1 August 2019
David Mattson, PhD

Assessment of Kasworm et al. (2018) as Applied in the *Draft Supplemental Environmental Impact Statement Montanore Evaluation Project*

What follows is my assessment of methods and results in Kasworm et al. (2018) as applied by the US Forest Service and US Fish & Wildlife Service to the draft supplemental EIS for Phase I of the Montanore Mine project. My assessment is organized by broad issues, and then by subtopics within.

I begin, though, by framing my critique in terms of what seems to be the central argument of the supplemental EIS, at least insofar as effects on grizzly bears are concerned: (1) Status of the Cabinet-Yaak grizzly bear population has improved; (2) likely because of efforts by a conflict management specialist; (3) therefore an additional specialist coupled with more resources for law enforcement will offset any negative effects attributable to initial and follow-on phases of the Montanore Mine.

My purview here is limited to points [1] and [2], although [3] is especially problematic because it requires cogently contrasting any evidence for the past efficacies of a conflict management specialist with the probable direct and indirect impacts of the Mine, whether attributable to the onsite effects of Mine personnel or the more diffuse effects of a larger regional population and related changes in culture and behaviors.

> Very briefly, the USFS's first claim is unsubstantiated given that the methods used by Kasworm et al (2018) to estimate vital rates, population trend, and changes in annual average mortality are all compromised to some extent by bias, irrelevance, incomplete coverage, misrepresentation, and/or substantial uncertainty. The sparse credible evidence is more consistent with a static or even declining rather than an increasing population, especially in the Cabinet Mountains.
>
> The USFS's second claim is also unsubstantiated given that the probable dominant driver of demography for the Cabinet-Yaak grizzly bear population has been availability and distribution of natural foods. Dominant causes of bear mortality argue against the conclusion that conflict management drove mortality reductions during the relevant period, as does a better temporal correlation between annual size of berry crops and annual numbers of bear deaths.

More specifically:

A. The 2.1% Per Annum Growth Rate is Not Justified Nor Applicable

Use of a 2.1% per annum growth rate to project total size of the Cabinet-Yaak population from the Kendall et al. (2016) 2012 point estimate, as was done by Kasworm et al (2018), is not defensible. Such use is, moreover, guaranteed to produce spurious results that cannot legitimately be used to reach conclusions of management relevance. There are several unambiguous reasons.

A.1. The growth rate is not representative of the total population

First, the estimated 2.1% per annum growth rate only applies to an unknown fraction of the total Cabinet-Yaak grizzly bear population. Vital rates used to estimate this growth rate were based solely on "native" or "natural" research-trapped bears, and expressly excluded bears captured because of conflicts or part of the augmentation program (Kasworm et al. 2018: 10). The growth rate, moreover, applies almost exclusively to the Yaak portion of the population given that 95% of the data used to estimate survival rates and 85% of the data used to estimate reproductive rates came from this subpopulation (ibid: 36)—protestations by the authors notwithstanding (ibid: 36). On top of this, the 2.1% per annum rate was estimated only for the female portion of this high-grade (ibid: 10), which is of consequence even though female survival is disproportionately important in determining growth rate, as such.

In other words, the 2.1% per annum growth rate can only be legitimately applied to females residing in the Yaak subpopulation that were not trapped and marked as a result of conflicts nor part of the augmentation program. Put another way, management-trapped bears, augmentation bears, and males would need to be represented in a modeling framework if any estimated population growth rate were to be prima facie representative of the total population. Moreover, if the fates of all such bears were to be considered, estimated population growth rate would almost certainly be lower given that survival rates of males, augmentation bears, and management bears are substantially less than survival rates of the females used to estimate the 2.1% per annum growth rate (ibid: 33-35).

If a growth rate were to be used to project a *total* population estimate, comparable to the Kendall et al. 2012 point estimate of 49 bears (95% CI = 44-62), then such a growth rate would need to represent birth and death rates of the *total* population, and apply specifically to the period of interest (e.g., 2012-2017) rather than a longer period of time that masks the relevant trajectory (see my point below).

A.2. The growth rate does not apply to the Cabinet grizzly bear population

As a preface, the Cabinet population is almost totally isolated from the Yaak population as well as from grizzly bears elsewhere. As Kendall et al (2016) emphasized in the abstract of her paper: "The two populations were demographically and genetically isolated from each other and the Cabinet population was highly inbred." Despite representations by Kasworm et al (2018) of connectivity, this amounts to only 1 male bear documented to have been present in both the Cabinet and Yaak populations, with no evidence of genetic exchange (ibid: 27).

Given that the growth rate used in the draft EIS is, in fact, based almost wholly on vital rates from females in the Yaak population and explicitly excludes data from augmentation bears that comprise a substantial portion of the Cabinet population, the population growth rate has no relevance to the Cabinet population, and therefore little relevance to an assessment of impacts from the proposed Montanore Mine.

