List of Appendices

Appendix A. Chronological List of the Grizzly Bear Recovery Process for the Greater Yellowstone Ecosystem

I. Grizzly Bear Recovery Plan revision (1993)

II. Workshop on habitat-based recovery criteria (1997)

III. Achievement of recovery targets in the Recovery Plan for demographic values and for habitat criteria specified for that grizzly bear population (1999)

IV. Conservation Strategy development for the Yellowstone area, including habitat-based recovery criteria, and release of draft Conservation Strategy for review (2000)

V. Publication of Proposed Rule in the Federal Register (2005). Proposed Rule documents the status of the population according to the five factors in ESA Section 4(a)(1) including population and habitat status, and references Conservation Strategy for documentation of the existence of adequate regulatory mechanisms and consideration of DPS policy.

VI. Public comment period with public hearings

VII. Consideration and incorporation of public comments and any new information developed as a result of the comment period

VIII. Publication of Final Rule in the Federal Register of status change or continuation of listed status in conjunction with release of the final Conservation Strategy, final Habitat Criteria, and final DPS analysis (2007).

IX. Relisting of the Yellowstone grizzly bear population (2010) in compliance with an order from the District Court of Montana that overturned the final rule (2009).

X. Concurrent publication in the Federal Register of the draft 2016 Conservation Strategy, draft Recovery Plan Supplement: Demographic Criteria, and Proposed Rule. Proposed Rule documents the status of the population according to the five factors in ESA Section 4(a)(1) including population and habitat status, and references Conservation Strategy for documentation of the existence of adequate regulatory mechanisms and consideration of DPS policy.

XI. Public comment period with public hearings

XII. Peer review

XIII. Consideration and incorporation of public comments, peer review, and any new information developed as a result of the comment period

XIV. MOU to implement the Conservation Strategy signed by all agencies

XV. Publication of Final Rule in the Federal Register of status change or continuation of listed status in conjunction with release of the final 2016 Conservation Strategy and final Recovery Plan Supplement: Demographic Criteria.

Appendix B. Estimating Numbers of Females with Cubs-of-the-Year in the Yellowstone Grizzly Bear Population

ESTIMATING NUMBERS OF FEMALES WITH CUBS-OF-THE-YEAR IN THE YELLOWSTONE GRIZZLY BEAR POPULATION

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Abstract: For grizzly bears (*Ursus arctos horribilis*) in the Greater Yellowstone Ecosystem (GYE), minimum population size and allowable numbers of human-caused mortalities have been calculated as a function of the number of unique females with cubs-of-the-year (F_{CUB}) seen during a 3-year period. This approach underestimates the total number of F_{CUB}, thereby biasing estimates of population size and sustainable mortality. Also, it does not permit calculation of valid confidence bounds. Many statistical methods can resolve or mitigate these problems, but there is no universal best method. Instead, relative performances of different methods can vary with population size, sample size, and degree of heterogeneity among sighting probabilities for individual animals. We compared 7 nonparametric estimators, using Monte Carlo techniques to assess performances over the range of sampling conditions deemed plausible for the Yellowstone population. Our goal was to estimate the number of F_{CUB} present in the population each year. Our evaluation differed from previous comparisons of such estimators by including sample coverage methods and by treating individual sightings, rather than sample periods, as the sample unit. Consequently, our conclusions also differ from earlier studies. Recommendations regarding estimators and necessary sample sizes are presented, together with estimates of annual numbers of F_{CUB} in the Yellowstone population with bootstrap confidence bounds.

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Key words: Greater Yellowstone Ecosystem, grizzly bear, nonparametric statistics, population estimation, *Ursus arctos horribilis*, Yellowstone National Park

Criteria for recovering the grizzly bear in the lower United States include annual limits on mortalities (U.S. Fish and Wildlife Service 1993). Since 1993, these limits have been calculated as a function of the number of F_{CUB} present in the population, as estimated during 6-year running periods. Currently, the number of F_{CUB} present each year (N) is estimated as the number of such animals actually observed ($\hat{N}_{Obs}$). To the extent that criteria for distinguishing family groups are conservative (see Knight et al. 1995), and because it is highly unlikely that all such animals are seen, $\hat{N}_{Obs}$ almost certainly underestimates N. This helps ensure that mortality limits are conservative, but precludes calculation of valid confidence bounds. Moreover, use of a biased estimator like $\hat{N}_{Obs}$ effectively removes decisions regarding the appropriate degree of conservatism from the purview of managers. This is not a trivial issue because the magnitudes of biases and uncertainties inherent in $\hat{N}_{Obs}$ may be biologically and managerially significant.

Efforts to calculate statistically sound estimates of N have focused on parametric approaches. Eberhardt and Knight (1996) applied the Peterson-type estimators of Chapman and Bailey (Seber 1982), and Boyce et al. (M.S. Boyce, D. MacKenzie, B.F.J. Manly, M.A. Haroldson, and D. Moody, 1999, Cumulative counts of unique individuals for estimating population size, U.S. Fish and Wildlife Service, Missoula, Montana, USA) recommended the maximum likelihood method of Lewontin and Prout (1956). These methods assume that each family group has an equal probability of being sighted. Because this assumption is untenable for the Yellowstone data (K.A. Keating, M.A. Haroldson, D. Moody, and C.C. Schwartz, 1999, Estimating the number of females with cubs-of-the-year in the Yellowstone grizzly bear population: are maximum-likelihood estimates that assume equal sightability conservative? U.S. Fish and Wildlife Service, Missoula, Montana, USA) estimates based on these methods will be negatively biased. Seeking a more robust approach, Boyce et al. (2001) recommended joint estimation of N over all years using an estimator derived from the zero-truncated negative binomial distribution. This estimator can be traced to Greenwood and Yule (1920), with early applications to wildlife population estimation by Tanton (1965, 1969) and Taylor (1966). The sampling model assumed by the negative binomial estimator allows for heterogeneous sighting probabilities among individuals and, thus, is equivalent to model M_h of Otis et al. (1978). Unfortunately, Boyce et al. (2001) found that the negative binomial estimator gave reasonable results only when the coefficient of variation among individual sighting probabilities (CV) was assumed to be constant over time. This assumption is difficult to justify for grizzly bears in Yellowstone, where year-to-year differences in distributions and abundances of foods affect bear movement patterns and, in turn, the likelihood of seeing particular bears (Picton et al. 1986). Such differences almost certainly affect heterogeneity among individual sighting probabilities, implying that CV varies among years. Also, because the size, distribution, and behavior of bear populations may interact in ways that affect sightability (Keating 1986), CV likely changes with N. The claim of an increased bear population in Yellowstone (Boyce et al. 2001), therefore, is inconsistent with the assumption of a constant CV. The joint estimation procedure recommended by Boyce et al. (2001) suffers other drawbacks as well. Most seriously, estimates of N from previous years may change retrospectively as new data are added — a property that is justifiable only if CV is truly constant over time. Overall, problems with the parametric methods used to date argue for considering other alternatives.

Many nonparametric estimators might apply to this problem (e.g., Otis et al. 1978, Bunge and Fitzpatrick 1993, Lee and Chao 1994). Indeed, when estimating N under model M_h, many studies have favored non-parametric methods such as the jackknife (Burnham and Overton 1978, 1979), Chao (Chao 1984, 1989), and sample coverage estimators (Chao and Lee 1992, Lee and Chao 1994). Among the nonparametric methods available, however, there is no universal best choice, as relative performances can vary with N, CV, or sample size (Burnham and Overton 1979, Smith and van Belle 1984, Chao 1988). What we require is an estimator that is reasonably robust to variations in these parameters over the range of values experienced when sampling the Yellowstone grizzly bear population. To identify such an estimator, we used Monte Carlo methods to compare performances of 7 nonparametric methods when sampling from a range of conditions that encompassed those deemed plausible for observations of F_{CUB} in the GYE.

METHODS

General Problem and Notation

The sampling model we used approximates the true sampling scheme, in which reports of F_{CUB} come from observers using various sampling methods (ground-based observation, trapping, systematic fixed-wing observations, or fixed-wing observations made incidental to other work). Because the sampling period associated with each of these methods varies considerably (or, in some cases, is undefined) we used the sighting of an individual F_{CUB} as the sample unit. The problem of estimating population size from repeated sightings of unique individuals may then be phrased as a special case of the more general model in which multiple individuals may be sighted during a given sampling period (e.g., Otis et al. 1978).

Suppose that, during a given year, after recording n independent random sightings of individuals from a closed population of size N (where N is unknown), we observe m unique animals. The average probability that any particular sighting will be of the ith individual is p_i, and probabilities for all N individuals are given by $\mathbf{p} = (p_1, p_2, ..., p_N)$ where

$$\sum_{i=1}^{N} p_i = 1$$

Because the model allows for heterogeneous p_i values, temporal or spatial differences in habitat use or sampling effort are incorporated into $\mathbf{p}$, as are differences in probabilities of reporting and recording sightings of particular animals. We assume all individuals are correctly identified (consequences of misidentification are considered below). In our sample, individuals were observed with frequency $\mathbf{n} = (n_1, n_2, ..., n_N)$, which is multinomially distributed with cell probabilities $(p_1, p_2, ..., p_N)$. However, we do not know the identities of the $N - m$ animals for which $n_i = 0$. The number of different individuals observed exactly j times was f_j, and $\mathbf{f} = (f_0, f_1, f_2, ..., f_n)$ is fully observable except for f_0, the number of bears not observed in our sample. Important relationships include

$$n = \sum_{i=1}^{N} n_i = \sum_{j=1}^{N} j f_j$$
$$m = \sum_{j=1}^{N} f_j$$

and $N - m = f_0$. The problem is to estimate N (or, equivalently, f_0) using only the observable information in $\mathbf{f}$ and n.

