

- **ISSUE 40:** Confusion around how total and background mortality is calculated
  - The rule provides definitions and calculations not included in the CS (i.e., total mortality, background mortality, discretionary mortality, Table 3 and subsequent 3 paragraphs) that should be included for clarity
  - Background mortality fails to account for unknown-unreported grizzly bears deaths. This is incorrect, background mortality includes unknown/unreported mortalities as based on methodology developed by Cherry et al. (2002), with specific application of the method provided in IGBST (2005, 2006).
  - Need to discuss the uncertainty in the number of bears that die from natural causes or unreported human-caused mortality, broad credible intervals depending on priors and how unexplained an unresolved cases are dealt with (Cherry-Cherry et al. 2002). IGBST reports do not show credible intervals and natural deaths are not included in the estimation. IGBST indeed does not report credible intervals for the estimate of unknown/unreported mortalities. When estimates of unknown/unreported mortalities were first implemented by the IGBST, it was discussed if and how the credible intervals would be used. The conclusion of those discussions was that this would substantially complicate implementation (i.e., a range of mortality thresholds is not practical for managers) and to instead rely on the central tendency of the data. For decision making, relying on the central tendency of the data is justified. Uncertainty is often interpreted to reflect a possibility of worst-case scenarios (i.e., the low end of a credible interval that underestimates unknown/unreported mortality in this instance) but it should be noted that the tendency is towards the median and that about 50% of estimates will be conservative (i.e., above the median and thus overestimating unknown/unreported mortality). All reported mortalities for independent-aged bears, including those from natural causes, are used in the estimate of unknown/unreported mortality.
  - The method used to calculate total deaths is biased (biased low – IGBST 2012, Table 2.1) and the degree of that bias is not consistent (e.g., effort expended to locate dead bears) and is unknown. The method of estimating unknown/unreported mortalities indeed has a slight underestimation bias. However, this same table shows that all other estimations associated with calculation of mortality rates are conservative (and in several cases very conservative, such as the Knight et al. [1995] Rule Set, see Schwartz et al. [2008]). Thus, the slight low bias associated with estimation of unknown/unreported mortalities is relatively inconsequential.
  - The period over which the moving average of background mortality should be defined and account for uncertainty. It is important to note that the table in the Proposed Rule is only an example. The period over which background mortality was calculated was 4 years in the example presented in the Proposed Rule. The choice of using a moving average based on multiple years is justified to account for annual variation. We addressed the issue of uncertainty above.
  - Fails to address loss by emigration out of the DMA and is not counted towards total mortality limits or background mortality when calculating allowable discretionary mortality. This assertion is incorrect. Emigration out of the DMA, if it occurred, would result in a lower population estimate, which would result in a higher mortality rate if the number of mortalities were the same.

**Comment [FTvM1]:** This comment has merit. The decision point is whether to include the example of Table 3 at all. See my notes below: many members of the Study Team were not in favor of an example.

**Comment [HMA2]:** Interagency Grizzly Bear Study Team. 2005. Reassessing sustainable mortality limits for the Greater Yellowstone Ecosystem grizzly bear. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

**Comment [HMA3]:** Interagency Grizzly Bear Study Team. 2006. Reassessing methods to estimate population size and sustainable mortality limits for the Yellowstone grizzly bear: workshop document supplement. U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

- Difficult to plan to close hunting seasons when total mortality reaches threshold levels when up to half of individual grizzly bear mortalities are never discovered in non-telemetered bears (McLellan et al. 1999). McLellan et al. (1999) estimated the **reporting rate** of radio-monitored bears, which was about 50%. IGBST uses a similar method but our estimates of unknown/unreported mortalities are actually higher (as based on methodology developed by Cherry et al. (2002), with specific application of the method provided in IGBST [2005, 2006]): for every reported mortality, our estimates are closer to 2 unreported mortalities. The estimate of unknown/unreported mortalities allows a full accounting of total mortality and thus ensures that hunting mortality does not contribute to exceeding allowable mortality thresholds.
- Cumulative annual mortality should be analyzed on a month-to-month or seasonal basis to be used a better predictor to alert managers if annual mortality is progressing in a “normal” pattern or if it is likely to be exceeded. An additional trigger could be added to stop discretionary mortality for the current year in light of this information. IGBST already summarizes mortalities on a continuous basis, i.e., as records come in. This information is posted on the IGBST web site (under mortality tables) and is available to both the public and managers.
- Governor Mead requests the removal of language following Table 3 explaining mortality allocation beginning with “[t]here are mortalities that occur...” through the sentence, “[t]hese examples serve to explain the process...”

#### Draft Conservation Strategy language

\*The draft Strategy did not include the table and explanations addressing background mortality and examples of how discretionary mortality will be calculated that were included in the proposed rule.

#### Proposed Rule language

**Table 3. Allowable number of total mortalities from all causes inside the DMA under the total mortality limits for independent females and independent males at different population sizes.**

	Population size			
	600 to 673	674	675 to 747	>747
<b>1. Total annual mortality limit from all causes for independent FEMALES (≥2 years).</b>	At <7.6% mortality = 16 to 17	At 7.6% mortality = 18	At 9% mortality = 21 to 23	At 10% mortality = >26

**Comment [FTvM4]:** Without knowing the reason for this suggestion, we should point out that a number of members on the Study Team did not see much value in the mortality example and though it might muddy things up more than it clarified. As is clear from the comments above, the example did cause some confusion.

The new language and Table adequately address some of these earlier concerns..