A.3. Status of the Cabinet grizzly bear population is unimproved and highly precarious

The only reliable information on status of the Cabinet grizzly bear population comes from the synthesis of genetic and other information used by Kasworm et al to estimate a *minimum* number. This updated estimate for 2017 amounted to only 13 bears (ibid: 27). Importantly, Kendall et al. estimated that there were a total of 22-24 bears in the Cabinet population during 2012, with lower confidence intervals near 20 bears. In other words, the current minimum estimate for the Cabinet population is more consistent with stasis, or even decline, rather than increase since 2012. Interestingly, the current minimum population estimate is also comparable to the estimated "15 or fewer in 1988" (Kasworm et al 2018: 28), indicating little or no improvement in population status.

A.4. The growth rate does not represent 2012-2017

The 2.1% per annum growth rate used by Kasworm et al to project 2017 population size was calculated using data that span 1983-2017 and so, therefore, axiomatically represent a generalized growth rate for Yaak females during this lengthy 35-year period. Put another way, the 2.1% per annum growth *is not* an estimate of growth for the period 2012-2017. For it to be so, the rate would have necessarily been estimated only using data from the approximate 2012-2017 period.

More to the point, estimates of growth for the Yaak female population are increasing back-weighted by inclusion of data that are, on average, increasingly old. Figure 1 (herein) shows the approximate average age of data used to calculate vital rates with the passage of time (from ibid: Table 17, 40-42). Notice that average age has increased from around 6-7 years in 1998 to nearer 15 years in 2017. In other words, with the progression of time estimates of population growth for the female segment of the Yaak population have become increasingly irrelevant to judging current population trajectory.

The Government retort to these contentions would probably be that the data from such a short period of time would be so sparse as to preclude a usefully accurate estimate. That is almost certainly the case, and a commentary in its own right on the profound limitations imposed by intrinsically small sample sizes. Nonetheless, this does not negate the point that the 2.1% per annum growth rate for 1983-2017 is spurious when applied to the 2012-2017 period. As Figure 11 clearly suggests (ibid: 37), population growth rate has almost certainly varied over time, albeit in largely indeterminate ways (see my following point).

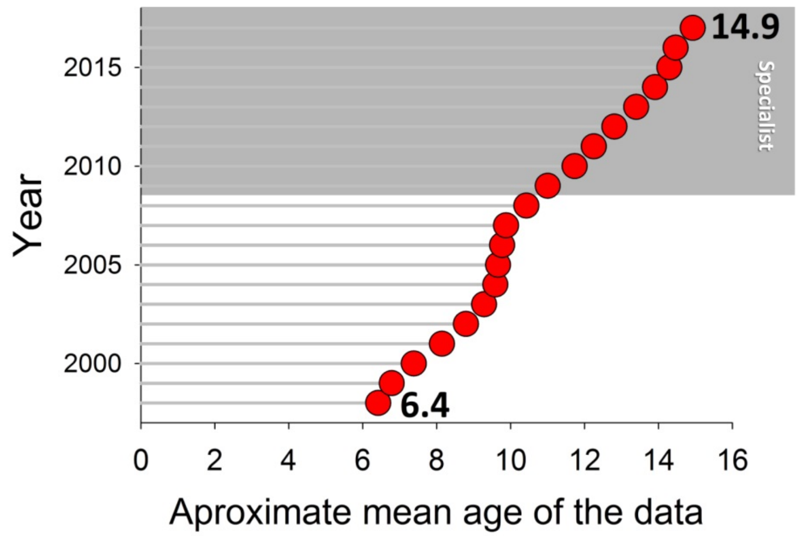

Figure 1. Trend in mean age of data used to calculate vital rates of Cabinet-Yaak grizzly bears with passage of years from 1998 to 2017. Mean age has more than doubled, with trend towards increased aging accelerating since deployment of a conflict management specialist in the ecosystem. Increasing age renders estimated vital rates increasingly irrelevant to current conditions.

A.5. Uncertainty of the growth rate as currently (or even ideally) calculated debars use
Small sample sizes impose very real constraints on the precision and accuracy of all demographic rates being used by Cabinet-Yaak researchers and managers. These constraints follow ineluctably from the small size of the Cabinet-Yaak grizzly bear population, which is a non-negotiable feature of this ecosystem.