In this idealized model, all information about population size is obtained from the n randomly sighted individuals. For the Yellowstone grizzly bear population, observations of radiomarked F_{CUB} made during radiorelocation flights provide additional information from non-randomly sighted individuals. In particular, observations of otherwise unobserved F_{CUB} may be added to m to improve the estimate of minimum population size, yielding $\hat{N}_{Obs} \geq m$. $\hat{N}_{Obs}$ provides a natural lower bound for estimating N and is the estimator that has been used previously to set annual mortality limits. Overall, we seek an estimator that improves upon $\hat{N}_{Obs}$ while minimizing the risk of overestimating N.

The Estimators

In addition to m and $\hat{N}_{Obs}$, which we included in our analyses for comparative purposes, we evaluated 7 nonparametric estimators (see Table 1 for example calculations). The first 5 methods we considered estimate N as $\hat{N} = m + \hat{f}_0$, where $\hat{f}_0$ is an estimate of the number of unobserved individuals.

We first examined Chao's (1984) estimator,

$$\hat{N}_{Chao1} = m + \frac{f_1^2}{2f_2} \quad (1)$$

In Eq. (1), $\hat{f}_0 = f_1^2/(2f_2)$. Using $\hat{N}_{Chao1}$, the statistical expec-

Table 1. Example calculations for the 7 non-parametric estimators compared in this study, using 1997 grizzly bear sighting data from the Greater Yellowstone Ecosystem. For 1997, $n = 65$ sightings of females with cubs-of-the-year (F_{CUB}) were made via means other than radiotelemetry. Distinguishing individuals as per Knight et al. (1995), $m = 29$ unique animals were seen; 13 were seen once ($f_1 = 13$), 7 were seen twice ($f_2 = 7$), 4 were seen 3 times ($f_3 = 4$), 1 was seen 4 times ($f_4 = 1$), 3 were seen 5 times ($f_5 = 3$), and 1 was seen 7 times ($f_7 = 1$). Two additional and otherwise unobserved F_{CUB} were seen only as a result of using radiotelemetry. Because all calculations were carried out in double precision, rounding errors are evident in some of the examples.

Estimator	Example calculation
Unique F_{CUB} observed via random sightings	$m=29$
Unique F_{CUB} observed via random sightings and radiotelemetry	$\hat{N}_{Obs}=29+2=31$
Chao	$\hat{N}_{Chao1}=m+\frac{f_1^2}{2f_2}=29+\frac{13^2}{2(7)}\approx 41.1$
Bias-corrected Chao	$\hat{N}_{Chao2}=m+\frac{f_1^2-f_1}{2(f_2+1)}=29+\frac{13^2-13}{2(7+1)}\approx 38.8$
First-order jackknife	$\hat{N}_{J1}=m+\left(\frac{n-1}{n}\right)f_1=29+\left(\frac{65-1}{65}\right)13=41.8$
Second-order jackknife	$\hat{N}_{J2}=m+\left(\frac{2n-3}{n}\right)f_1-\left(\frac{(n-2)^2}{n(n-1)}\right)f_2=29+\left(\frac{2(65)-3}{65}\right)13-\left(\frac{(65-2)^2}{65(65-1)}\right)7\approx 47.7$
Best-order jackknife	$\hat{N}_{Jk1}=\hat{N}_{J1}=41.8$ was selected because $T_1=\frac{\hat{N}_{J2}-\hat{N}_{J1}}{[\widehat{\mathrm{var}}(\hat{N}_{J2}-\hat{N}_{J1}\mid m)]^{1/2}}\approx\frac{47.7-41.8}{[17.996]^{1/2}}\approx 1.396<1.960$, where $\widehat{\mathrm{var}}(\hat{N}_{J2}-\hat{N}_{J1}\mid m)=\frac{m}{m-1}\left[\sum_{j=1}^{2}(b_j)^2 f_j-\frac{(\hat{N}_{J2}-\hat{N}_{J1})^2}{m}\right]$ $\approx\frac{29}{29-1}\left[\left(\frac{2(65)-3}{65}-\frac{65-1}{65}\right)^2 13+\left(\frac{(65-2)^2}{65(65-1)}\right)^2 7-\frac{(47.7-41.8)^2}{29}\right]\approx 17.996$
First-order sample coverage	$\hat{N}_{SC1}=\frac{m+f_1\hat{\gamma}^2}{\hat{C}_1}=\frac{29+13(0.325)}{0.800}\approx 41.5$, where $\hat{C}_1=1-\frac{f_1}{n}=1-\frac{13}{65}=0.800$ and $\hat{\gamma}^2=\max\left\{\frac{m}{\hat{C}_1}\sum_{j=1}^{n}\frac{j(j-1)f_j}{n(n-1)}-1,\ 0\right\}=\max\left\{\frac{29}{0.800}\left(\frac{2(7)+6(4)+12(1)+20(3)+42(1)}{65(65-1)}\right)-1,\ 0\right\}\approx 0.325$
Second-order sample coverage	$\hat{N}_{SC2}=\frac{m+f_1\hat{\gamma}^2}{\hat{C}_2}=\frac{29+13(0.319)}{0.803}\approx 41.3$, where $\hat{C}_2=1-\frac{f_1-2f_2/(n-1)}{n}=1-\frac{13-2(7)/(65-1)}{65}\approx 0.803$ and $\hat{\gamma}^2=\max\left\{\frac{m}{\hat{C}_2}\sum_{j=1}^{n}\frac{j(j-1)f_j}{n(n-1)}-1,\ 0\right\}=\max\left\{\frac{29}{0.803}\left(\frac{2(7)+6(4)+12(1)+20(3)+42(1)}{65(65-1)}\right)-1,\ 0\right\}\approx 0.319$

tation for the estimate, $E(\hat{N})$, equals N only when sighting probabilities are the same for all animals; i.e., when CV= 0. Theoretically, when CV > 0, $E(\hat{N}) < N$ (Chao 1984). This does not ensure $\hat{N}_{Chao1} \leq N$ in all cases, but does suggest that $\hat{N}_{Chao1}$ might provide an inherently conservative approach to estimating N. We also considered a similar bias-corrected form of this estimator, developed by Chao (1989). Where the sample unit is the individual animal, Chao's (1989) estimator is given by (Wilson and Collins 1992),

$$\hat{N}_{Chao2} = m + \frac{f_1^2 - f_1}{2(f_2 + 1)}$$

Here, $\hat{f}_0 = (f_1^2 - f_1)/[2(f_2 + 1)]$. Unlike $\hat{N}_{Chao1}$, $\hat{N}_{Chao2}$ will yield an estimate even when $f_2 = 0$.

Burnham and Overton (1978, 1979) devised a jackknife estimator ($\hat{N}_{Jk}$) of the general form

$$\hat{N}_{Jk} = m + \sum_{j=1}^{k} \alpha_{jk} f_j$$

where α_{jk} is a coefficient in terms of n, and $\alpha_{jk} = 0$ when $j > k$ (see Table 2). Here, f_0 is estimated as the series

$$\sum_{j=1}^{k} \alpha_{jk} f_j$$

Theoretically, jackknife estimates of order $k = 1$ to n could be calculated, but variance increases rapidly with k so that, in practice, k is small (Burnham and Overton 1979). We considered the first- and second-order jackknife estimators ($\hat{N}_{J1}$ and $\hat{N}_{J2}$, respectively; Table 2), as well as a best kth-order jackknife estimator. Burnham and Overton (1979) suggested 2 methods for choosing a best value for k for a particular study. Because previous work showed little difference between them (K.A. Keating unpublished data), we considered only their first method, which evaluates estimates of order $k = 1$ to 5 (Table 2). The method is as follows. Beginning with $k = 1$ and proceeding to subsequently higher values of k, test the null hypothesis that $E(\hat{N}_{J,k+1} - \hat{N}_{Jk}) = 0$ versus the alternative hypothesis that $E(\hat{N}_{J,k+1} - \hat{N}_{Jk}) \neq 0$. If the observed difference is not significant, testing ends and $\hat{N}_{Jk}$ is taken as the best jackknife estimate. We reference the resulting kth-order estimate as $\hat{N}_{Jk1}$. The test is based on the statistic

$$T_k = \frac{\hat{N}_{J,k+1} - \hat{N}_{Jk}}{[\hat{\text{var}}(\hat{N}_{J,k+1} - \hat{N}_{Jk} \mid m)]^{1/2}}$$

where

$$\hat{\text{var}}(\hat{N}_{J,k+1} - \hat{N}_{Jk} \mid m) = \frac{m}{m-1}\left[\sum_{j=1}^{n}(b_j)^2 f_j - \frac{(\hat{N}_{J,k+1} - \hat{N}_{Jk})^2}{m}\right]$$

Table 2. Jackknife estimators of population size, $\hat{N}_{Jk}$, for order k = 1-5, where m is the number of unique individuals observed after n samples and f_i is the number of individuals observed exactly i times (after Burnham and Overton 1979).