**Comment [HMA5]:** I agree with Frank. It was example only and may have added an element of confusion.

<b>2. Total annual mortality limit from all causes for independent MALES (≥2 years).</b>	At 15% mortality = 31 to 34	At 15% mortality = 35	At 20% mortality = 47 to 52	At 22% mortality = >57
<i>Total mortality:</i> Documented known and probable grizzly bear mortalities from all causes including but are not limited to: management removals, illegal kills, mistaken identity kills, self-defense kills, vehicle kills, natural mortalities, undetermined-cause mortalities, grizzly bear hunting, and a statistical estimate of the number of unknown/unreported mortalities.				

The mortalities in table 3 are the total number of allowable mortalities inside the DMA from all causes for different population sizes. Total mortality limits in table 3 for each sex/age class are based on the size of each sex/age cohort, which changes with population size.

There are mortalities that occur every year due to multiple sources including management removals, illegal kills, self-defense, calculated unknown/unreported mortalities, natural mortalities, and other causes such as vehicle collisions. These are considered background levels of mortality and must be taken into account in any calculation and allocation of additional mortality available for hunting in order to remain within the total mortality limits. The expected numbers of background mortalities inside the DMA are calculated by taking the average number of mortalities from the most recent 4-year period from all sources, other than grizzly bear hunting, including calculated unknown/unreported numbers. Because background mortality levels vary from year to year, averaging these over several years is a reasonable predictor of these numbers. This average number of expected background mortalities for independent females and males is then subtracted from the total number of allowable mortalities for the most recent population estimate as per table 3. The resulting number is the expected number of independent female and male bears available for hunting allocation.

As an example, the average background mortality from 2012 to 2015 was 37 (15 females and 22 males) independent bear deaths/year due to management removals, illegal kills, calculated

unknown/unreported, natural causes, and other deaths. These are from inside the DMA only. In this example, with an average background mortality of 37 (15 females and 22 males), if the DMA population in a given year was at 674 bears as calculated by the modeled-averaged Chao 2 method, using table 3 there would be 3 female bears and 13 male bears available for discretionary hunting mortality ( $18 - 15 = 3$  independent females and  $35 - 22 = 13$  independent males). Once either one of these mortality limits was met in any year, the state regulatory mechanisms closing hunting seasons would apply. For the 2015 DMA population estimate of 717, the total allowable mortality for independent females is 22 and for independent males is 50. Applying the average background mortality of 15 and 22 for independent females and independent males, respectively, that would allow for a discretionary mortality inside the DMA of  $22 - 15 = 7$  independent females and  $50 - 22 = 28$  independent males. If the average background mortality was higher than the 2012-2015 average of 37, there may not be any discretionary mortality in a given year. Concurrently, if the average background mortality declined, there may be additional discretionary mortality available.

These examples serve to explain the process that will be used to determine discretionary mortality. Within these mortality limits, state fish and wildlife agencies have discretion to determine whether they intend to propose a grizzly bear hunting season and/or how much discretionary mortality (within allowable limits) to allocate to hunting.

**Proposed revisions to include in both the Rule and the Strategy**

**Table 3. Example calculations of allowable total annual mortality from all causes inside the DMA and expected number of independent female and male bears available for hunting inside the DMA at estimated population sizes of 674 and 717.**

	Estimated population size	
	674 (2002–2014 average population size)	717 (2015 population size)

	Independent Females	Independent Males	Independent Females	Independent Males
Size of sex/age cohort at this population size	236	236	250	250
Total annual mortality rate	7.6%	15%	9%	20%
Total annual mortality number	18	35	22	50
Average background mortality from 2012–2015, inside the DMA	15	22	15	22
<b>Bears available for hunting inside the DMA</b>	<b>3</b>	<b>13</b>	<b>7</b>	<b>28</b>

The number of bears available for discretionary mortality in a given year is based on the population estimate inside the DMA from the previous year and calculated using the size of the sex/age cohort, the total annual mortality rate (see Table 1), and the average background mortality. Total annual mortality numbers are calculated by multiplying the total annual mortality rate by the size for each sex/age class. The size of each sex/age cohort varies with population size. Total mortality includes documented known and probable grizzly bear mortalities from all causes including but not limited to: management removals, illegal kills, mistaken identity kills, self-defense kills, vehicle kills, natural mortalities, undetermined-cause mortalities, grizzly bear hunting, and a statistical estimate of the number of unknown/unreported mortalities.

There are mortalities that occur every year due to multiple sources, including management removals, calculated unknown/unreported mortalities, natural mortalities, and other human-causes such as vehicle collisions, illegal kills, and self-defense kills. These are considered background levels of mortality and must be taken into account in any calculation and allocation of additional mortality available for hunting in order to remain within the total mortality limits. Inside the DMA, expected background mortality is calculated by taking the average number of mortalities from the most recent 4-year period from all sources other than grizzly bear hunting. Because background mortality levels vary from year to year, averaging these over several years is a reasonable predictor of these numbers and will reduce the risk of exceeding the total allowable mortality limit. The average number of expected background mortalities for independent females and males will then subtracted from the total number of allowable mortalities for the most recent population estimate, as per table 3 above, resulting in the expected number of independent female and male bears available for hunting allocation.

**Comment [FTvM6]:** Although this is a reasonable argument, the decision for a 4-year period was somewhat arbitrary (and see comment below). I'm not necessarily suggesting to use any other moving average but a 3-year period would match moving averages we have used on e.g., mark-resight and chao2 comparisons and it would be biologically more supported, matching the 3-year reproductive cycle.

**Comment [FTvM7]:** The 4-year average helps to prevent large swings in the level of discretionary mortality. However, I'm not sure it actually reduces the risk of exceeding the total allowable mortality.

For example, suppose background mortality was low over the 4-year period but the current year was high, it would increase the likelihood of "overharvest" in that year. One could actually argue that using annual background mortality would be less likely to result in exceeding mortality limits (but would make it challenging to set harvest seasons with a relatively consistent number).