As a practical upshot, all of the population growth rates calculated to date have uncertainty intervals (e.g., 95% confidence intervals) that not only substantially overlap zero (i.e., no growth) but also, over time, each other. More specifically, despite purporting to show trend in cumulative growth rate over time, the confidence intervals shown in Figure 10 (ibid: 37) all overlap—most almost completely (see also Figure 2A herein). Because of this, there is little or no basis for concluding that growth rate has varied with time. Likewise, taking a *precautionary* approach, there is little or no justifiable basis for concluding that growth rate is currently positive, despite statements in Kasworm et al. such as “The probability that the population was stable or increasing was 73%” (ibid: 36), especially in light of the fact that the point estimate of 2.1% per annum is a *cumulative rate* spanning 1983-2016 with little or no known relationship to *current rate* of population increase or decline.

Moreover, when the totality of point estimates and uncertainty is taken into consideration for the period 1998-2017, there is a cumulative 62% probability that the population was *declining* during these 19 years, consistent with the 2017 estimate of population size for Yaak females still being around 52% less than the estimate of population size for 1998 (Figure 2A and 2B herein).

The implications of uncertainty are thrown into relief by examining the specifics of projecting population size forward in time from 1983 to 2017 using the 1.021 (95% CI = 0.949-1.087) growth rate that is the basis for claims in the draft EIS about population size (ibid: 36), noting up front that uncertainty in annual growth rate magnifies exponentially over time when manifest in population size. For example, after back-casting to obtain a plausible 1983 population starting point, deterministic projections of population size using the upper and lower confidence intervals of growth allow for a current population (2017) of anywhere between 3 and 256. Stochastic projections, e.g., using the software RISKMAN, generate a similar and not particularly useful range of 4 to 154 individuals.

The point here is that the raw cumulative uncertainty is huge, especially when dealing with a time period as long as 1983-2017. It is also important to note that this exercise takes the 1.021 estimate of lambda at face value, which, as per my previous points, is unwarranted.

Related to this last point, the current basis for modeling population growth rate using Booter (ibid: 10-11) is egregiously simplistic given the self-evident structural complexity of grizzly bear population demography in the Cabinet-Yaak Ecosystem. For any estimate of growth rate to be realistic, explanatory, relevant, and accurate, all of the main structure needs to be accommodated. More specifically, a relevant demographic model would ideally include source-sink structures accounting for management-trapped versus research-trapped bears, bears in the Yaak area versus the Cabinet Mountains, augmentation bears versus in situ bears—in addition to accounting for the male segment as well as inter-annual variation attributable to variation in key food resources (see later). The model described in Kasworm et al. does none of this.

Again, the probable retort would be that sample sizes are too small to support estimating the many rates required for such a model. But that is, indeed, the point. The uncertainty is real and unavoidable, and should be acknowledged in management decision-making.

A.6. Even taking estimated growth rate at face value, population status is problematic

Even taking the population growth rate estimated by Kasworm et al. at face value, the most defensible conclusions would be, first, that status of the population has worsened during 2014-2017 compared to 2006-2013, and, second, that numbers are still substantially less than the presumed peak reached around 1998. These conclusions are based on trend in *population growth rate* over time (as per ibid: 37), and trend in *population size* estimated by projections using year-specific cumulative population growth rates (e.g., projecting population size for 1998 using the 1983-1998 growth rate estimate, and then doing the same for each successive year, with 1983 the starting year throughout).

Figure 2 (herein) shows seminal results. In Figure 2A I've identified three periods typified by trends in *population growth*: rapid decline of 2% per annum during 1998-2006, coincident with the berry famine (see below); a nearly as rapid 1.1% rate of improvement during 2006-2014; followed by stalling in the rate of improvement to around 0.2% per annum since 2014—an 82% decline in rate of change—coincident with population growth rate finally reaching positive territory. Importantly, this refers to the *per annum rate of deterioration or improvement* in *population trajectory*, which is perhaps the most relevant information to be gleaned from the estimates of population growth rate presented by Kasworm et al.

