difficulty of estimating the full extent of meta-population contributed to wide limits and uncertainty.</p> <p>Z – asked D for reasoning for high interquartile range</p> <p>D – The area currently has a favourable landowner and is well protected. Most development in this area is million-dollar homes on large lots, and the relative footprint and impact of such low density development is not great.</p> <p>B – optimistic about this locality. The area is well-healed from historic logging and the species has persisted. G collected a large number of individuals in 2014.</p>

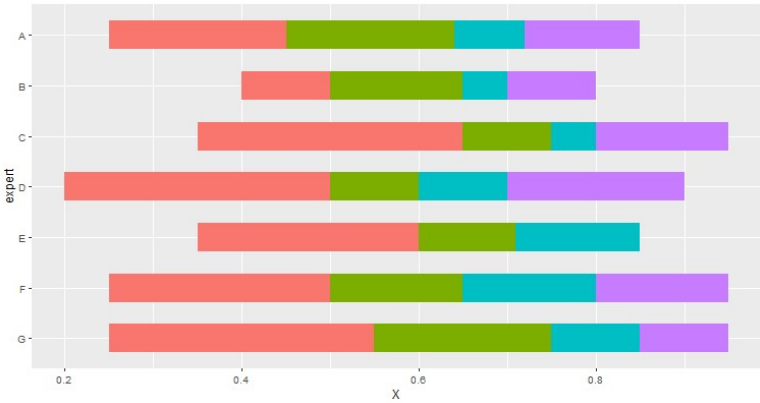
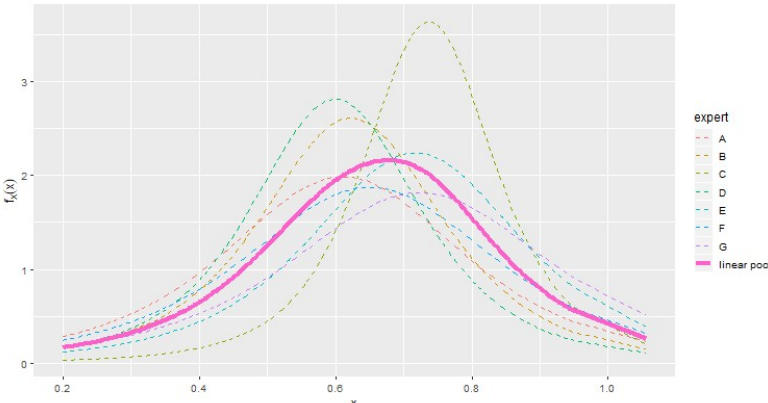
	<p>G – This cave is currently in great shape.</p> <p>C – agreed with G’s earlier reasoning for lower plausible limit and would bring down their personal lower limit. Their higher median reflects that there is probably more habitat that is not accessible and there seem to be low impacts based on discussion. Uncertainty largely due to where limits of meta-population lie.</p>
<p>Group plausible range</p>	<p>0.25 – 0.99</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record</p> <p>Q1: 0.64</p> <p>Median: 0.76</p> <p>Q3: 0.87</p> 
<p>Fitting and feedback</p>	

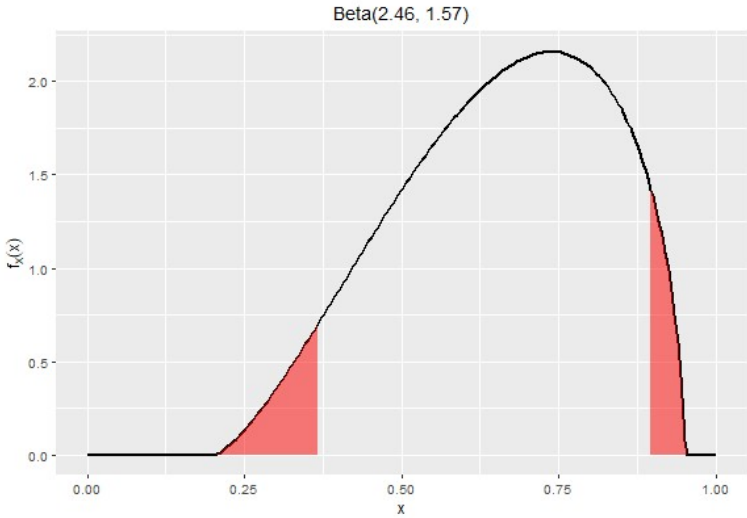


Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	Day 3 – <i>Stygobromus morrisoni</i>
Date	25 June 2020
Quantity	Corbett and Secret Anthodite Caves
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:36

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narratives. Experts agreed to provide judgments for these two localities simultaneously due to similarities in threat scenarios and proximity along a contiguous region of karst.</p> <p>Z – crops in watershed are, in order of percent composition: hay, corn, alfalfa, and soybean. Sites are in highland county, both are one private lands.</p> <p>G – There are plans to sample these localities soon to update the element occurrence in the NatureServe database, but currently has no information on numbers previously collected.</p> <p>C – asked about size of caves and if they are large enough to be frequented by cavers</p> <p>G – Secret Anthodite cave is likely not visited much due to location, access, and relatively small size; Corbett cave has a history of visitation by cavers. The meta-population may extend far in the area of karst between the two caves and to the east, but the area has not been well sampled.</p> <p>E – Have the other caves on the karst map been sampled?</p> <p>G - No</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

