

Bulleted summary of peer review and public comments, organized into issues

Green = public comment

Blue = peer review

Purple = both public comment and peer review

- **ISSUE 14: Concerns about how we measured and interpreted population trend (Jennifer):**
 - Concerns about measurement/methods
 - Annual uncertainty in the population estimate should be compared to long-term averages to give more insight into the population trend
 - Negative trend may not be detected with current statistical rigor until too late
 - The model-averaged approach to estimate population size and trend is insensitive to rapidly changing conditions. The “smoothing” approach should not include data from before 2000 when drastic changes occurred in the GYE. The results, both population size and trend, are highly dependent on the time period being modeled. The more data included, the more optimistically the result is biased. Since 2007, the population trend has declined significantly to 0.8%.
 - “The Service employs linear and quadratic models, without statistical or theoretical justification.”
 - The population growth rate has been over-estimated because it does not account for senescence in both birth and death rates of female grizzly bears (Doak & Cutler 2014a, 2014b).
 - Population size is inflated by inflation of survival rates male and female bears 2+ years old and is insensitive to rapidly changing conditions.
 - Van Manen et al. (2016) and Bjornlie et al. (2014), the papers cited in the rule, use trapping-effort data instead but should use the more reliable capture-recapture population count method.
 - Doak (1995) published that there’s an 8-13 year lag between habitat decline and population decline, McLellan (2015) recently demonstrated lag effects for grizzly bears in the North Fork of the Flathead River drainage of BC and MT.
 - Use of an independent measure to verify model trends, including independent sampling for this purpose, would strengthen interpretation of any model employed.
 - The IGBST workshops concluded that it is not possible to rely on FCOY observations as a trend indicator at the current high densities (IGBST 2012).
 - Alternative interpretations
 - 2015 population estimate was down 6% from the 2014 estimate. Decline due to increased mortalities as a result of conflicts with hunters and livestock and lower cub survival
 - The population has not increased since the early 2000s
 - More older bears and fewer cubs and young bears is not a good trend to maintain a healthy population.

Proposed Rule Language

Population and Demographic Recovery Criteria

Below, we summarize relevant portions of the demographic analyses contained in the IGBST's 2012 report (IGBST 2012, entire) and compare them with the previous results of Schwartz *et al.* (2006b, entire) to draw conclusions concerning the grizzly bear population in the GYE DMA using these collective results. These analyses inform the scientific basis for our proposed revisions. While Schwartz *et al.* (2006b, p. 11) used data from 1983 through 2001; the 2012 IGBST report examined a more recent time period, 2002 through 2011 (IGBST 2012, p. 33). The IGBST found that population growth had slowed since the previous time period, but was still stable to slightly increasing, meaning the population had not declined. Because the fates of some radio-collared bears are unknown, Schwartz *et al.* (2006b, p. 48) and the IGBST (2012, p. 34) calculated two separate estimates of population growth rate: one based on the assumption that every bear with an unknown fate had died (i.e., a conservative estimate); and the other simply removing bears with an unknown fate from the sample. The true population growth rate is assumed to be somewhere in between these two estimates because we know from 30 years of tracking grizzly bears with radio-collars that every lost collar does not indicate a dead bear. While Schwartz *et al.* (2006b, p. 48) found the GYE grizzly bear DMA population increased at a rate between 4.2 and 7.6 percent per year between 1983 and 2002, the IGBST (2012, p. 34) found this growth had slowed and leveled off and was between 0.3 percent and 2.2 percent per year during 2002–2011.

Demographic Recovery Criteria 1

The model-averaged Chao2 method is currently the best available science to estimate the total population size in the GYE. The IGBST has been calculating population size on an annual basis using the model-averaged Chao2 (see glossary) estimate since 2002, and this method has been published in the peer-reviewed scientific literature. The model-averaged Chao2 method is the population estimate method that has the lowest amount of annual variation, and it is the most sensitive method to detect increasing or decreasing population trends over time. As the grizzly bear population has increased, model-averaged Chao2 estimates have become increasingly conservative (i.e., prone to underestimation). As a conservative approach to population estimation, the model-averaged Chao2 method will continue to be the method used to assess Criterion 1 (see U.S. Fish and Wildlife Service 2016, Appendix C, for the application protocol for annual population estimation using the Chao2 method) until a new population estimator is approved. If new methods become available, these will be considered for application in the GYE as long as they represent the best available science. However, until possible new methods are developed, the model-averaged Chao2 method will continue to be used. *Status:* This recovery criterion has been met since 2003 (see IGBST annual reports available at <http://www.nrmssc.usgs.gov/products/IGBST>).

Cumulative effects of Factors A through E

While these numerous stressors on grizzly bear persistence are challenging to conservation, our experience demonstrates that it is possible for large carnivore conservation to be compatible with them (Linnell *et al.* 2001, p. 48). Despite these risks, the best available information indicates the GYE grizzly bear population's trend and range has been increasing. We consider estimates of population trend (i.e., "lambda") to be the ultimate metric to assess

cumulative impacts to the population. It reflects all of the various stressors on the population and provides a scientific basis to correct a negative trend. This calculation reflects total mortality, changes in habitat quality, changes in population density, change in range, displacement effects, and so forth. In other words, there will always be threats to the GYE grizzly bear population that lead to human-caused mortality or displacement, but if these are not causing the population to decline, we cannot consider them substantial.