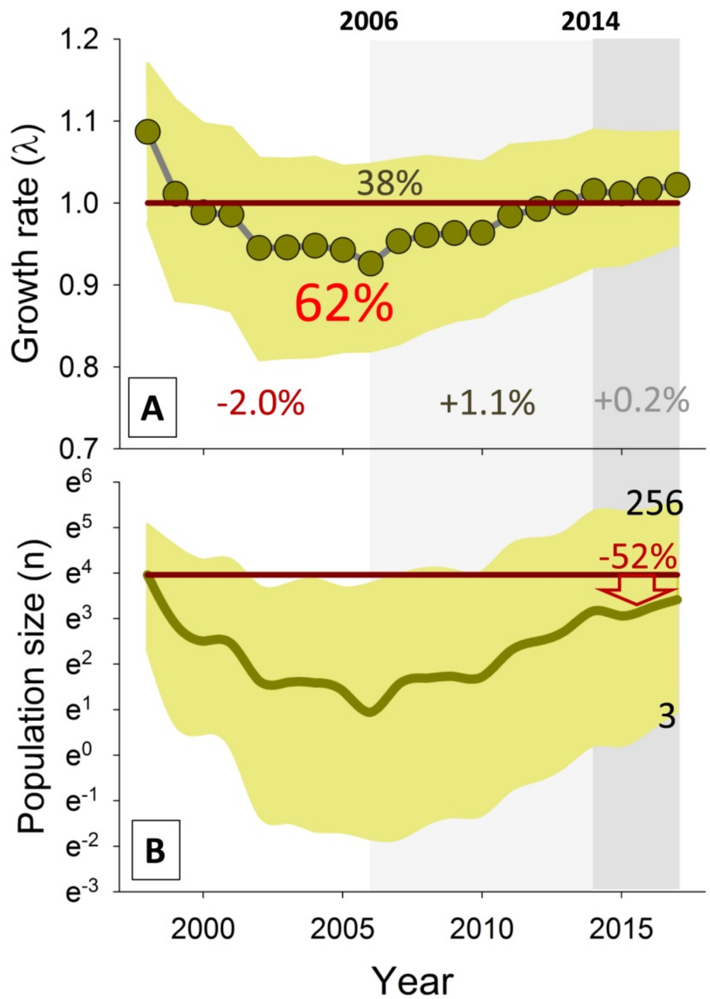

Figure 2. Trend in estimated population growth rate (A) and related estimated total population size (B) for Cabinet-Yaak grizzly bears, with the notable proviso that both sets of estimates are based almost wholly on data obtained from female grizzly bears in the Yaak population. Dark green dots or lines denote central tendencies, large green bands bounds of uncertainty. The horizontal dark red line in (A) denotes no growth, with any values above leading to increase and any values below leading to decline. The red line in (B) corresponds with estimated population size in 1998. In (A) I also show the cumulative weight of evidence for population declines versus increases for 1998-2017 along with average annual rates of change in lambda during three periods characterized by non-stationary shifts in dynamics. The numbers at right in (B) correspond to the range in estimated population size given uncertainties in growth rate (3-256), as well as the deviance in current estimated population size from the 1998 benchmark.

Finally, Figure 2B (herein) shows trend in estimated *size* of the Yaak female population, both as a central tendency (dark green line) as well as bounding uncertainty (light green band, based on projections using the upper and lower confidence intervals for each cumulative estimate of growth rate). Parenthetically, I transformed the values to a natural log scale in Figure 2B to visually emphasize trends given that the bounds of uncertainty explode with projections increasingly farther forward in time. The take-away point is that, according to these values, population size peaked during 1998, reached a nadir during the height of the berry famine in 2006, increased through 2014, and then stalled during 2015-2017 at a size that was still around 52% less than peak numbers reached during 1998.

The key points here are that improvement in status of the female segment of the Yaak population *stalled* beginning in 2014 at numbers that were still approximately 52% less than the peak reached during 1998. Having said this, both of these conclusions remain severely compromised by the intrinsic uncertainties, lack of relevance, and bias of methods used by Kasworm et al.

A.7. Conclusion

The upshot of all this is that there is *no legitimate basis* for estimating current population size (e.g., 55-60) by applying a biased 1983-2017 growth rate—based on high-graded data representing only a fraction of the population—to a point population estimate made during 2012. Moreover, even taken at face value, the current cumulative population growth rate is not applicable to the Cabinet population; shows stalled improvement in population status; and a population still substantially less than peak numbers reached during 1998.

The best that can be perhaps be invoked is a contrast between the presumed minimum estimate of 35 bears during 2014-2017 (ibid: 27) and the 2012 estimate of 49 (44-62) bears reported by Kendall et al. (2016). The estimate of 35 for 2014-2016 is self-evidently less than the lower bound of the 2012 confidence interval, more consistent with a *static or even declining population* than with an increasing one. Of greater relevance to the draft EIS, this general conclusion also holds for comparisons specific to the Cabinet population (a current minimum of 13 bears compared to lower confidence intervals of around 20 reported by Kendall et al. for 2012).

B. Comparison of Pooled Survival Rates is Not Legitimate

As ancillary support for the proposition that size of the Cabinet-Yaak population has increased between 1999-2006 and 2007-2017, Kasworm et al state that “Grizzly bear survival of all sex and age classes decreased from 0.899 during 1983–1998 to 0.792 during 1999–2006 and then rose to 0.934” (ibid: 34), and then summarize these same numbers in Table 13 (ibid: 34).

Most of the problems and associated bias noted above applies to this comparison. Note, first, that the 95% confidence intervals reported in Table 13 for pooled estimates from all three time periods overlap, which precludes confidently concluding there is any difference in mean rates. Moreover, note the restriction to “native” bears, which excludes any consideration of conflict-trapped or augmentation bears, which were very much a component of the 2012 point estimate of population size.