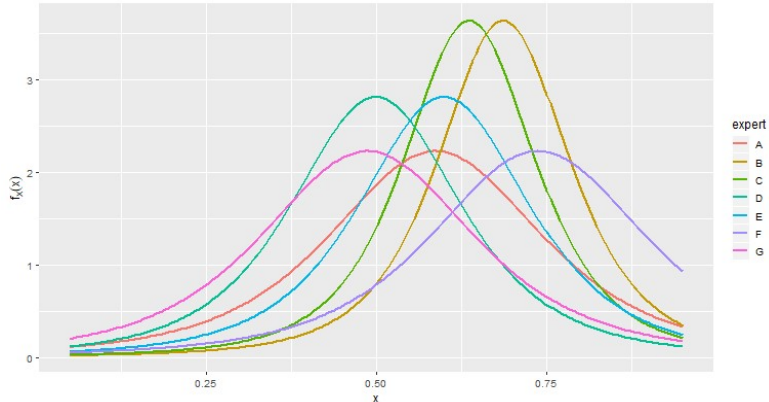
<p>Fitting</p>	
<p>Group discussion</p>	<p>Z – began discussion with experts who provided the lowest plausible limits.</p> <p>F – wider plausible limits are due to unknowns with this locality. Lack of information on year last observed or number of individuals collected and uncertainty in extent of meta-population lead to uncertainty in probability of persistence.</p> <p>A – Concerns about large scale animal farms and the spreading of manure in the agricultural areas of watershed. The stream impairment indicates this may be occurring.</p> <p>G – Doesn't think the surface stream feeds into these localities, but it is a surrogate for what might be going on across the landscape.</p> <p>Z – emphasized that all the variables we are considering are proxies or surrogates of the threats identified in the evidence dossier. We should view them as our best estimate at quantifying what stressors may be occurring.</p> <p>C – It was challenging to think about the likelihood of persistence for this locality due to uncertainty of where the habitat is, but is optimistic for this species.</p> <p>G – You could have a large impactful event in this specific area, but if the meta-population is contiguous throughout the unsampled karst, then any locally extirpated meta-</p>

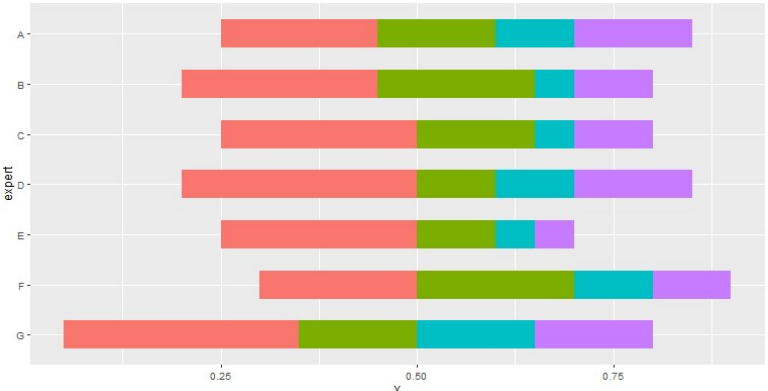
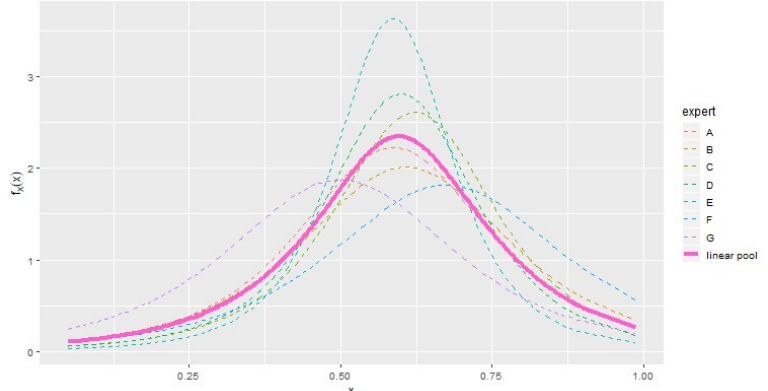
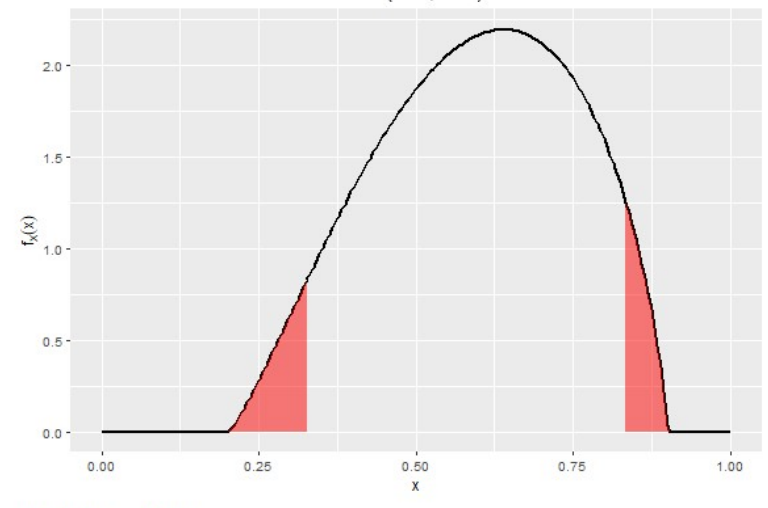
	population could be recolonized from nearby regions.
<p>Group plausible range</p>	<p>0.2 – 0.95</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> <p>Q1: 0.54</p> <p>Median: 0.67</p> <p>Q3: 0.79</p> 
<p>Fitting and feedback</p>	

<p>Chosen distribution</p>	 <table border="1" data-bbox="581 735 779 850"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.37</td> </tr> <tr> <td>0.95</td> <td>0.90</td> </tr> </tbody> </table>	quantiles	values	0.05	0.37	0.95	0.90
quantiles	values						
0.05	0.37						
0.95	0.90						
<p>Discussion</p>	<p><i>Several experts found this locality particularly challenging to judge due to the paucity of information available from previous sampling and uncertainty in the current conditions and extent of meta-population</i></p>						