$$\hat{N}_{J1} = m + \left(\frac{n-1}{n}\right) f_1$$

$$\hat{N}_{J2} = m + \left(\frac{2n-3}{n}\right) f_1 - \left(\frac{(n-2)^2}{n(n-1)}\right) f_2$$

$$\hat{N}_{J3} = m + \left(\frac{3n-6}{n}\right) f_1 - \left(\frac{3n^2-15n+19}{n(n-1)}\right) f_2 + \left(\frac{(n-3)^3}{n(n-1)(n-2)}\right) f_3$$

$$\hat{N}_{J4} = m + \left(\frac{4n-10}{n}\right) f_1 - \left(\frac{6n^2-36n+55}{n(n-1)}\right) f_2 + \left(\frac{4n^3-42n^2+148n-175}{n(n-1)(n-2)}\right) f_3 - \left(\frac{(n-4)^4}{n(n-1)(n-2)(n-3)}\right) f_4$$

$$\hat{N}_{J5} = m + \left(\frac{5n-15}{n}\right) f_1 - \left(\frac{10n^2-70n+125}{n(n-1)}\right) f_2 + \left(\frac{10n^3-120n^2+485n-660}{n(n-1)(n-2)}\right) f_3 - \left(\frac{(n-4)^5-(n-5)^5}{n(n-1)(n-2)(n-3)}\right) f_4 + \left(\frac{(n-5)^5}{n(n-1)(n-2)(n-3)(n-4)}\right) f_5$$

and $b_j = \alpha_{j,k+1} - \alpha_{jk}$. T_k was evaluated at $\alpha = 0.05$ using P values determined from the standard normal distribution.

Chao and Lee (1992) proposed an estimator based on sample coverage (C), where C is the sum of the p_i values for the m individuals actually observed in the sample. Lee and Chao (1994) offered 2 estimators of C that, in the notation of our sampling model, are given by

$$\hat{C}_1 = 1 - \frac{f_1}{n} \quad (2)$$

and

$$\hat{C}_2 = 1 - \frac{f_1 - 2f_2/(n-1)}{n} \quad (3)$$

In Eqs. (2) and (3), the quantities f_1/n and $[f_1 - 2f_2/(n-1)]/n$, respectively, estimate the sum of the p_i values for the f_0 unobserved animals. For our model (equivalent to model M_h of Otis et al. [1978]), Lee and Chao (1994) then estimated N as

$$\hat{N}_{SCj} = \frac{m}{\hat{C}_j} + \frac{f_1}{\hat{C}_j}\hat{\gamma}^2 = \frac{m + f_1\hat{\gamma}^2}{\hat{C}_j} \quad (4)$$

where $j = 1$ or 2, and γ is a measure of the coefficient of variation of the p_i's . Essentially, Eq. (4) begins with a Peterson-type estimator ($m/\hat{C}$) that assumes equal sightability (i.e., all $p_i = 1/N$; Darroch and Ratcliff 1980), then adds a bias correction term ($f_1\hat{\gamma}^2/\hat{C}_j$) that increases with heterogeneity, as estimated by $\hat{\gamma}^2$. Put another way, the quantity $f_1\hat{\gamma}^2$ estimates the number of additional individuals that would have been observed if **p** had, in fact, been homogeneous. Adding this to m then dividing by the estimated coverage estimates N. Where the sample unit is the sighting of an individual animal, $\hat{\gamma}^2$ is calculated as (Chao and Lee 1992),

$$\hat{\gamma}^2 = \max\left\{\hat{N}\sum_{j=1}^{n}\frac{j(j-1)f_j}{n(n-1)} - 1,\ 0\right\} \quad (5)$$

Calculation of $\hat{\gamma}^2$ requires an initial estimate of N. Following Chao and Lee (1992), we used $\hat{N} = m/\hat{C}_j$. We considered but did not use the partitioned sample coverage estimator of Chao et al. (1993, 2000) because preliminary Monte Carlo results showed the method offered no advantage over $\hat{N}_{SCj}$ when applied to our field data.

Monte Carlo Comparisons

Estimator performances were compared using Monte Carlo methods. Parameters for the Monte Carlo sampling were chosen to encompass the range of values deemed plausible when sampling F_{CUB} in the GYE. Overall, we simulated 15 populations, including all combinations of $N = 20, 40$, and 60 animals, where the coefficient of variation among the p_i values was set to CV = 0.0, 0.25, 0.50, 0.75, or 1.0. We calculated p_i as the integral of a standard beta distribution over the interval $(i - 1)/N$ to i/N; i.e.,

$$p_i = I_{i/N}(a,b) - I_{(i-1)/N}(a,b), \quad (6)$$

where $I_x(a,b)$ is the incomplete beta function ratio with parameters a and b (Johnson et al. 1995). We used a downhill simplex (Press et al. 1992) to select values for a and b (Table 3) that gave the desired CV among the p_i values. We then sampled each population, with replacement, by generating n pseudorandom numbers from the specified beta distribution and tallying each as a sighting of the ith animal if it fell within the interval $(i - 1)/N$ to i/N. We chose n so that the number of sightings per individual in the population (n/N) was equal to 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, or 4.0. After each sampling bout, we estimated N using each of the estimators described above. This process was repeated 1,000 times for each parameterization of the model. For each parameterization and estimator, performance was summarized as the bias and root mean square error (RMSE) of the estimator, where

$$\text{RMSE} = \sqrt{\text{bias}^2 + \text{SD}^2}$$

In addition, 2 estimators ($\hat{N}_{SC1}$ and $\hat{N}_{SC2}$) yielded explicit estimates of CV, in the form of $\hat{\gamma}$ (Eq. 5).

Following the above analyses, the most promising estimator was selected. Confidence bounds for estimates based on the best method were calculated using the method of Boyce et al. (2001), in which bootstrap samples were drawn from the distribution of individual sighting frequencies implied by $\hat{N}$ (i.e., from the estimate of the vector **n**). Details are as follows. A model population with $\hat{N}$ indi-

Table 3. Values of the parameters (a, b) of the standard beta distributions used to model p = (p_1, p_2, ...p_N), where p_i is the probability that a particular sighting will be of the ith animal. Values are listed by size (N) of the model population and the coefficient of variation (CV) among the p_i values.

	(*a*, *b*)				
N	CV = 0.00	CV = 0.25	CV = 0.50	CV = 0.75	CV = 1.00
20	(1.000, 1.000)	(0.955, 1.270)	(0.791, 1.380)	(0.664, 1.446)	(0.589, 1.600)
40	(1.000, 1.000)	(1.084, 1.398)	(0.797, 1.382)	(0.686, 1.477)	(0.593, 1.512)
60	(1.000, 1.000)	(1.173, 1.449)	(0.794, 1.369)	(0.688, 1.462)	(0.611, 1.559)

viduals was constructed and the first m individuals were assigned sighting frequencies $\mathbf{n}^* = (n_1^*, n_2^*, ..., n_m^*)$, corresponding to the actual sighting frequencies (n_i values) for the m animals observed in the original sample. The remaining $\hat{N} - m$ individuals were assigned sighting frequencies of 0. A bootstrap sample of $\hat{N}$ (rounded to the nearest integer) individual sighting frequencies (n_i^* values) was then randomly drawn with replacement from $\mathbf{n}^*$. The number of samples for which $n_i^* = j$ was tabulated as f_j^*, giving the bootstrap sighting frequency vector $\mathbf{f} = (f_1^*, f_2^*, ..., f_n^*)$, and the bootstrap number of sightings

$$n^* = \sum_{j=1}^{n} jf_j^*$$

The estimate was then recalculated using the information in $\mathbf{f}^*$ and n^*. This procedure was repeated 1,000 times for each estimate. Confidence bounds were calculated using both the percentile and bias-corrected-and-accelerated (BCA) methods (Efron and Tibshirani 1993). We assessed performances of the 2 methods by comparing observed versus nominal coverages.

Although 90 or 95% confidence bounds are normal for scientific hypothesis testing, managers may appropriately choose a higher level of risk. Thus, we compared coverages for lower, 1-tailed 70, 80, 90, and 95% confidence bounds. Earlier studies reported 2-tailed confidence bounds (e.g., Eberhardt and Knight 1996, Boyce et al. 2001). However, we believe 2-tailed bounds are inappropriate for this problem because managers charged with recovering the Yellowstone grizzly bear population are concerned with possible overharvest, not underharvest. Thus, they seek assurance that the true population size is greater than or equal to the estimated size. It follows that lower, 1-tailed confidence bounds provide the appropriate measure of uncertainty.

Field Data

Sightings of F_{CUB} were examined for 1986–2001. We considered only sightings from within the grizzly bear recovery zone and the surrounding 10-mile buffer area because calculated mortality limits only apply to human-caused mortalities within this area. Boyce et al. (2001) considered sightings throughout the GYE. Consequently, sample sizes (n values) and numbers of unique, randomly observed F_{CUB} (m values) reported herein differ slightly from values reported by Boyce et al. (2001).

For each year, unique family groups were distinguished as per Knight et al. (1995). Observations of radiocollared animals made during radiolocation flights were included when calculating the minimum number of F_{CUB} known to exist in the population each year ($\hat{N}_{Obs}$), but were excluded from statistical estimates of N because such sightings were non-random. Sightings were summarized by year as the number of unique family groups seen once, twice, etc. Total numbers of F_{CUB} for each year were then estimated using the method selected following our Monte Carlo comparisons. Lower, 1-tailed confidence bounds were calculated using the selected bootstrap procedure.