The other problematic aspect of this comparison is that data from all bear sex and age-classes were pooled, without any apparent attempt to determine whether this collapse of data preserves representation of the population at large. Are males over- or under-represented?...likewise subadults versus adults? Some sort of weighting scheme reflective of current or even stable population structure could provide some remedy, but without compensating for other biases.

The other interesting aspect of this data-pooling is the extent to which it is at odds with other results and commentary in Kasworm et al. More specifically, this aggregation of data ignores the disproportionate importance of subadult females to population dynamics. This importance is evident in the near 85% variance in estimated population trend attributed to survival of subadult and adult female bears in Booter calculations (but with 60% attributable to subadult female survival, Table 15; ibid: 37), as well as the different contextual emphasis placed by the authors on female survival on Pages 32 ("…it is important to consider the rate of female mortality") and 37.

The implication of all this is that the comparison of survival rates estimated from pooled data presented by Kasworm et al on Pages 33 and 34 does not mitigate the many fatal problems with their estimates of population growth rate.

C. The Comparison of Annual Average Deaths is Uninformative

Kasworm et al. (2017) present information on grizzly bear deaths in the Cabinet-Yaak Ecosystem in terms of numerous contrasts and adjustments presumably designed to be of relevance to various management deliberations. On pages 15-16 a running average of annual mortalities is related to recovery criteria; on pages 16-18 a full list of deaths with ancillary details is provided; and on pages 31-33 mortality is summarized in multiple ways presumably relative to different management considerations. Throughout, the parsing, categories, and nomenclature are confusing, obfuscated, and confounded. As a result, I needed to reconstruct much of the analysis of mortalities presented by Kasworm from the raw data on pages 16-18. The contrast among time periods presented in Table 11 (ibid: 33) was a particular focus.

C.1. Table 11 is a Tangled Mess

The totals in the column farthest right in Table 11 include all mortalities—human-caused, natural, within 16-km of the Recovery Area boundary, in the US as well as Canada—plus the estimated unrecorded *human-caused* mortalities. For some inexplicable reason, and unlike in the NCDE and GYE, natural mortalities and mortalities of unknown cause were not accounted for in estimations of unrecorded mortalities.

The upshot is that the row totals in Table 11 represent a mishmash of natural, human-caused, and estimated unrecorded human-caused mortalities, without any straight-forward connection to judging overall population status. In fact, the inattention and even outright dismissal in this context of natural mortality as a factor in judging population status is mystifying given that a dead bear, for whatever reasons, matters in assessing the toll taken by mortality.

C.2. Comparison of 'rates' between 1999-2006 and 2007-2016 is Uninformative

By contrast, the comparison of annually-averaged human-caused mortality between 1999-2006 and 2007-2017 on Page 32 only considers human-caused mortality, but without including any of the estimated unrecorded human-caused mortality included in Table 11—and without any cogent explanation. The confusion implicit to this inexplicable parsing is compounded by use of the term 'rate' in reference to an annual average, in context of 'rate' being used elsewhere in reference to survival and reproductive rates referenced to fates of individual bears. On top of this, a typo was made in reference to the 2007-2017 'rate,' which should be 2.2, not 2.1. This error amplified the potential for confusion arising from comparing '2.1' with '2.25' and calling the first value an increase over the second.

The annually averaged number of known and probable human-caused deaths during 1999-2006 was 2.13. Using all currently available data, for 2007-2018 the average was 2.08. When the estimate of unreported human-caused deaths is included, the average for 1999-2006 was 2.75 (95% CI 1.6-3.9). For 2007-2018 it was 3.2 (95% CI 2.2-4.2). Considering total known-probable mortality plus estimated unreported human-caused mortality—but without any correction for unreported natural deaths—the annual averages for 1999-2006 and 2007-2018 were virtually identical: 3.9 and 3.8.

The important point is, here again, that rote statistical uncertainty debars any conclusion about increase, stasis, or decrease in numbers of human-caused deaths. The confidence intervals of annual averages overlap substantially, which is not surprising given the small sample of years and dead bears. This statistical uncertainty is amplified by uncertainty attached to detecting any bear death other than that of an actively radio-monitored animal. Considering only human-caused deaths, this certainly holds for poached bears, deaths 'under investigation,' and deaths from unknown (but human-related) causes. A back-of-the-envelope calculation suggests that such deaths need to be increased by around 70 to 120% in year-end tallies.