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	Day 3 – <i>Stygobromus morrisoni</i>
Date	25 June 2020
Quantity	Dyers Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:52

Definition	Probability that the meta-population surrounding each locality will persist over four generations.																																								
Evidence	<p>See evidence dossier and site narrative.</p> <p>There have been suggestions in the literature, and during the workshop, that this locality may represent a genetically distinct species or subspecies. Experts were instructed to evaluate this population based on current taxonomy.</p> <p>E - 3668 ft of cave passage; 169 ft vertical profile. The current landowner is active with tri-state grotto association/society, but owner is elderly and there is a high chance ownership could change in the near future.</p> <p>G – This site is close to corridor H (part of Appalachian Development Highway System; aka US Route 48). The cave is down below the road, the drainage follows along the road and any road runoff would run directly into the cave.</p>																																								
Plausible range	See judgments spreadsheet for complete record.																																								
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> <table border="1"> <caption>Approximate Quartile Judgments from Chart</caption> <thead> <tr> <th>Expert</th> <th>Q1 (Red)</th> <th>Q2 (Green)</th> <th>Q3 (Cyan)</th> <th>Q4 (Purple)</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>0.25</td> <td>0.45</td> <td>0.65</td> <td>0.85</td> </tr> <tr> <td>B</td> <td>0.30</td> <td>0.55</td> <td>0.75</td> <td>0.90</td> </tr> <tr> <td>C</td> <td>0.30</td> <td>0.55</td> <td>0.75</td> <td>0.90</td> </tr> <tr> <td>D</td> <td>0.15</td> <td>0.40</td> <td>0.60</td> <td>0.85</td> </tr> <tr> <td>E</td> <td>0.20</td> <td>0.50</td> <td>0.70</td> <td>0.85</td> </tr> <tr> <td>F</td> <td>0.30</td> <td>0.60</td> <td>0.80</td> <td>0.95</td> </tr> <tr> <td>G</td> <td>0.15</td> <td>0.40</td> <td>0.60</td> <td>0.85</td> </tr> </tbody> </table>	Expert	Q1 (Red)	Q2 (Green)	Q3 (Cyan)	Q4 (Purple)	A	0.25	0.45	0.65	0.85	B	0.30	0.55	0.75	0.90	C	0.30	0.55	0.75	0.90	D	0.15	0.40	0.60	0.85	E	0.20	0.50	0.70	0.85	F	0.30	0.60	0.80	0.95	G	0.15	0.40	0.60	0.85
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<p>Fitting</p>	
<p>Group discussion</p>	<p>Z – began by asking expert F for reasoning behind upper plausible limit.</p> <p>F – upper limit was based on the fact that it's been observed relatively recently (2006). In other words, expressing a higher confidence in future persistence due to higher confidence that the population is currently extant. Acknowledged uncertainty due to land ownership.</p> <p>Z – asked for experts providing the lowest plausible ranges for their reasoning.</p> <p>D – Because the cave is close to corridor H, the possibility of future development is great. The cave access is easy; although, this is not a big caving. This is one population that wouldn't surprise me if the condition decreased or became extirpated.</p> <p>B – Corridor H has been built in the area for around 10 years. There will likely be greater pressure for development in future, but doesn't think this will happen in the near term.</p> <p>G– Lower plausible limit is based on proximity to Corridor H. It only takes one good spill along the road and it all goes into the cave (<i>i.e.</i>, risk of catastrophic event). This becomes particularly important if this locality turns out to be a single site endemic species.</p> <p>Z – summarizing, there is a high possibility for stochastic events (particularly related to road traffic) to have a large impact on this meta-population.</p>
<p>Group plausible range</p>	<p>0.2 – 0.9</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record</p> <p>Q1: 0.48</p>

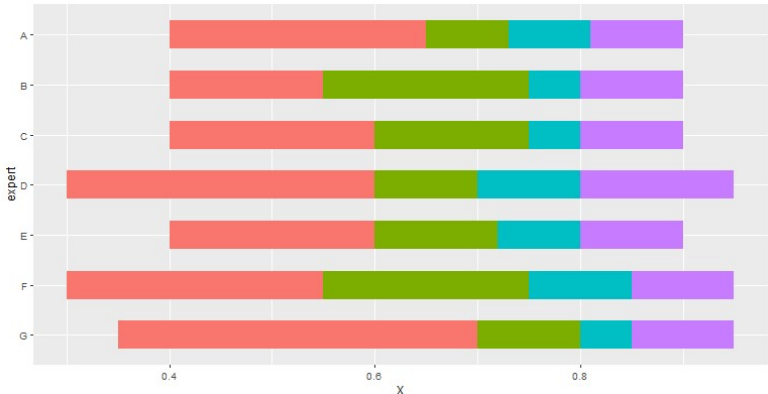
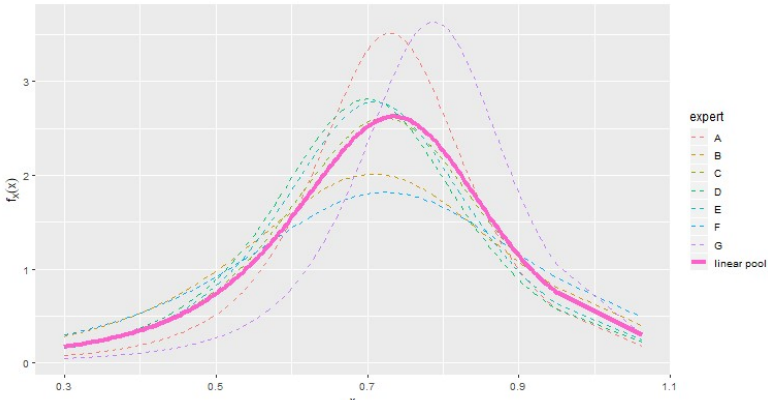
	<p>Median: 0.6 Q3: 0.72</p> 						
<p>Fitting and feedback</p>							
<p>Chosen distribution</p>	<p>Beta(2.25, 1.74)</p>  <table border="1" data-bbox="560 1680 771 1785"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.33</td> </tr> <tr> <td>0.95</td> <td>0.83</td> </tr> </tbody> </table>	quantiles	values	0.05	0.33	0.95	0.83
quantiles	values						
0.05	0.33						
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<p>Discussion</p>	<p><i>Z – If this population were genetically distinct, would that affect your probabilities? Does this population occur in a</i></p>						