RESULTS

Monte Carlo Comparisons

Patterns of estimator performance varied little with population size. For brevity, therefore, we discuss only results for model populations with $N = 40$ individuals.

Population Estimates.—All estimates tended to converge toward N as relative sample size (n/N) increased, but rate of convergence and direction of bias at small to moderate sample sizes varied considerably among estimators and with CV (Fig. 1). Contrary to expectations, Chao's (1984) estimator, $\hat{N}_{Chao1}$, was postively biased when CV was small. This bias was especially pronounced when n/N also was small. However, $\hat{N}_{Chao1}$ was among the least biased estimators when CV was large, regardless of sample size. As predicted by theory (Chao 1989), $\hat{N}_{Chao1}$ was nearly unbiased when CV = 0, but became increasingly and negatively biased as CV increased. The jackknife estimators ($\hat{N}_{J1}$, $\hat{N}_{J2}$, and $\hat{N}_{Jk1}$) were all negatively biased when $n/N < 1.0$, but tended to overestimate N at sample sizes where $1.0 < n/N \leq 3.0$, particularly when CV was small. The jackknife estimators also did not converge toward N as quickly as other estimators as sample size increased. Patterns for the 2 sample coverage estimators were similar: both tended to overestimate N when n/N and CV were small, but converged relatively quickly toward N as n/N exceeded 1.0, particularly when $0.25 \leq CV \leq 0.75$.

With some methods, it was not always possible to estimate N. Over the full range of conditions modeled, $\hat{N}_{Chao1}$ $\hat{N}_{Jk1}$, $\hat{N}_{SC1}$, and $\hat{N}_{SC2}$ failed to yield estimates in 0.2% of the cases (range = 0.0–29.0% for $\hat{N}_{Chao1}$; range = 0.0–6.6% for $\hat{N}_{Jk1}$, $\hat{N}_{SC1}$, and $\hat{N}_{SC2}$). Reasons for failures varied. For $\hat{N}_{Chao1}$, no estimate is possible when $f_2 = 0$ because this leads to division by zero (Eq. 1). For $\hat{N}_{Jk1}$, the selection process was aborted if a best jackknife estimate was not selected from the estimates $\hat{N}_{J1}$ - $\hat{N}_{J5}$. Using $\hat{N}_{Jk1}$, Burnham and Overton (1979) similarly failed to identify a best estimate in 3.7% of their trials. For $\hat{N}_{SC1}$ and $\hat{N}_{SC2}$, no population estimate is possible if the estimated sample coverage is zero, as this also leads to division by zero (Eq. 4). This occurs when individuals in the sample are seen only once each, so that $f_1 = n$ and $f_2 = 0$ (Eqs. 2 and 3). For all of these methods, failure rates declined as sample size and, hence, information content increased.

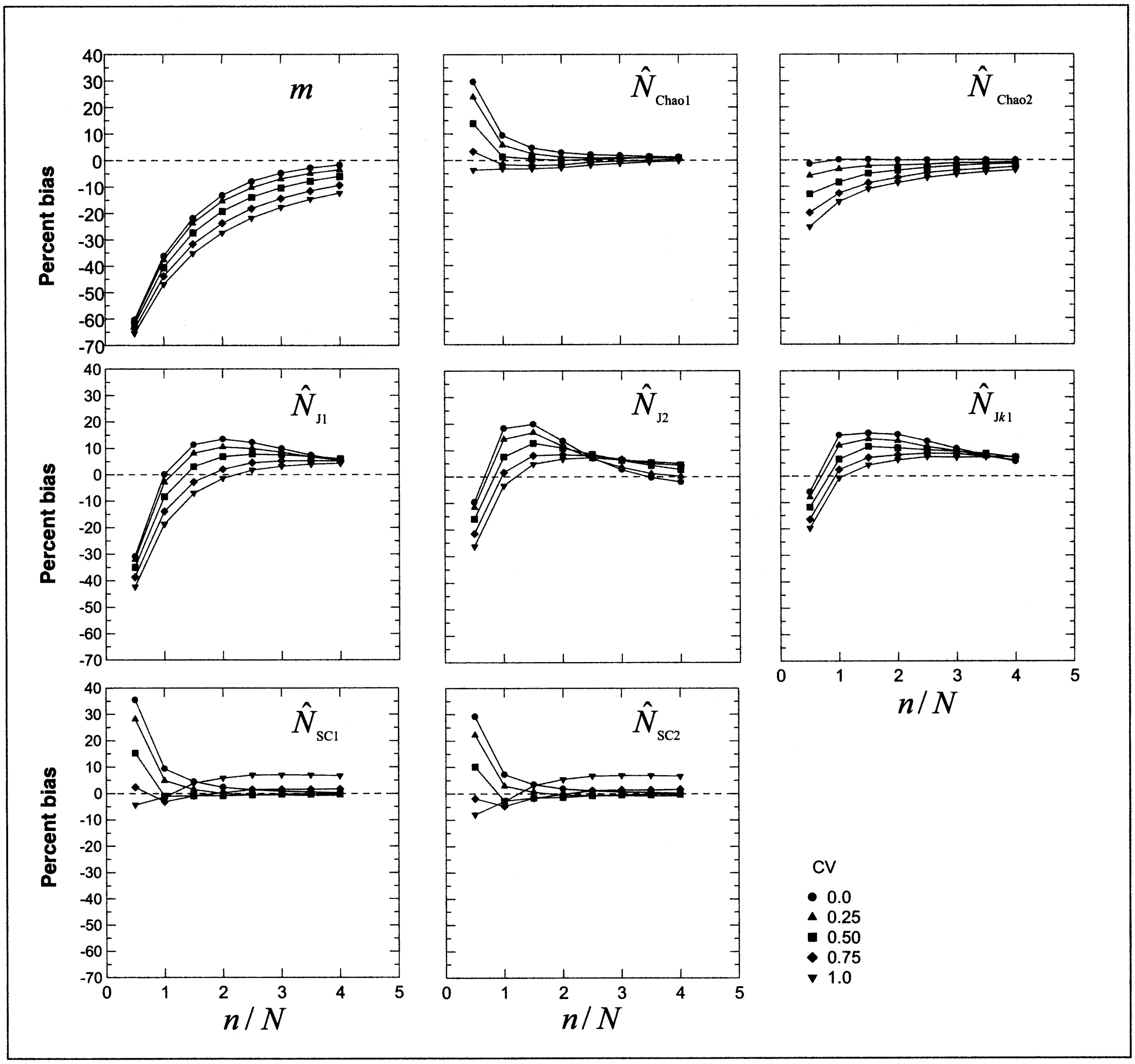

Fig. 1. Percent bias of population estimates calculated using the Chao ($\hat{N}_{Chao1}$), bias-corrected Chao($\hat{N}_{Chao2}$), first-order jackknife ($\hat{N}_{J1}$), second-order jackknife ($\hat{N}_{J2}$), best-order jackknife ($\hat{N}_{Jk1}$), first-order sample coverage ($\hat{N}_{SC1}$), and second-order sample coverage ($\hat{N}_{SC2}$) estimators. Number of unique individuals observed (*m*) is shown for comparison. Each point represents the mean of 1,000 Monte Carlo replicates; in each, calculations were based on *n* random sightings drawn from a model population with *N* = 40 individuals. CV gives the coefficient of variation among sighting probabilities for the 40 individuals. CV = 0.0 indicates equal sightability.

For $\hat{N}_{Chao1}$, $\hat{N}_{Chao2}$, $\hat{N}_{SC1}$, and $\hat{N}_{SC2}$, RMSE declined monotonically toward zero as n/N increased (Fig. 2). Patterns of decline were indistinguishable for $\hat{N}_{SC1}$ and $\hat{N}_{SC2}$, and RMSE converged more quickly toward zero for these estimators than for $\hat{N}_{Chao1}$ or $\hat{N}_{Chao1}$. Also for these 4 estimators, RMSE increased with CV when $n/N \geq 1$. When n/N was small, $\hat{N}_{J1}$, $\hat{N}_{J2}$, and $\hat{N}_{Jk1}$ exhibited the lowest RMSEs of the estimators we evaluated. However, rate of convergence toward zero as sample size increased was slow compared to other methods; indeed, RMSE for the jackknife estimators often increased with sample size when $0.5 \leq n/N \leq 2.0$. Also, relatively low RMSEs, especially for $\hat{N}_{J1}$, often were due to low standard deviations overcompensating for high bias. This suggested that $\hat{N}_{J1}$ may yield narrow confidence bounds, but that those bounds will be centered around highly biased estimates, likely resulting in poor coverage.