In the face of such irrefutable uncertainty, Kasworm et al resort to focusing on and then emphasizing female mortality, which reduces the absolute values of calculated averages even further. When an estimate of unreported human-caused female mortalities is added to known mortalities (using the long-term proportion of F:M deaths=0.4), the result is an annual average of 1.75 (95% CI 0.83-2.67) female deaths for 1999-2006 and 0.80 (95% CI 0.34-1.54) female deaths for 2007-2018. All of the reported differences in mean values are so far within the range of statistical uncertainty as to render these comparisons a bit absurd.

C.3. Conclusion

Again, researchers and managers in this ecosystem might argue that small samples prevent any degree of certainty about conclusions, but this does not obviate the obligation to acknowledge uncertainty. Nor does it eliminate the practical consequences of small sample sizes and the compromising effects of chance processes—highlighted recently by a jump in recorded deaths from 1 in 2017 to 3 in 2018, a tripling in just one year. More certainly, it recommends humility and precaution in the face of such statistical ambiguities.

But all of this still leaves open the question of why natural mortalities as well as mortalities that cannot be definitively ascribed to human causes are not accounted for in assessing population status. This question is especially relevant given that Kasworm et al comment in several places on the extent to which variation in abundance of key natural foods likely drives population dynamics, often through the ‘natural’ death of dependent young (see below). Or, even, why, when considering only human-caused mortality, adjustments to account for unrecorded deaths were not included. This is all a bit mystifying as well as prima facie unjustified.

D. Education and Conflict Mitigation Probably Did Not Affect Population Status

As a hypothetical, it is worth taking claims regarding an improvement in status of the Cabinet-Yaak grizzly bear population between 1999-2006 and 2007-2018 at face value. Again, the emphasis here is on the hypothetical given all of the compromising or even fatal flaws in analyses and conclusions reported in Kasworm et al. More specifically, if an improvement did occur, what was (were) the likely cause(s)? And, more specific yet, would such improvement likely be attributable to the institution of the mitigation program as per the claim in Kasworm et al that “Declines in the mortality rate on private lands beginning in 2007 correspond to and may be the result of the initiation of the MFWP bear management specialist position” (ibid: 34)? Up front, the notable proviso in this comment is “on private lands,” which does not pertain to mortality, *in toto*.

D.1. Kasworm et al ascribe more effect to augmentation and variation in natural foods
Causation is notoriously hard to establish with any reliability or confidence. Nonetheless, even taking comments in Kasworm et al (again) at face value, one can establish to what extent these authors ascribed causation, based on the balance of their comments. The relevant quotes include:

“The *increase in total known mortality beginning in 1999 may be linked to poor food production during 1998-2004* (Fig. 9). Huckleberry production during these years was about half the long term average…Poor nutrition may not allow females to produce cubs in the following year and cause females to travel further for food, exposing young to greater risk of mortality from conflicts with humans, predators, or accidental deaths.” (emphasized in Figure 10; ibid: 32).

“Some of this decrease [in survival] in the 1999-2006 period could be attributed to *an increase in natural mortality probably related to poor berry production during 1998-2004*. *Mortalities on private lands within the U.S. increased during this period*, suggesting that bears were searching more widely for foods to replace the low berry crop.” (ibid: 34).

In reference to a probable increase in size of the Cabinet Mountains subpopulation from around <15 (possibly 5-10) in 1988 to around 22-24 in 2012: “These data indicate the Cabinet Mountains population has increased 2-4 times since 1988, but this increase is *largely a product of the augmentation effort* with reproduction from that segment.” (ibid: 36).

On balance, Kasworm et al ascribe more weight to variation in natural foods and the augmentation program than to any mitigation measures in explaining the plight of Cabinet-Yaak grizzly bears during 1999-2006, and the subsequent presumed improvement in status of this population during 2007-2017. This conclusion is consistent with that reached by McLellan (2015) from research in the nearby North Fork of the Flathead River showing a major influence of huckleberry fruit crops on demography of the local grizzly bear population. Also, contrary to Government statements, Kasworm et al clearly associate the increase of deaths on private lands during 1999-2006 and, by implication, the subsequent abatement of deaths on these lands during 2007-2016, to bears foraging more widely—including into conflict situations—during times of dearth in late-season fruit crops. This does not imply a significant role for conflict mitigation specialists in driving reduced mortalities during 2007-2016.

D.2. Weight of available evidence questions effects of a conflict management specialist

The extent to which poaching, malicious killing, or other suspect circumstances are associated with human-caused deaths is also instructive regarding the overall effectiveness of conflict mitigation efforts during 1999-2017. By its nature, malicious killing/poaching is a criminal act undertaken by criminals. Such behavior is rooted in attitudes and outlooks that are notoriously unresponsive to education and 'outreach'. The phenomenon is about willful malfeasance. As such, law enforcement and successful subsequent prosecution is logically the most appropriate redress—not conflict mitigation by a specialist who is not tasked primarily with law enforcement. Put another way, if mitigation efforts were to have any major prospective role in governing numbers of grizzly bear deaths in the Cabinet-Yaak Ecosystem, human-caused deaths that were amenable to education and outreach would dominate (e.g., due to mistaken ID or home-site attractants) and such deaths would have proportionately declined between 1999-2006 and 2007-2017.