Post-delisting monitoring

Within the DMA, the IGBST will continue to document population trends, distribution, survival and birth rates, and the presence of alleles from grizzly bear populations outside the GYE grizzly bear DPS boundaries to document gene flow into the population. Throughout the DPS boundaries, locations of grizzly bear mortalities on private lands will be provided to the IGBST for incorporation into their annual report. To examine reproductive rates, survival rates, causes of death, and overall population trends, the IGBST will radio collar and monitor a minimum of 25 adult female grizzly bears every year. These bears will be spatially distributed throughout the ecosystem so they provide a representative sample of the entire population inside the DMA. Mortalities will be monitored and reported annually and maintained in accordance with the total mortality limits and population objectives in table 2, above.

Draft Conservation Strategy Language

Population Trend

Background

The population of grizzly bears was increasing at approximately 4% to 7% annually between 1983 and 2001 (Eberhardt *et al.* 1994, Boyce 1995, Boyce *et al.* 2001b, Harris *et al.* 2006). While there is some debate related to the actual level of increase since the bear was listed in 1975, all information, number of unduplicated females (Figure 3), distribution of reproducing females (Figure 4), distribution of bears, informal sightings by agency personnel, and areas where nuisance bears are being managed indicate this population has increased in both numbers of bears (Figure 5) and the geographic area they occupy (Schwartz *et al.* 2002).

Schwartz *et al.* (2006b) used data from 1983 through 2001, while the 2012 IGBST report examined a more recent time period, 2002 through 2011 (IGBST 2012). The 2012 report (IGBST 2012) reported that population growth had slowed since the previous time period, but was still stable to slightly increasing, and had not declined. Because the fates of some radio-collared bears are unknown, Schwartz *et al.* (2006b) and the IGBST (2012) calculated two separate estimates of population growth rate: one based on the assumption that every bear with an unknown fate had died (a conservative estimate); and the other simply removing bears with an unknown fate from the sample. The true population growth rate is assumed to be somewhere in between these two estimates because we know from 30 years of tracking grizzly bears with radio-collars that every lost collar does not indicate a dead bear. While Schwartz *et al.* (2006b) found the GYE grizzly bear population increased at a rate between 4.2 and 7.6 percent per year between 1983 and 2002, the IGBST (2012) found this growth had slowed and is stable to slightly increasing and was between 0.3 percent and 2.2 percent per year during 2002–2011.

Schwartz *et al.* (2006b) analyzed survivorship of cubs-of-the-year, yearlings, and independent bears based on whether they lived inside Yellowstone National Park, outside the Park but inside the Recovery Zone or Primary Conservation Area (PCA), or outside the PCA entirely. The PCA

boundaries (containing 23,853 sq km (9,210 sq mi) correspond to those of the Yellowstone Recovery Zone (U.S. Fish and Wildlife Service 1993) and will replace the Recovery Zone boundary (Figure 1). They concluded that grizzly bears were approaching carrying capacity inside Yellowstone National Park. Consistent with this conclusion, the IGBST (2012) documented lower cub and yearling survival than in the previous time period. Importantly, annual survival of independent females (the most influential age-sex cohort on population trend) remained the same while independent male survival increased (IGBST 2012). Collectively, these two studies indicate that the growth rate of the grizzly bear population inside the DMA had slowed as bear densities have approached carrying capacity, particularly in the core area of occupied range. Recent work by van Manen *et al.* (2015) confirms that population growth has slowed and the population is showing density dependent population regulation as the population occupies almost all suitable habitat in the DMA.

Monitoring Protocol

This Strategy recognizes that any one factor cannot provide the needed information to assess population size and trend. Ultimately, population assessments will require multiple sources of information.

Population trend, using the Lotka equation as calculated from adult female survivorship and reproductive rate data for the appropriate period (Eberhardt *et al.* 1994, Eberhardt and Knight 1996), will be used as supportive information to evaluate population trend. This method will be applied to the population inside the DMA.

The agencies will strive to maintain a minimum of 25 adult female grizzly bears fitted with mortality-sensing radio collars and monitored at all times. To adequately sample survival, these 25 adult females will be spatially distributed throughout the ecosystem. The target distribution of these 25 radio-collared adult females will be determined by the IGBST; the expected distribution of collared females by agency will be assigned. Each female will be monitored using aerial telemetry flights during the non-denning period. These data will be collected in conjunction with other regularly scheduled relocation flights. When a radio collar indicates that

a bear may have died, a field crew will evaluate the actual status of the female and determine cause of death. The IGBST will coordinate field crew collection of mortality data on each bear.

Data to calculate reproduction and survival are collected annually in all areas occupied by grizzly bears throughout the DMA. These data sets will be maintained by the IGBST and used periodically to evaluate population trend.