Of the methods we compared, our overall choice was the second-order sample coverage estimator, $\hat{N}_{SC2}$ (see Discussion). Comparing observed versus nominal lower, 1-tailed confidence bounds for $\hat{N}_{SC2}$ showed that coverage was affected by n/N and CV, and by the method used to calculate confidence bounds (Figs. 3 and 4). Disparities between observed and nominal coverages generally

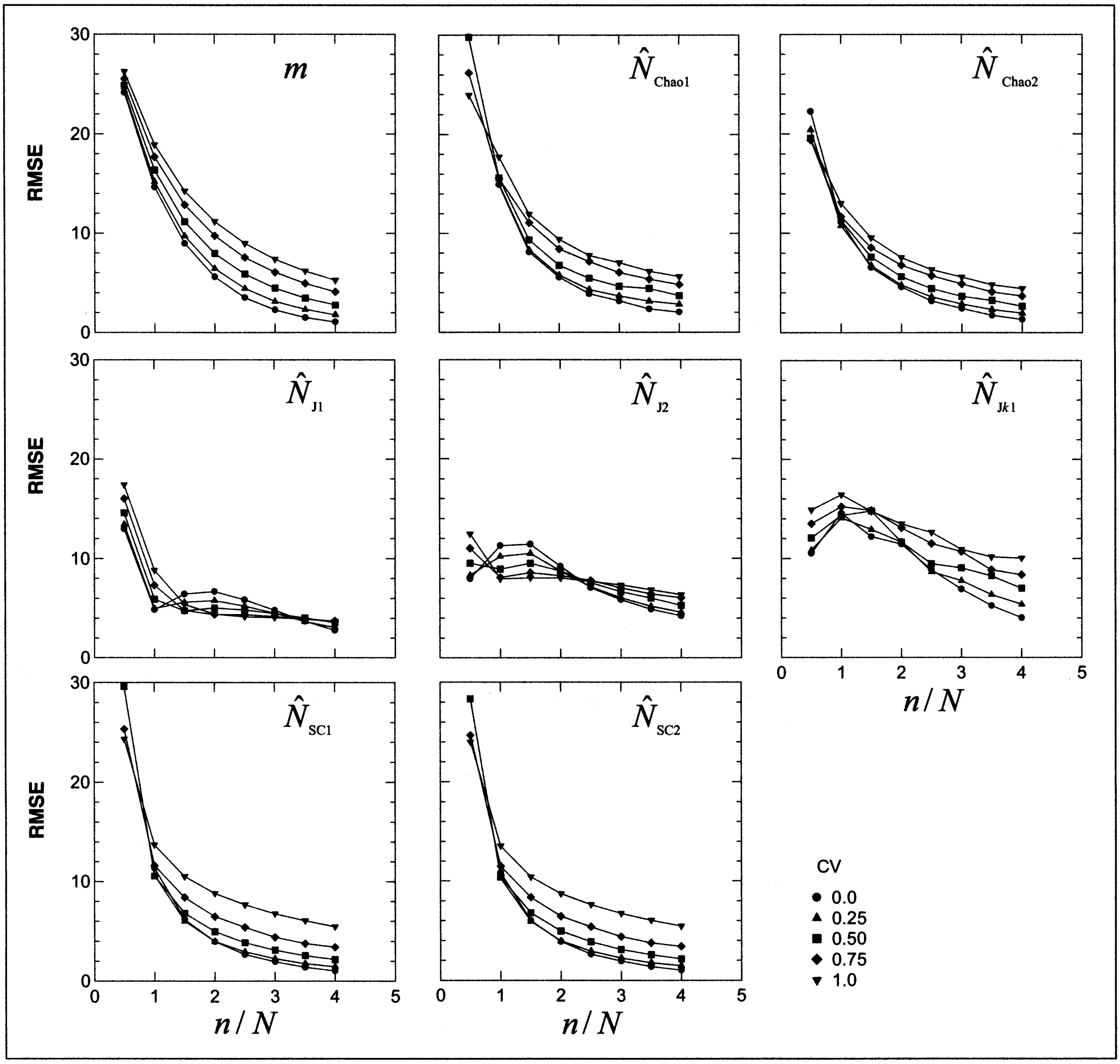

Fig. 2. Root mean square error (RMSE) of population estimates calculated using the Chao ($\hat{N}_{Chao1}$), bias-corrected Chao ($\hat{N}_{Chao2}$), first-order jackknife ($\hat{N}_{J1}$), second-order jackknife ($\hat{N}_{J2}$), best-order jackknife ($\hat{N}_{Jk1}$), first-order sample coverage ($\hat{N}_{SC1}$), and second-order sample coverage ($\hat{N}_{SC2}$) estimators. Number of unique individuals observed (*m*) is shown for comparison. Each data point represents the mean of 1,000 Monte Carlo replicates; in each, calculations were based on *n* random sightings drawn from a model population with *N* = 40 individuals. CV gives the coefficient of variation among sighting probabilities for the 40 individuals. CV = 0.0 indicates equal sightability.

increased with CV, but declined as the nominal confidence level increased. Results varied most noticeably with n/N when CV ≥ 0.75. Using the percentile bootstrap method, nominal values sometimes overstated the true coverage when CV = 0.0, but tended to either closely approximate or understate true coverage when 0.25 ≤ CV ≤ 1.0 (Fig. 3). Using the BCA bootstrap method, nominal values more closely approximated observed coverages when CV = 0.0, and tended to either approximate or understate true coverage when 0.25 ≤ CV ≤ 0.75. For CV = 1.0, however, nominal values tended to overstate true coverage by a large margin when n/N ≥ 2.0. Overall, we chose the percentile bootstrap method for calculating confidence bounds because, with CV = 0.0 unlikely in natural populations, we believe that it better minimizes the risk of overestimating *N*.

Estimates of n/N *and CV.*—In our Monte Carlo study, n/N and CV were important determinants of performance for our estimator of choice, $\hat{N}_{SC2}$. Estimates of these values are given by $n/\hat{N}_{SC2}$ and $\hat{\gamma}$ (Eq. 5), respectively. Presumably, such estimates might be used to ask whether actual values of n/N and CV in our field studies were within the range of values in which $\hat{N}_{SC2}$ performed well. First, however, it is prudent to ask whether $n/\hat{N}_{SC2}$ and $\hat{\gamma}$ themselves provide

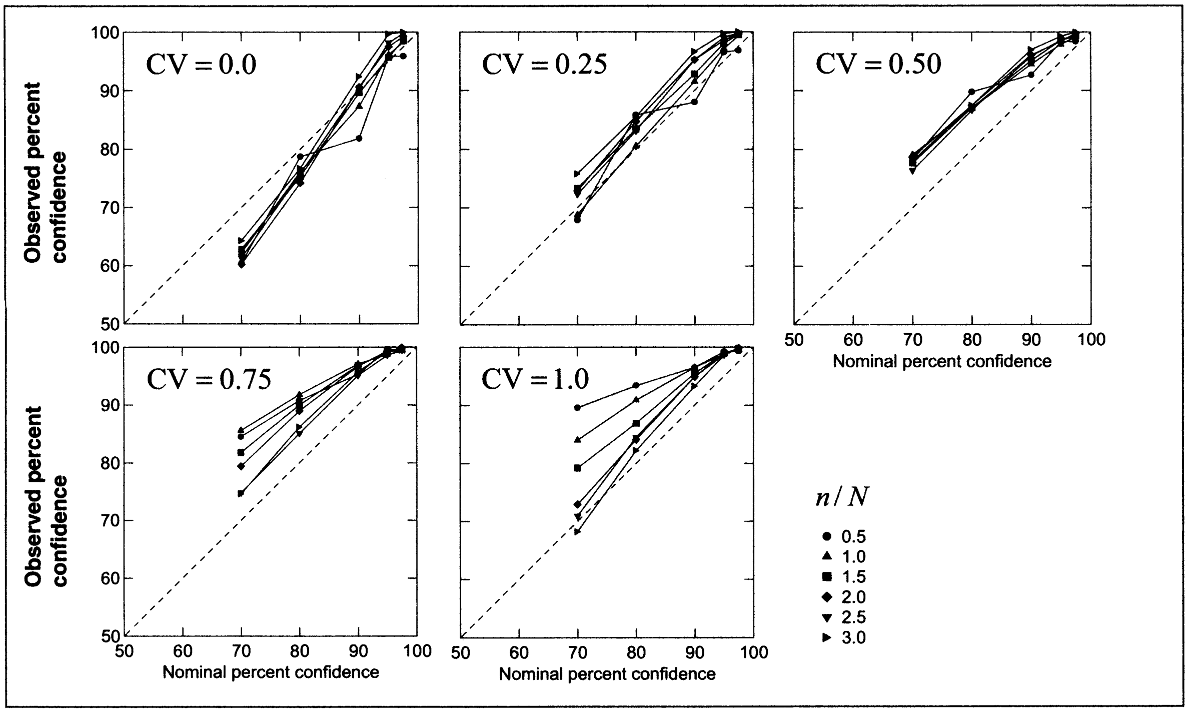

Fig. 3. Observed versus nominal coverages of lower, 1-tailed confidence bounds for second-order sample coverage estimates ($\hat{N}_{SC2}$), calculated using the percentile bootstrap method (Efron and Tibshirani 1993). Points above the dashed line indicate that mean observed coverage was greater than nominal coverage, so confidence bounds tended to be conservative. Each data point represents the mean of 1,000 Monte Carlo replicates; in each, calculations were based on *n* random sightings drawn from a model population with *N* = 40 individuals. CV gives the coefficient of variation among sighting probabilities for the 40 individuals. CV = 0.0 indicates equal sightability.