Before pursuing this any farther, some clarification of obfuscations in the dead bear database is needed. During 1999-2017 a number of deaths were ascribed to 'Undetermined' human causes, 'Poaching' or listed as 'Under investigation'. The first and last categories are not explicit, but nonetheless strongly suggestive. Certainly, 'Under investigation' suggests that the death occurred under suspicious circumstances warranting investigation—with a strong likelihood of either poaching or other unwarranted lethal action by the involved people. Such suspicions are rarely definitively resolved. 'Undetermined' is also more suggestive of malfeasance rather than innocence on the part of the involved people. Given the alternatives, such deaths are more defensibly allocated to causes more resistant than not to mitigation.

With all of this as context, there were a total of 7 known-probable deaths during 1999-2006 attributed to either poaching or undetermined causes, representing 58% of total human-caused deaths. During 2007-2018 there were a total of 13 deaths either under investigation or ascribed to poaching, representing a nearly identical 59% of the total known-probable human-caused deaths. These are major fractions in their own right, but leave estimated numbers of unreported deaths unaccounted for. As Kasworm et al make clear (ibid: 33), their estimate of 'unreported' deaths did not apply to bears that were radio-collared or removed by managers, which leaves this unreported estimate levied almost entirely against malicious or otherwise suspect causes. When these unreported estimates are added to the known-probable toll taken by poaching, unknown causes, or suspicious circumstances, the percentage increases to around 70% during 1999-2006 and approximately 77% during 2007-2016.

Taken together, these figures support concluding that (1) malicious or otherwise suspect causes account for a large portion—if not majority—of grizzly bear deaths in the Cabinet-Yaak Ecosystem; (2) the fraction and even total numbers of deaths attributable to such causes did not decrease from 1999-2006 to 2007-2018; and (3) the conflict mitigation specialist operating during the most recent period did not have an obvious effect—nor logically would have given the nature of malicious killing.

E. Government Explanations for Shifts in Mortality from Private to Public Lands Are Not Supported

As per the several statements by Kasworm et al. summarized in D1, above, a dearth of berries during 1999-2006 probably drove a dynamic that led more grizzly bears to venture onto private lands in search of alternative foods where they were then more likely to die. Conversely, with improvement of berry crops since especially 2008, grizzly bears probably spent more of the critical late summer-fall period on public lands, where prime huckleberry patches and other productive habitats tend to be concentrated (Mattson and Merrill 2004; Proctor et al. 2015,2017). This explanation rooted in dynamics of berry crops is unambiguously more parsimonious and logical than one invoking a conflict management specialist addressing less prominent causes of mortality.

Moreover, as with every other comparative analysis by Kasworm et al, sample sizes are so small as to preclude any confident statements about trends. For example, it could be argued that human-caused deaths on public lands proportionately increased from 25% to 50% of the total between 1999-2006 and 2007-2017. Yet the small numbers of deaths from which these percentages are calculated (12 and 18, respectively) produce confidence intervals that overlap by over 30%, which alone debars any related confidence about the existence of a true difference. This holds even more so for changes in percentages of deaths on private lands (from 50% to 39%) given that confidence intervals in this case overlap by 64%.

Put another way, the redistribution of only a handful of deaths from one jurisdiction to another can radically change interpretations when overall numbers are so small. Under such circumstances, the appropriate paradigm is one of precaution, especially regarding the comparative hazards of reaching one conclusion versus another, in this case in registered against development of a Mine that will bring more humans and human activity in and near some of the best remaining habitat of the acutely small Cabinet grizzly bear population.

F. A Devil's Bargain Will Not Rescue This Small Population

The Cabinet-Yaak grizzly bear population is smaller than the smallest census population size ever posited as being viable. The Yaak/Yahk subpopulation has limited connectivity with grizzly bear populations elsewhere, and the Cabinet Mountains subpopulation is more isolated yet (Apps et al. 2016; Kendall et al. 2016; Proctor et al. 2012, 2015). Such isolation is well-known to magnify risk. The degree of this risk is evident in the fact that fates of populations as small of that of the Cabinet-Yaak grizzlies can be dictated solely by chance variation in birth and death rates, known as demographic variation. Yet demographic variation is a relatively minor stressor compared to environmental variation, catastrophes, negative deterministic trends, and loss of genetic diversity—all of which are documented or potential factors in the Cabinet-Yaak. The contemporary consensus of researchers is that populations of large mammals such as grizzly bears need to consist of thousands of animals to withstand all of these stochastic and deterministic threats over meaningful periods of time.