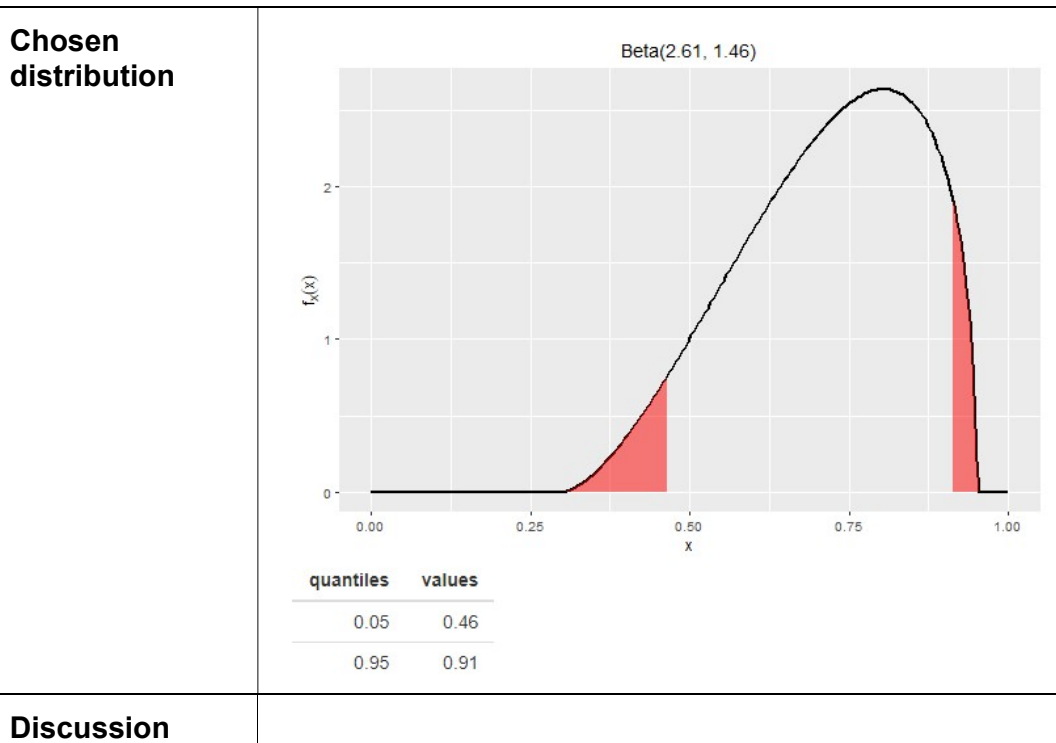
	<p><i>different habitat than other populations?</i></p> <p><i>D – No, it wouldn't change the threats, and this species would still be primarily a stream species.</i></p> <p><i>G – Wanted to point out there are two poultry operations in the area that hadn't been mentioned (can be seen on Google Earth imagery).</i></p>
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Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 3 – Stygobromus morrisoni</i>
Date	25 June 2020
Quantity	Mountain Grove and Starr Chapel Saltpetre Caves
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	14:10

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z – both caves are within George Washington and Jefferson National Forest. Caves have been gated since the mid-1990s for Indiana Bat protection and are closed during winter months. Species is on GWJNF sensitive species list. They do not manage specifically for this species, but believe bat management may also benefit.</p> <p>G – Mountain Grove individuals were described as near <i>morrisoni</i>. Chris Hobson collected, but he was reluctant to call it <i>S. morrisoni</i>. This may be another example of genetic differentiation; there were several morphological differences from <i>S. morrisoni</i>. Emphasizes need for additional genetic work.</p> <p>C – Is it safe to assume the saltpetre cave was mined historically?</p> <p>Wil – Yes, both caves were mined.</p>
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>