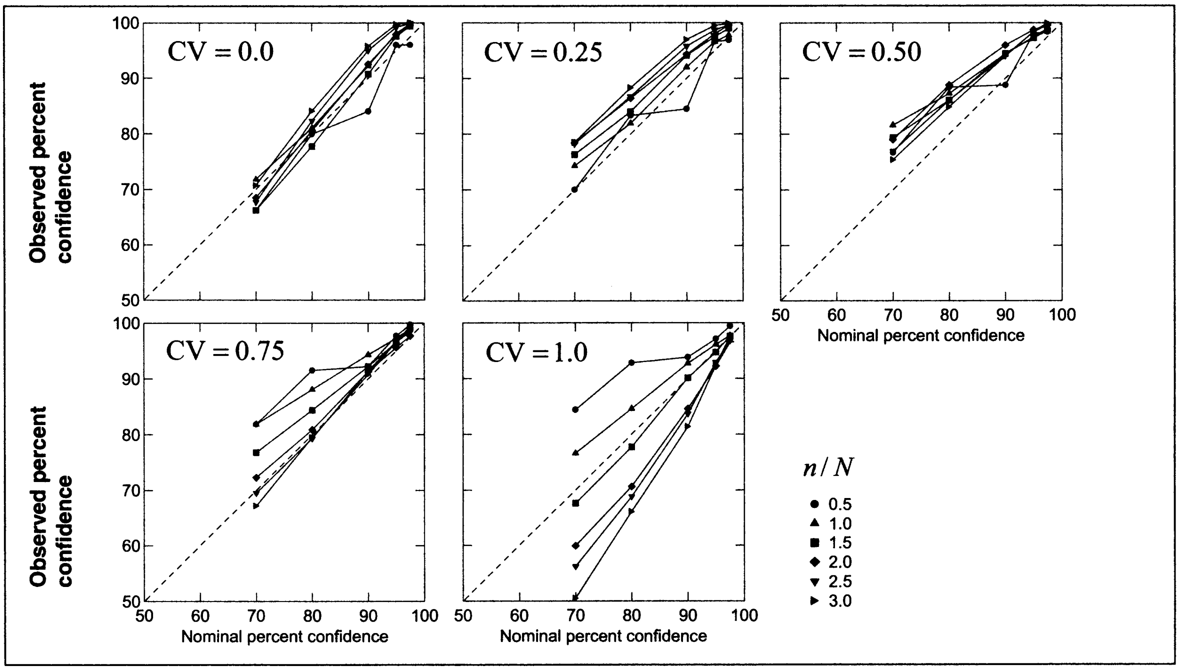

Fig. 4. Observed versus nominal coverages of lower, 1-tailed confidence bounds for second-order sample coverage estimates ($\hat{N}_{SC2}$), calculated using the bias corrected and accelerated bootstrap method (Efron and Tibshirani 1993). Points above the dashed line indicate that mean observed coverage was greater than nominal coverage, so that confidence bounds tended to be conservative. Each data point represents the mean of 1,000 Monte Carlo replicates; in each, calculations were based on *n* random sightings drawn from a model population with *N* = 40 individuals. CV gives the coefficient of variation among sighting probabilities for the 40 individuals. CV = 0.0 indicates equal sightability.

good estimates. Comparisons showed that $n/\hat{N}_{SC2}$ provided nearly unbiased estimates of n/N throughout the range of conditions we modeled (Fig. 5a). However, $\hat{\gamma}$ was a biased estimator of CV, overestimating the true value when CV = 0.0 and underestimating in all other cases (Fig. 5b). The degree to which $\hat{\gamma}$ underestimated CV when CV ≥ 0.25 was influenced by relative sample size. When $n/N = 3.0$, $\hat{\gamma}$ tended to underestimate CV by about 0.07–0.14. When $n/N = 0.5$, $\hat{\gamma}$ tended to underestimate CV by about 0.10-0.59.

Field Data

Observation frequencies for F_{CUB} in Yellowstone's grizzly bear recovery area and the surrounding 10-mile buffer zone were tabulated for 1986–2001 (Table 4). Sample sizes ranged from 20 observations in 1987 to 94 in 1999. Using $\hat{N}_{SC2}$ and rounding to the nearest integer, estimated numbers of F_{CUB} in the Yellowstone population ranged from 20 animals in 1987 and 1989 to 60 in 2000 (Table 5). Estimated relative sample size ($n/\hat{N}_{SC2}$) averaged 1.5 and ranged from 0.5 in 1995 to 2.6 in 1986 and 1999, with $n/\hat{N}_{SC2} \geq 1.0$ for 14 of the 16 years examined (Table 5). The estimated coefficient of variation among individual sighting probabilities ($\hat{\gamma}$) averaged 0.46 and ranged from 0.0 in 1990, 1993, and 1994 to 0.90 in 2000 (Table 5).

The total number of unique F_{CUB} actually observed ($\hat{N}_{Obs}$) ranged from 13 in 1987 to 42 in 2001 (Table 5). This included animals that would not have been detected without radiotelemetry. The number of unique F_{CUB} detected through random sightings alone (m) ranged from 12 in 1987 to 39 in 2001 (Table 5). On average, additional information provided by radiotelemetry increased the number of unique F_{CUB} observed by 2.1 animals/year (range = 0–5 animals). For every year, $\hat{N}_{SC2}$ exceeded $\hat{N}_{Obs}$ (Table 5). However, when rounded to the nearest integer, the lower, 1-tailed 95 and 90% confidence bounds for $\hat{N}_{SC2}$ were less than $\hat{N}_{Obs}$ for 10 and 5 of the years, respectively (Table 5). Lower, 1-tailed 70 and 80% confidence bounds were $\geq \hat{N}_{Obs}$ for all years except 1990 (Table 5).

DISCUSSION

Whether Yellowstone's grizzly bears are removed from the threatened species list depends, in part, on whether human-caused mortalities are within calculated limits. Because mortality limits are computed as a function of the number of F_{CUB} present in the population, statistically sound estimates of annual numbers of F_{CUB} (N) are needed. Parametric methods proposed by Eberhardt and Knight (1996) and Boyce et al. (2001; unpublished report, 1999) improved on the practice of basing mortality limits on a minimum estimate for N, determined as the number of unique F_{CUB} observed in a given year ($\hat{N}_{Obs}$). However, these methods require untenable assumptions about the form and constancy of distributions of individual sighting probabilities. At best, these assumptions leave unnecessary room for dispute, potentially undermining the credibility of results and diverting attention from other important issues. At worst, they can cause serious biases.

Nonparametric approaches are free of assumptions about distributions of sighting probabilities, but have not previously been applied to this problem. Nor should they be applied uncritically, as both absolute and relative performances of different estimators can vary with sampling conditions. In this study, we sought a nonparametric

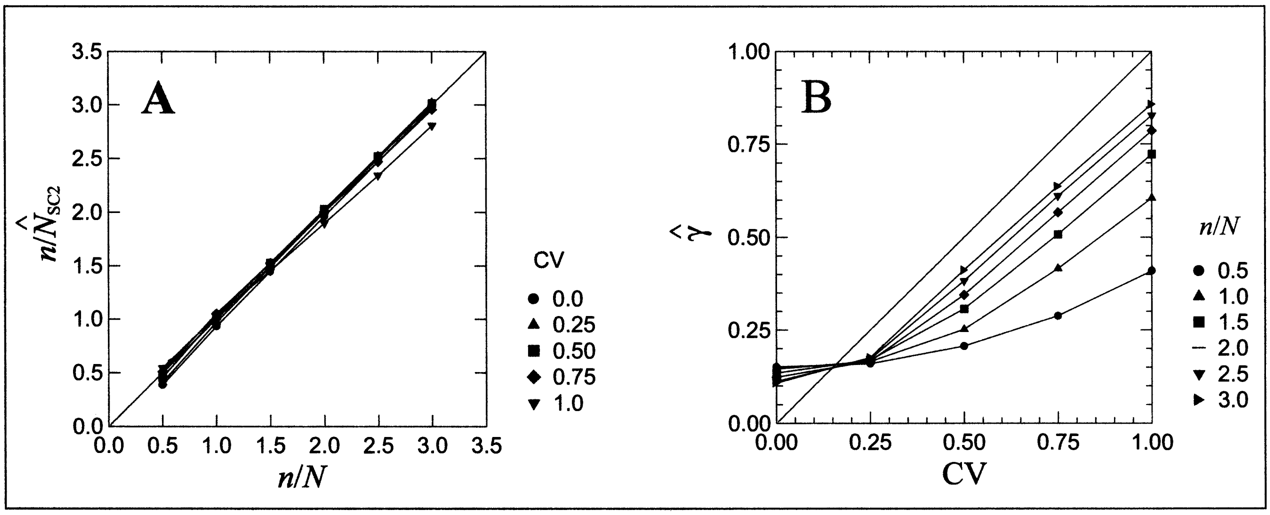

Fig. 5. Estimated ($n/\hat{N}_{SC2}$) versus observed (n/N) relative sample sizes (A), and estimated ($\hat{\gamma}$) versus observed (CV) values for the coefficient of variation among individual sighting probabilities (B). In both (A) and (B), each point represents the mean value, based on 1,000 Monte Carlo replicates; in each, calculations were based on n random sightings drawn from a model population with $N = 40$ individuals.

Table 4. Observation frequency (f_j) by year, where f_j is the number of unique females with cubs-of-the-year (F_{CUB}) that were seen exactly j times during that year. Total number of observations is given by $n = \sum_{j=1}^{\infty} jf_j$. Only observations made without the benefit of radiotelemetry and within or <10 miles of the designated grizzly bear recovery zone were included.