The vulnerability of the Cabinet-Yaak population can be illustrated through a simple exercise, even without accounting for spatial structure of the Cabinet and Yaak subpopulations. I input vital rates into a commonly-used risk management program named RISKMAN (currently being proposed for management of grizzly bear mortality in the NCDE). Using the stochastic function, I was able to reconstruct the c. 2.1% growth rate reported by Kasworm et al (2018) for 1983-2017. More specifically, the cumulative geometric mean growth rate (lambda) varied from a maximum of 1.035 to a minimum of 1.008. Accounting for variation in vital rates, the median ending population size at year 34 was 43, although the upper and lower 95% percentiles of simulated trajectories produced ending populations as small as 4 and as large as 154. I then simulated what would have happened if just one additional female died each year. In this scenario, the geometric cumulative mean growth rate dropped from 0.952 (already much less than 1) to an astounding 0.202 at year 34 of the simulation. Median total population size had reached 0 by year 23, with an upper 95th percentile of only 11 animals at the end of simulations. Results were not much improved when an additional 1 female was lost only once every 2 or 3 years. This is not presented as any definitive modeling result, but rather illustrative of how little the margin of error is for a population this small and isolated from ready demographic rescue.

Efforts to prevent and mitigate conflicts between bears and people are self-evidently desirable. So is effective law enforcement to thwart criminal activity such as poaching. But it makes no sense to make such efforts contingent upon inserting hundreds more people and industrial-scale activities into the heart of a highly-imperiled population of grizzly bears such as exists in the Cabinet Mountains. The negative impacts of human activities such as being proposed in conjunction with the Montanore and Rock Creek Mines have been amply demonstrated (see, for example, Proctor et al. 2018), including, for example, a very recent paper documenting displacement of grizzlies from trails subject to motorized human activity (Ladle et al. 2018). There is a certain perversity to making the sometimes speculative benefits of mitigation activities contingent upon allowing human activities that are known to be a substantial threat to bears and bear populations.

Please contact me at davidjmattson@gmail.com or 406-222-4702 if you have any questions.

David Mattson, PhD

References

Apps, C. D., McLellan, B. N., Proctor, M. F., Stenhouse, G. B., & Servheen, C. (2016). Predicting spatial variation in grizzly bear abundance to inform conservation. The Journal of Wildlife Management, 80(3), 396-413.

Kendall, K. C., Macleod, A. C., Boyd, K. L., Boulanger, J., Royle, J. A., Kasworm, W. F., ... & Graves, T. A. (2016). Density, distribution, and genetic structure of grizzly bears in the Cabinet-Yaak Ecosystem. The Journal of Wildlife Management, 80(2), 314-331.

Ladle, A., Avgar, T., Wheatley, M., Stenhouse, G. B., Nielsen, S. E., & Boyce, M. S. (2018). Grizzly bear response to spatio-temporal variability in human recreational activity. Journal of Applied Ecology.

Mattson, D. J., & Merrill, T. (2004). A model-based appraisal of habitat conditions for grizzly bears in the Cabinet–Yaak region of Montana and Idaho. Ursus, 15(1), 76-90.

McLellan, B. N. (2015). Some mechanisms underlying variation in vital rates of grizzly bears on a multiple use landscape. The Journal of Wildlife Management, 79(5), 749-765.

Proctor, M. F., Paetkau, D., Mclellan, B. N., Stenhouse, G. B., Kendall, K. C., Mace, R. D., ... & Wakkinen, W. L. (2012). Population fragmentation and inter-ecosystem movements of grizzly bears in western Canada and the northern United States. Wildlife Monographs, 180(1), 1-46.

Proctor, M. F., Nielsen, S. E., Kasworm, W. F., Servheen, C., Radandt, T. G., Machutchon, A. G., & Boyce, M. S. (2015). Grizzly bear connectivity mapping in the Canada–United States trans-border region. The Journal of Wildlife Management, 79(4), 544-558.

Proctor, M. F., Lamb, C. T., & MacHutchon, A. G. (2017). The grizzly dance between berries and bullets: relationships among bottom-up food resources and top-down mortality risk on grizzly bear populations in southeast British Columbia. Trans-border Grizzly Bear Project, Kaslo, British Columbia, Canada, <http://transbordergrizzlybearproject.ca/research/publications.html>.

Proctor, M. F., McLellan, B. N., Stenhouse, G. B., Mowat, G., Lamb, C. T., & Boyce, M. S. (2018). Resources roads and grizzly be4ars in British Columbia and Alberta, Canada. Trans-border Grizzly Bear Project, Kaslo, British Columbia, Canada, <http://transbordergrizzlybearproject.ca/research/publications.html>.