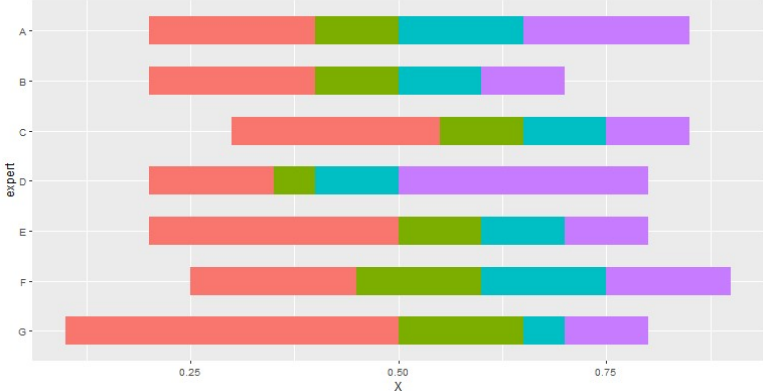
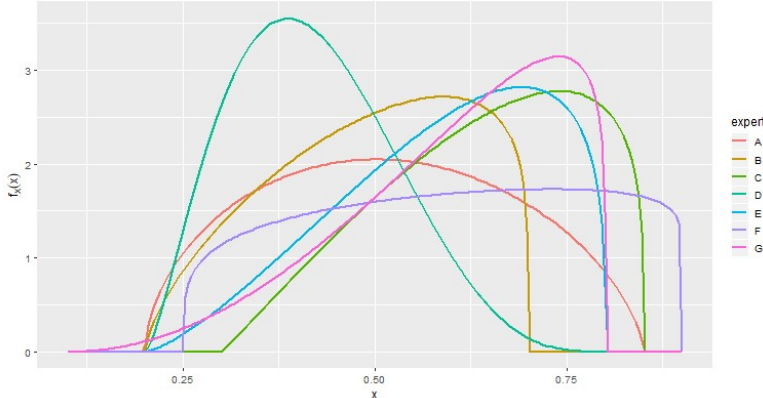
<p>Fitting</p>	
<p>Group discussion</p>	<p>G – high interquartile range reflects forest service owned land and Indiana bat protection measures. There is a low likelihood of timber harvest, you can't access the caves without keys to the gates, and the metapopulation likely extends north and south of the sampling points. Thinks this site has one of the highest chances of persistence.</p> <p>F – lower tail is again due to limited information available from past collections and the uncertainty in the current conditions.</p> <p>B – Included a longer lower tail to capture unknowns about the populations. They were discouraged by the high number of historic and current mines around the localities and the impaired streams.</p> <p>A – Mining was occurring in the past, but the species persisted until at least 2000 in the Mountain Grove Cave. They have seen some other caves in the region where densities of stygobionts are high even though mining has occurred. Finds it hard to explain, would have expected greater impacts. Noted the potential for impact due to nearby animal feeding operations.</p> <p>E – There should be less risk of animal agriculture impacts because sites are on NF lands.</p>

<p>Group plausible range</p>	<p>0.3 – 0.95</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record</p> <p>Q1: 0.62</p> <p>Median: 0.73</p> <p>Q3: 0.83</p> 
<p>Fitting and feedback</p>	

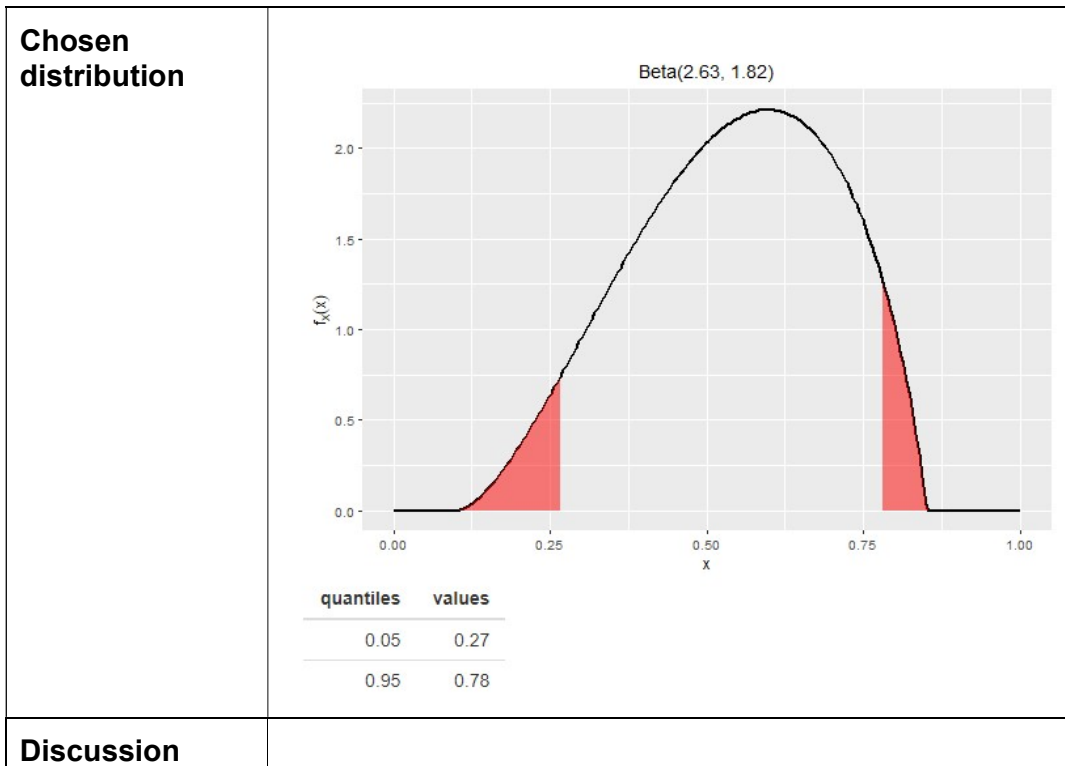


Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	Day 3 – <i>Stygobromus morrisoni</i>
Date	25 June 2020
Quantity	Clarks Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	14:30

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z – raised possibility of combining Clarks and Crossroads Caves due to similarity in threats and proximity.</p> <p>G - Sites are on opposite sides of the Cowpasture River, but not sure if they are connected because some cave passages may go under the river when the river is on the shale above. If river is a barrier, the metapopulation would be smaller. Thinks caves should be considered separately.</p> <p>B – asked for clarification on cave conservation sites presented.</p> <p>G – These are regions that could have an impact on a rare animal, compiled as part of NatureServe process. They do not provide any legal protections; they are used as tools to recommend conservation measure during project reviews.</p> <p>Z – clarified that we should think of these as areas of influence relative to the caves. We are not aware of any conservation activities occurring within these boundaries.</p> <p>The group decided that judgments should be provided separately due to differences in cave ownership and elevations of the cave entrances. Clarks cave is at river level and there is different cave ownership. Crossroads cave has a conservation easement and is owned by Virginia Speleological Survey. The river plays a bigger role in judgments for Clarks Cave.</p> <p>G – In Clarks Cave you enter at bottom of cave. This is also an Indiana bat cave. Fairly heavy visitation in summer. Clarks cave is subject to flooding by the stream.</p> <p>Z – mines in upper watershed are mostly Barium-Barite Mines, 1 Calcium mine, and past iron mine.</p>