		Observation frequency														
Year	n	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}	f_{11}	f_{12}	f_{13}	f_{14}	f_{15}
1986	82	7	5	6	1	1	0	1	2	0	0	0	0	0	0	1
1987	20	7	3	1	1	0	0	0	0	0	0	0	0	0	0	0
1988	36	7	4	4	1	1	0	0	0	0	0	0	0	0	0	0
1989	27	6	5	0	1	0	0	1	0	0	0	0	0	0	0	0
1990	49	7	6	7	1	1	0	0	0	0	0	0	0	0	0	0
1991	62	11	3	3	3	1	2	1	0	0	0	0	0	0	0	0
1992	37	15	5	1	1	1	0	0	0	0	0	0	0	0	0	0
1993	29	7	8	2	0	0	0	0	0	0	0	0	0	0	0	0
1994	29	9	7	2	0	0	0	0	0	0	0	0	0	0	0	0
1995	25	13	2	1	0	1	0	0	0	0	0	0	0	0	0	0
1996	45	15	10	2	1	0	0	0	0	0	0	0	0	0	0	0
1997	65	13	7	4	1	3	0	1	0	0	0	0	0	0	0	0
1998	75	11	13	5	1	1	0	2	0	0	0	0	0	0	0	0
1999	94	9	4	6	2	4	2	0	1	0	0	1	0	0	0	0
2000	72	17	8	1	2	1	0	2	0	1	0	0	0	0	0	0
2001	84	16	12	8	0	1	1	0	0	1	0	0	0	0	0	0

Table 5. Estimates of annual numbers ($\hat{N}_{Obs}$) of females with cubs-of-the-year (F_{CUB}) in the Yellowstone grizzly bear population, 1986–2001. $\hat{N}_{Obs}$ gives the number of unique F_{CUB} actually observed, including those located using radiotelemetry; m gives the number of unique F_{CUB} observed using random sightings only; and $\hat{N}_{SC2}$ gives the second-order sample coverage estimates, per Lee and Chao (1994; Eqs. 3–5). Lower, 1-tailed confidence bounds are for $\hat{N}_{SC2}$ and were calculated using Efron and Tibshirani's (1993) percentile bootstrap method. Also included are annual estimates of relative sample size ($n/\hat{N}_{SC2}$, where n is the total number of observations of F_{CUB}) and of the coefficient of variation among sighting probabilities for individual animals ($\hat{\gamma}$, Eq. 5).

				Lower 1-tailed confidence bounds					
Year	$\hat{N}_{Obs}$	m	$\hat{N}_{SC2}$	70%	80%	90%	95%	$n/\hat{N}_{SC2}$	$\hat{\gamma}$
1986	25	24	31.9	28.4	27.0	25.1	23.5	2.6	0.86
1987	13	12	19.5	16.8	15.2	13.3	11.7	1.0	0.37
1988	19	17	21.5	20.1	19.1	17.7	16.7	1.7	0.25
1989	15	13	20.2	16.9	15.3	13.7	12.3	1.3	0.71
1990	25	22	25.5	24.4	23.5	22.2	21.3	1.9	0.00
1991	24	24	34.5	31.1	29.3	27.0	25.2	1.8	0.63
1992	25	23	47.6	40.0	36.4	32.1	28.9	0.8	0.61
1993	19	17	21.8	20.1	19.0	17.9	16.3	1.3	0.00
1994	20	18	25.5	23.4	21.8	19.9	18.8	1.1	0.00
1995	17	17	54.9	41.2	35.9	28.8	24.7	0.5	0.86
1996	33	28	41.4	38.7	36.6	34.0	31.8	1.1	0.00
1997	31	29	41.3	37.5	35.5	33.0	31.1	1.6	0.57
1998	35	33	40.9	38.4	37.1	35.1	33.7	1.8	0.44
1999	32	29	35.7	33.3	32.1	30.4	29.0	2.6	0.61
2000	35	32	59.7	51.8	48.2	43.8	40.3	1.2	0.90
2001	42	39	54.6	49.5	47.3	44.6	42.2	1.5	0.58

method that performs well over the range of sampling conditions deemed plausible for sightings of F_{CUB} in the GYE. Comparing 7 variations of the Chao (Chao 1984, 1989), jackknife (Burnham and Overton 1978, 1979), and sample coverage (Chao and Lee 1992, Lee and Chao 1994) methods, our provisional choice for estimating numbers of F_{CUB} in the Yellowstone population was the second-order sample coverage estimator, $\hat{N}_{SC2}$. Differences between $\hat{N}_{SC2}$ and the first-order sample coverage estimator, $\hat{N}_{SC1}$, were minor, with both methods converging more rapidly toward N as sample size increased than did other estimators. For both estimators, however, the coefficient of variation among individual sighting probabilities (CV) affected performance. Over all CV values, $\hat{N}_{SC2}$ exhibited a slightly better balance than $\hat{N}_{SC1}$ between tendencies to overestimate and underestimate when relative sample size (n/N) was in the range of $1.0 < n/N \leq 2.0$ (Fig. 1). Performance under these conditions was seen as particularly important because estimates of n/N for our field study were within this range most years (Table 5).

Chao's (1984) estimator ($\hat{N}_{Chao1}$) showed a greater tendency toward positive bias and exhibited somewhat larger RMSEs than $\hat{N}_{SC2}$ (Figs. 1, 2), but otherwise performed well. Because the most serious biases were associated with model populations where CV = 0 (an unlikely situation in nature), $\hat{N}_{\text{Chao1}}$ may be a suitable alternative to the sample coverage estimators. However, we cannot recommend the other methods we compared. Over all CV values, RMSEs for $\hat{N}_{\text{Chao2}}$ were lower than for $\hat{N}_{\text{SC2}}$ (Fig. 2), but $\hat{N}_{\text{Chao2}}$ became increasingly and negatively biased as CV increased (Fig. 1). Because individual animals clearly are not equally sightable, use of such an estimator would introduce a chronic, negative bias into estimates of population size and sustainable mortality. Jackknife estimates oscillated, being negatively biased when n/N was small, positively biased at moderate values of n/N, and converging toward N only as n/N increased beyond values observed in our field study (Fig. 1). Neither bias nor RMSE declined monotonically with sample size for any of the jackknife estimators. This suggested that, relative to the other methods examined, larger sample sizes would be needed to achieve comparably accurate estimates and that increased sample size might actually lead to increased bias in some situations. The latter problem was particularly pronounced in the range of $1.0 < n/N \leq 2.0$ (Figs. 1, 2).

In a similar analysis, Mowat and Strobeck (2000) evaluated nonparametric estimators available in the program CAPTURE (Otis et al. 1978, White et al. 1982, Rexstad and Burnham 1991). They selected Burnham and Overton's (1979) best-order jackknife method ($\hat{N}_{Jkl}$) for estimating numbers of grizzly bears in 2 Canadian populations that showed evidence of "relatively weak heterogeneity" among individual capture probabilities (Mowat and Strobeck 2000:191). Our study differed in important respects. First, all else being equal, the underlying distribution of sighting probabilities should be more heterogeneous in our study (i.e., CV should be larger) because our sample unit consisted of a single sighting rather than a sample period. Second, because our sampling universe included only F_{CUB}, population size appeared to be smaller than the 74 and 262 animals estimated by Mowat and Strobeck (2000). Although population size was not a major determinant of estimator performance in our study, we considered only a narrow range of values (N = 20, 40, and 60 animals). Over a larger range, N might emerge as a more important factor. Third, we considered sample coverage estimators (Chao and Lee 1992, Lee and Chao 1994) not available in CAPTURE. Fourth, Mowat and Strobeck (2000), apparently, did not vary sampling effort in a way that would have revealed the oscillatory pattern we observed for the jackknife estimators.

Like all estimators we examined, performance of $\hat{N}_{\text{SC2}}$ varied with n/N. As expected, the largest biases and RMSEs were associated with the smallest relative sample size, $n/N = 0.5$. Performance improved dramatically, however, with even modest increases in n/N, leading us to recommend a minimum sample size of $n/N = 1$. A nearly unbiased estimate of n/N was $n/\hat{N}_{\text{SC2}}$ (Fig. 5a). Observed values for $n/\hat{N}_{\text{SC2}}$ met or exceeded our recommended minimum for all but 2 years during 1986–2001 (Table 5). This suggested that observed sample sizes were large enough in most years to support fairly good estimates of N (Fig. 1). At this minimal level of sampling effort, however, confidence bounds were sometimes undesirably broad (Table 5). To narrow confidence bounds, we suggest that $n/N = 2$ is a reasonable and achievable goal. Based on estimates of N for 1996–2001 (Table 5), such a goal would translate into target sample sizes of about 80–120 independent random sightings of F_{CUB} per year. This compares with observed sample sizes of 45–94 sightings/year during that same period and indicates a need for increased support for this aspect of the Yellowstone grizzly bear monitoring effort.

