APPLICATION PROTOCOL
Yellowstone Grizzly Bear Demographic Recovery Criteria
March 2013

To evaluate Demographic Recovery Criterion #1, the Interagency Grizzly Bear Study Team will use the following procedures to estimate total population size:

1. The number of females with cubs of the year will be estimated using the best available science. These include:
   a. Raw observations of sightings of females with cubs of the year will be separated into observations of unique females and repeat observations of the same female using the methods of Knight et al. (1995, p. 246). The Chao2 estimator (Keating et al. 2002, p. 173) will be applied to sighting frequencies of unique females with cubs of the year to estimate the number of females with cubs of the year in the population.
   b. Mark-resight estimator based on aerial surveys to estimate females with cubs of the year (Interagency Grizzly Bear Study Team 2012, pp. 21-31).
   c. Other techniques that may be developed in the future that produce reliable estimates of females with cubs of the year.
2. The number of unique females with cubs of the year obtained from estimators described in step #1 above each year will be added to the dataset and the model-averaging process described in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 2-10). These include linear and quadratic models but other models may be added as appropriate to improve detection of change.
3. The predicted number of females with cubs of the year obtained from the model-averaged estimates described in step #2 will be used as the best estimate of the total number of independent females in the population accompanied by cubs of the year for that year.
4. The purpose of using the model-averaged estimate is to get the best estimate of the current number of females with cubs of the year borrowing information from past estimates, recognizing that with each iteration some change is expected. Estimates of females with cubs of the year for previous years will not be retrospectively adjusted with data from the current year. Model-averaging will be based on estimates of females with cubs of the year from 2000 to the current year.
5. The predicted number of females with cubs of the year will be divided by the proportion of females ≥4 years old estimated to be accompanied by cubs of the year (transition probability = 0.270). The resulting value represents the best estimate of the total number of females in the population ≥4 years old.
6. The number of females ≥4 years old will be divided by the estimated proportion of females ≥4 years old in the population of females ≥2 years old (0.844). The resulting value is the best estimate of the number of independent females (≥2 years old) in the population that year.
7. The number of independent males in the population will be based on the estimated ratio of independent males to independent females (1.000) derived via stochastic modeling described in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 10-11). The number of independent females in the population will be multiplied by 1.000 and the resulting value represents the best estimate of the number of independent males that year.
8. The number of cubs of the year in the annual population estimate will be calculated directly from the model-predicted estimate of females with cubs of the year (Interagency Grizzly Bear Study Team 2006, p. 17). The number of cubs of the year will be estimated by multiplying the modeled estimate by the mortality-adjusted mean litter size (2.49) observed from 2002–2011.
9. The number of yearlings will be estimated by multiplying the estimated number of cubs from the previous year by the mean survival rate for cubs (0.553) observed from 2002–2011.

10. The estimated total population size will then be calculated as the sum of the estimates of each age and sex class:
    a. independent females + independent males + cubs of the year + yearlings = estimate of total population size
    b. Due to the known biases in the Knight rule set that underestimate population size as true population size increases (Schwartz et al. 2008, p. 550; Study Team 2012, p. 21), this is a conservative estimate of population size.
11. Estimates of uncertainty about the number of independent females, independent males, dependent young, and total population size will be derived following methods detailed in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 10–15).
12. If the AIC_c weight favors models and trend lines indicating decline in the rate of change of females with cubs (Interagency Grizzly Bear Study Team 2006, pp. 4–8), a full review of the population's demographics will be undertaken by the Study Team to better understand population status.

To evaluate Demographic Recovery Criterion #2, the Interagency Grizzly Bear Study Team will use the following procedures to document distribution of females with offspring in Bear Management Units:

1. The distribution of reproductive female grizzly bears in Bear Management Units is assessed using verified observations of female grizzly bears with young. This includes observations of females with young of any age and/or young of unknown age. Verified observations are direct observations by trained agency personnel or observations from the public accompanied by photographic evidence and/or confirmation by trained agency personnel.

To evaluate Demographic Recovery Criterion #3, the Interagency Grizzly Bear Study Team will use the following procedures to establish annual sustainable mortality rates and count numbers of grizzly bear mortalities:

1. The Study Team will estimate the number of individuals in the population each year that are independent females, independent males, or dependent young using steps #5 – 11 under Demographic Recovery Criterion 1 above. The Study Team will then apply sustainable mortality rates to each of these age and sex classes to obtain mortality limits for that year.
2. Based on demographic analyses using data from 2002-2011, the sustainable mortality rate for independent females is **7.6%** of the population estimate of independent females. This rate will be applied to the estimate of the total number of independent females to obtain a mortality limit for that year.
3. Unknown and unreported mortality will be estimated based on the methods of Cherry et al. (2002, p. 179) and the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2005, pp. 39-41).
4. Based on demographic analyses using data from 2002-2011, the sustainable mortality rate for independent males is **15%** of the population estimate of independent males. This rate will be applied to the estimate of the total number of independent males to obtain a mortality limit for that year.
5. Based on demographic analyses using data from 2002-2011, the sustainable mortality rate for dependent young (cubs and yearlings) is **7.6%** of the annual estimate of dependent young. Only human-caused deaths (reported known and probable) will be tallied against this threshold. Unknown and unreported mortality will not be estimated for dependent young.
6. Sustainable mortality limits for independent males and females will be evaluated based on the total number of known and probable mortalities from all sources and an estimate of unknown/unreported mortality (Cherry et al. 2002). Because model-averaged estimates are used, annual variability among years has been addressed and annual mortality limits are calculated for the current year.

7. Dead bears reported in years subsequent to the actual year of mortality will be tallied against the estimated year of death and mortality total will be recalculated for that year. If mortality exceeds the threshold for that year, the difference (total mortality minus threshold) should be counted against the current years' threshold. If sex of the dead bear cannot be determined, sex will be assigned randomly using a ratio of 59:41 male:female, for independent aged bears, and 50:50 male:female for dependent young (Schwartz and Haroldson 2001, Annual Grizzly Bear Investigations 2000, Appendix A, page 120).