<p>Plausible range</p>	<p>See judgments spreadsheet for complete record.</p>
<p>Individual elicitation</p>	<p>Method: Quartile Judgements: See judgments spreadsheet for complete record.</p> 
<p>Fitting</p>	
<p>Group discussion</p>	<p>Z – asked D to provide reasoning for lower median value D – The fact that the cave floods creates a significant risk; however, the Cowpasture River is relatively protected. B – took flooding into account, but Cowpasture River has flooded into the cave in the past and species has persisted. The historical pollutants might have been different. These factors led them to provide a distribution with a median of 0.5 to reflect the uncertainty. A – the median of 0.5 was balancing heavy visitation, no collection data available, cave is at river level, and no history of status to judge whether currently extant. E – flooding is not new so this might have limited impacts, but if the frequency and contents (i.e., pollutants) change it could be much more of a concern. B – if not an active stream, discounted the surface stream impairments in the upper watershed, low risk</p>
<p>Group plausible</p>	<p>0.1 – 0.85</p>

<p>range</p>	
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record</p> <p>Q1: 0.43</p> <p>Median: 0.55</p> <p>Q3: 0.67</p>
<p>Fitting and feedback</p>	



<p>Day 3 End time</p>	<p>15:00</p>
<p>Attachments</p>	<p>Evidence dossier Site narratives Judgments spreadsheet</p>

ELICITATION RECORD – Part 2

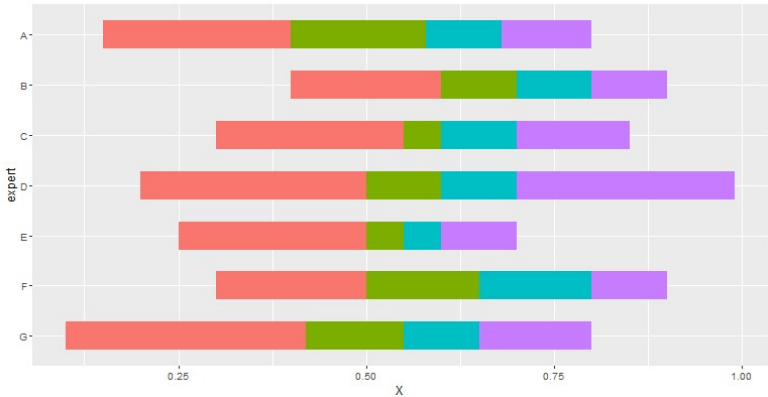
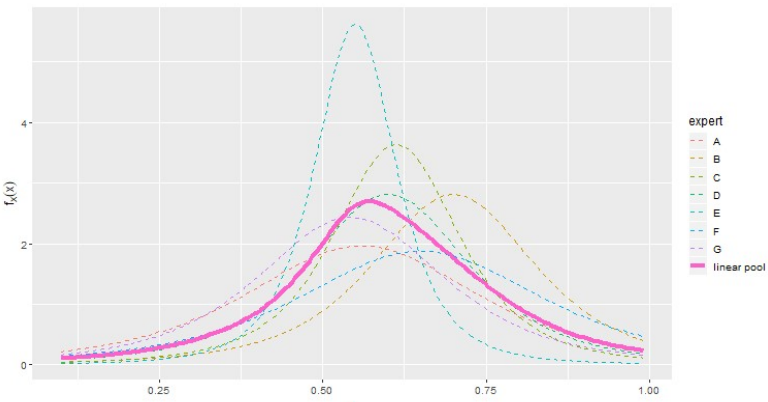
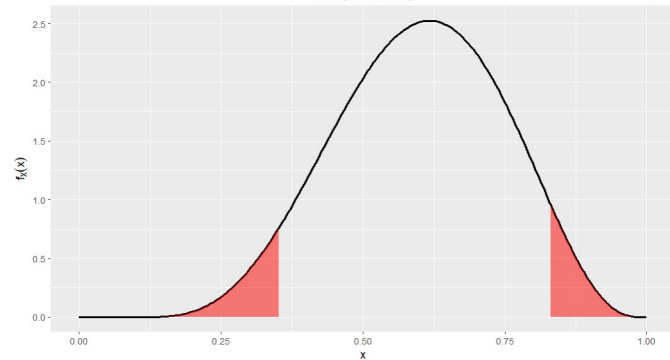
Eliciting a Continuous Distribution

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 4 – Stygobromus morrisoni</i>
Date	2 July 2020
Quantity	Crossroads Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:00

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narrative.</p> <p>Z – Mines in the watershed are mostly past Barium-barite, manganese, cobalt, and iron mines. The agriculture in the watershed is predominantly hay, corn, alfalfa, and soybeans. The cave entrance is on land owned by the Virginia Speleological Society (VSS).</p> <p>G – land ownership was transferred to the VSS around 5 or 6 years ago. The property is managed, but open for caving. There is animal agriculture in the vicinity.</p> <p>B – Do we know the source of water in the cave?</p> <p>G – We have tried dye tracing, but the results were inconclusive. The emergence of the stream is at a spring in the northeast part of the cave. The stream is likely dominated by epikarstic source water from area northwest of the cave, but we haven't been able to trace that to confirm.</p> <p>B – In that case the mining in the northern, upper part of the watershed is not relevant, not likely to impact cave stream.</p> <p>A – Is this a big cave, what is the flow rate of the stream emergence?</p> <p>G – The emergence is around 0.5 – 1 cfs, so fairly big. The flow varies greatly based on precipitation over the previous couple weeks. The overburden, land use over top of cave, is almost entirely cleared pasture. Most of the cave lies to the Northeast of grey dot in the closeup imagery on site narrative. The road is right over top of the</p>

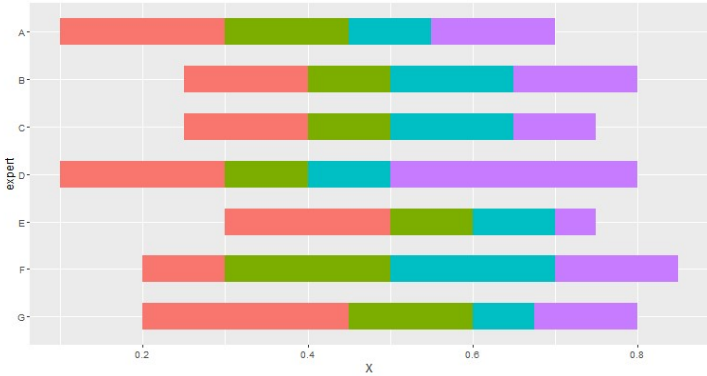
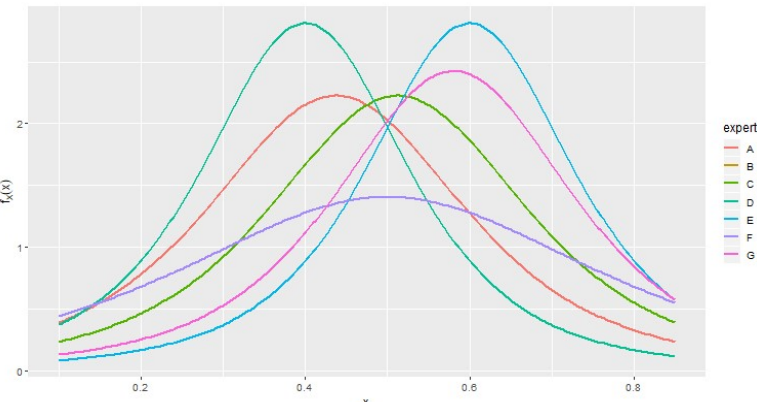
	cave.
Plausible range	See judgments spreadsheet for complete record.
Individual elicitation	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p>
Fitting	
Group discussion	<p>Z – asked G to start with reasoning behind lower plausible limit.</p> <p>G – Lower limit reflects the fact that the conservation easement on the property is not relevant because most of the cave passage (~ 80%) is under the neighboring properties. The cave is near the road, and if a poultry house was developed (there are many nearby) or there was any change in land use you could foresee negative impacts to the species.</p> <p>Z – It was mentioned earlier that the property is owned by VSS, and that this would come with both awareness of protecting the cave, but also potential increase in visitation. How did this play into other’s judgments?</p> <p>D – Gave a higher probability of persistence because of VSS ownership, but thought most of the cave was under the VSS property. They would likely extend their lower limit in a second judgment round based on points raised by G.</p>

	<p>Z – Asked for clarity on the certainty of cave location.</p> <p>G – About 80% of the passage is under the neighboring owner, based on a recent cave map. The cave is well mapped.</p> <p>B – Also gave a higher probability for persistence than they might otherwise have because of land ownership. The cave is a maze; they remember it taking a long time to get back out of the cave, so they expect visitation might not be that high, maybe experienced cavers only.</p> <p>Z – At the end of our last session, someone mentioned that VSS ownership might mean opening up the cave to visitation</p> <p>G – Remembers discussions when VSS was purchasing the property (board of directors) that the owners are attempting to conserve the cave for people’s access as opposed to species conservation. Visitation includes all types of cavers, such as Boy Scout groups, etc.</p> <p>A – Lower plausible limit reflected that most of the land is agriculture, and the large emergence stream suggests the cave has a larger catchment area. That means more potential for agricultural pollution and similar, but that also means there could be a chance the meta-population persists in some parts of the catchment. This was reasoning for probabilities reflecting both chance of persisting and extirpation.</p> <p>B – Asked about land use history in the area.</p> <p>G – Has been going to this cave since childhood, and the immediate area has not seen much land use change over past three decades. The most likely negative scenario is a poultry house being developed.</p> <p>B – asked about health of poultry houses due to COVID, or potential expansion in the future.</p> <p>X – Unsure, hasn’t heard of shutdowns of poultry houses or slaughterhouses in WV, not sure of potential for future expansion.</p> <p>G – experts poultry houses will continue to expand in the area.</p> <p>C – Fixated on road being directly over the cave, but considers that risk as being more of a point source, which may not affect entire karst area containing the meta-population.</p>
Group plausible range	0.1 – 0.99
Group	Method: Quartile

<p>elicitation</p>	<p>Judgements: See judgments spreadsheet for complete record</p> <p>Q1: 0.5</p> <p>Median: 0.6</p> <p>Q3: 0.71</p> 						
<p>Fitting and feedback</p>							
<p>Chosen distribution</p>	<p>Beta(4.62, 3.61)</p>  <table border="1" data-bbox="560 1711 714 1806"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.35</td> </tr> <tr> <td>0.95</td> <td>0.83</td> </tr> </tbody> </table>	quantiles	values	0.05	0.35	0.95	0.83
quantiles	values						
0.05	0.35						
0.95	0.83						
<p>Discussion</p>							

Elicitation title	<i>Stygobromus</i> Species Status Assessment
Workshop	<i>Day 4 – Stygobromus morrisoni</i>
Date	2 July 2020
Quantity	Kenny Simmons Cave
Anonymity	In this record, experts are identified by letters A through G, and the facilitators by letters X, Y and Z
Start time	13:30

Definition	Probability that the meta-population surrounding each locality will persist over four generations.
Evidence	<p>See evidence dossier and site narratives.</p> <p>Z – last visited by WVDNR in 1999, the cave has been closed due to whitenose syndrome being present in other Pendelton County caves, no recent observations.</p> <p>E – 1500 ft of passage, 40 ft deep, one very large room with 3 entrances to the surface.</p> <p>B – Any description of what's in there? Is there water at the bottom?</p> <p>E – Based on a very old map, there is a level floor, flat rock slabs covered in clay, and a cross section with one large lake, doesn't see any flowing streams listed.</p> <p>D – Suspects the cave has been closed for quite a while. This cave was not visited for the recent WV cave invertebrate book revision. This is the type locality; they would have visited it if able.</p> <p>E – Listing in database states as of 2010 cave closed by landowner. Cave has been in the Simmons family since the 1700s.</p> <p>B – The large barns in closeup aerial imagery clearly look like poultry houses, but we don't know where the cave entrance is.</p> <p>A – noted the similarities to poultry barns (e.g., large fans) and that the manure would likely be spread on nearby hills, so impact not limited to barn footprint.</p> <p>E – Cave entrance is under a rounded knoll and cave goes off to northeast. The road heading SW-NE in image is likely HWY 220.</p>
Plausible range	See judgments spreadsheet for complete record.

<p>Individual elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> 
<p>Fitting</p>	
<p>Group discussion</p>	<p>E – There is always uncertainty in how someone will manage their property, but with long-term ownership they expect it to be roughly similar to management in the past.</p> <p>Z – So, that idea uses the logic that the surrounding threats appear to have been present in the past and the species persisted. Did the fact that the last known collection was in 1966 weigh on anyone’s judgments?</p> <p>B – The 1966 collection weighed on judgments. No one has been to this cave in quite some time; there is a strong possibility it is already extirpated.</p> <p>D – The high intensity poultry agriculture and the fact that it has not been seen for 50 years was basis behind lower plausible limit. The current landowner is in the same family, but it’s different person and there is no guarantee how they will manage the land.</p> <p>E – No one has gone into the cave to look for the species, so the fact there are no records could simply reflect sampling.</p>

	<p>B – The chicken houses have definitely come into the area since the 1966 observation. The habitat sounds like a phreatic lake (below water table), so not much flow to remove potential pollution from fertilizer. Thinks this site is pretty threatened.</p> <p>B – Agrees, thinks this site has the most risk of any site we've consider.</p> <p>G – it is difficult to define some unknown meta-population to be able to judge. Didn't rank the site as low as they might have because there are other caves in the karst belt; the meta-population is likely larger and more extensive than just the individuals at crossroads.</p> <p>F – wide inter-quartile range was due to the same uncertainty and points already raised.</p>
<p>Group plausible range</p>	<p>0.1 – 0.8</p>
<p>Group elicitation</p>	<p>Method: Quartile</p> <p>Judgements: See judgments spreadsheet for complete record.</p> <p>Q1: 0.35</p> <p>Median: 0.47</p> <p>Q3: 0.59</p>

<p>Fitting and feedback</p>							
<p>Chosen distribution</p>	<table border="1" data-bbox="565 1010 706 1087"> <thead> <tr> <th>quantiles</th> <th>values</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.21</td> </tr> <tr> <td>0.95</td> <td>0.71</td> </tr> </tbody> </table>	quantiles	values	0.05	0.21	0.95	0.71
quantiles	values						
0.05	0.21						
0.95	0.71						
<p>Discussion</p>	<p><i>Z – summarizing, the resulting distribution for this locality reflects large uncertainty due to the fact that the species has not been observed since 1966 and the dominant threat is agriculture, which has been occurring on the landscape for some time, but perhaps not in the form of large-scale poultry houses.</i></p> <p><i>G - Uncertainty has to do with the species; the site is clearly degraded, but we don't know how resilient this species is.</i></p> <p><i>D – Thinks the uncertainty is coming from the specifics of this site.</i></p> <p><i>E – Agreed, we don't have negative data, so we don't know the current status, we also don't know parcel size information, which adds to the uncertainty.</i></p> <p><i>Z – Asked for any final thoughts on the elicitation process or experience.</i></p> <p><i>C – Found the process highly useful, and thinks the results produced will help inform the listing decision. Group discussions made them think of issues they would not have otherwise, which gives greater confidence in the results. Thinks they represent the best information we</i></p>						

	<p><i>could provide decision makers given the data limitations for these species.</i></p> <p><i>G – Tends to disagree and is uncomfortable with the results. We know more about the geology. We are missing lots of information on the species: incomplete distribution data, sampling data, genetic information. We need more information to make more informed decisions and feels we are doing a disservice to the species if the listing recommendation is made based on these workshops.</i></p> <p><i>Z – Clarified that we only turn to expert elicitation in the absence of empirical data, as a last resort, but that through this exercise we've helped characterize the uncertainty involved in the decision. Additional genetic work would clearly help delineate populations and identify potential cryptic species, but would additional sampling improve our understanding of species' resilience or identify the true extent of each population within the epikarst?</i></p> <p><i>D – There are standardized approaches to sampling drips that could help estimate population size, but the data are expensive to analyse due to large volumes of water to sort through for small inverts. This could work for the epikarst species, but Morrisoni is more difficult because we don't really know its habitat.</i></p> <p><i>Y – Clarified that the choice isn't between making the listing decision now or waiting until more sampling data is available. Due to statutory requirements and legal ramifications if a decision is delayed, the choice is between making the decision now with or without your expert input.</i></p>
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Day 4 End time	14:14
Attachments	Evidence dossier Site narratives Judgments spreadsheet