Performance of $\hat{N}_{\text{SC2}}$ also varied with the degree of heterogeneity among individual sighting probabilities, as measured by CV. However, such variation was dramatic only when $n/N = 0.5$. When $n/N \geq 1$, $\hat{N}_{\text{SC2}}$ was fairly robust to variations in CV, especially in the range of $0.0 \leq \text{CV} \leq 0.75$ (Fig. 1). Even when CV = 1.0, bias was <10%, regardless of n/N (Fig. 1). An advantage of $\hat{N}_{\text{SC2}}$ is that CV is estimated ($\hat{\gamma}$, Eq. 5) as part of the calculation. For 1986–2001, $\hat{\gamma}$ averaged 0.46 and ranged from 0.0–0.9, suggesting that actual CVs were within the range of values in which $\hat{N}_{\text{SC2}}$ performs well. Our Monte Carlo study demonstrated, however, that $\hat{\gamma}$ was negatively biased when $\text{CV} \geq 0.25$, particularly when n/N is small (Fig. 5). Using calculated values for $n/\hat{N}_{\text{SC2}}$ and $\hat{\gamma}$ (Table 5), rough corrections for such biases can be inferred from Fig. 5. For example, when $n/N = 1.0$ and CV = 0.4, $\hat{\gamma}$ tended to underestimate CV by about 0.2 (Fig. 5). Given $n/\hat{N}_{\text{SC2}} = 1.5$ and $\hat{\gamma} = 0.58$ for 2001 (Table 5), this suggests an unbiased estimate for CV of about 0.85 for that year. Similar inferences for other years yielded a maximum estimated CV of around 1.3 in 2000, but suggested that, overall, CV rarely was much greater than 1. Thus, we believe that actual CVs for sighting probabilities of F_{CUB} in the Yellowstone population typically are within the range of values in which $\hat{N}_{\text{SC2}}$ performs well.

Regardless of method, there is an inherent risk of overestimating N that, in turn, could lead to setting mortality limits at unsustainably high levels. To minimize this risk, we believe it is prudent to base management on some lower, 1-tailed confidence bound. This would provide a specified level of assurance that the population of F_{CUB} is at least as large as estimated. For example, calculated confidence bounds indicated that we can be 95% certain there were at least 42 F_{CUB} in the Yellowstone grizzly bear population in 2001, and 80% certain there were at least 47 (Table 5). To determine whether such bounds accurately depict the risk of overestimating N, we compared nominal versus observed sample coverages using both the BCA and percentile bootstrap methods (Efron and Tibshirani 1993). The BCA method, theoretically, is superior to the percentile method (Efron and Tibshirani 1993). Nonetheless, we recommend the percentile method for this application because the BCA method substantially overstated true coverage under conditions that might reasonably occur in field studies; i.e., when CV= 1.0 and $n/N \geq 2.0$ (see Table 5). Such an error would cause us to understate the true risk of overestimating N. Although the percentile method overstated true coverage when CV = 0.0 and nomimal coverage was 70 or 80%, we view this as less serious because it is not reasonable to expect that CV = 0.0 for natural populations.

In general, we believe $\hat{N}_{SC2}$ is superior to $\hat{N}_{Obs}$ as a basis for calculating mortality limits for Yellowstone's grizzly bears, particularly if lower, 1-tailed confidence bounds are used to minimize the risk of overestimation. In some years, however, depending on the confidence level that is chosen, $\hat{N}_{Obs}$ may be the better alternative. For example, $\hat{N}_{Obs}$ equaled or exceeded the lower, 1-tailed 90% confidence bound for $\hat{N}_{SC2}$ (rounded to the nearest integer) in 8 of the 16 years examined (1986–90, 1993, 1994, 1998, and 1999; Table 5), yet is unburdened by the same risk of overestimation. Thus, it offers a superior estimate of a lower bound for N for those years. This situation occurs largely because $\hat{N}_{Obs}$ incorporates additional information from non-random sightings of radiocollared animals; information that cannot legitimately be used when calculating $\hat{N}_{SC2}$ or its confidence bounds.

Overall, we sought a reliable statistical method for estimating numbers of F_{CUB} because such estimates are essential for setting mortality limits for grizzly bears in the GYE. Given recommended sample sizes, we believe $\hat{N}_{SC2}$ is a reasonable choice for this purpose and that it improves on earlier approaches. We emphasize, however, that knowledge of the number of F_{CUB} is not, by itself, sufficient for setting mortality limits. Other calculations and assumptions are involved that merit additional and comparable scrutiny. Thus, we have refrained from using estimates generated in this study to project total population size or infer acceptable levels of mortality, believing that the remaining issues should be addressed first. An important issue is the assumption that every sighting was correctly identified to individual. Misidentifications undoubtedly occurred, leading to errors of Type I (sightings of the same animal mistakenly classified as sightings of different animals) or Type II (sightings of different animals mistakenly classified as sightings of the same animal). Our experience in applying the rule set of Knight et al. (1995) suggests that Type II errors are much more likely. Such a bias would cause a tendency to undercount the number of unique animals actually seen (m), while also inflating sighting frequencies (n_i values) for the $\hat{m}$ animals estimated to have been seen. In turn, this would lead to estimates of N that are more negatively biased than depicted in our Monte Carlo results, regardless of the estimator that is used. Such a bias, although undesirable, is not by itself inconsistent with our goal of improving on $\hat{N}_{Obs}$ while minimizing the risk of overestimating N. Effects of misidentification on precision are less clear, however. Misidentification introduces uncertainty in sighting frequencies and, thus, would increase uncertainty in estimates based on those frequencies. Our lower, 1-tailed confidence bounds did not incorporate this additional uncertainty and, thus, were probably higher than they would have been if effects of misidentification had been fully accounted for. The tendency toward positive bias in the lower confidence bound would have been countered to some degree by 2 factors. First, any negative bias in $\hat{N}$ resulting from misidentification would necessarily have been accompanied by a similar bias in the confidence bounds surrounding $\hat{N}$. Second, our lower, 1-tailed confidence bounds already were biased low within the range of conditions most often experienced in this study (Fig. 3). Overall, effects of misidentifications on precision would be mitigated, but to an unknown degree. Additional work to better define the nature, magnitude, and consequences of identification errors is needed and has been undertaken. In the meantime, we offer this work as the first in what we hope will be a series of refinements that better ensure reliable estimates of allowable mortality, while minimizing the risk of error.

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Appendix C. Calculation of Total Population Size and Mortality Limits

Efforts to improve the population size estimation and management methods and to reevaluate the sustainable mortality limits in the Greater Yellowstone Ecosystem (GYE) have continued with the Interagency Grizzly Bear Study Team (IGBST) leading these efforts. Notably, several special reports have been produced including: "Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear" (hereafter referred to as the Reassessing Methods Document, IGBST 2005, Appendix L), which was released for public comment and peer review. In response to comments received during this process, a second document, "Reassessing Methods To Estimate Population Size And Sustainable Mortality Limits For The Yellowstone Grizzly Bear: Workshop document supplement on 19–21 June 2006" (hereafter referred to as the Supplement to the Reassessing Methods Document, IGBST 2006, Appendix M) was produced after further peer review. Most recently, a third document "Updating and Evaluating Approaches to Estimate Population Size and Sustainable Mortality Limits for Grizzly Bears in the Greater Yellowstone Ecosystem" (hereafter referred to as the Updated Demographics document, IGBST 2012) was prepared in response to updated information and changes in population trajectory related to grizzly bear demographics. This 2012 document is attached to this 2016 Conservation Strategy as Appendix N.

The goals of these IGBST workshops were to assemble internal and external experts to review and enhance existing methods and, to the extent feasible, use existing data to develop new population estimation methods to ensure that population estimation and mortality management methods for the GYE grizzly bear population are based on the best available science. This effort was undertaken as per the commitment in the Conservation Strategy of all management agencies to employ adaptive management using the best available science to manage the GYE grizzly bear population.

The IGBST will, for the foreseeable future, use the protocol described in this Appendix to annually estimate population size within the Demographic Monitoring Area (DMA), and then set mortality limits inside the DMA for the following year based on the sliding scale in Table 1. Methods used in this protocol are described in the Reassessing Methods Document (IGBST

2005), summarized in the Supplement to the Reassessing Methods Document (IGBST 2006), and revised in the Updated Demographics Rates Document (IGBST 2012).

The following procedures detail how population size and mortality thresholds would be calculated:

1. Observations of sightings of females with cubs-of-the-year[1] will be separated into an estimate of unique females with cubs-of-the-year and repeat observations of the same female using the methods of Knight *et al*. (1995).
2. Only sightings of unique females with cubs-of-the-year from within the DMA will be used for subsequent estimates.
3. The Chao2 estimator (Keating *et al*. 2002) will be applied to sighting frequencies of unique females with cubs-of-the-year to estimate the total number of females with cubs of the year in the population.
4. The number of unique females with cubs-of-the-year obtained from the Chao2 estimator each year will be added to the long-term dataset to conduct the model-averaging process described in the Supplement to the Reassessing Methods Document (IGBST 2006). This process involves fitting a linear and quadratic trend model, followed by averaging model parameters based on the respective Akaike's Information Criterion (AIC_c) weights of the linear and quadratic models. These model-averaged parameters are then used to estimate the number of females with cubs-of-the-year.
5. The estimated number of females with cubs-of-the-year obtained through the model averaging will be used as the best estimate of the total number of independent females with cub-of-the-year in the DMA for that year.
6. The purpose of fitting the trend model is to obtain the best estimate of the current number of females with cubs-of-the-year by using information from past estimates, recognizing that with each iteration, some change is expected. Retrospectively adjusting estimates from previous years will not occur.

1 Adult female grizzly bears accompanied by cubs that are less than one year old.

7. The estimated 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 = 0.2965) observed during 2002–2011. The resulting value represents the best estimate of the total number of females in the population ≥4 years old.
8. 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 (proportion = 0.844) observed during 2002–2011. The resulting value is the best estimate of the number of independent females (≥2 years old) in the population that year.
9. The sustainable mortality limit for independent females is dependent on the population estimate of independent females (Table 1).
10. Unknown and unreported mortality will be estimated based on the methods of Cherry *et al*. (2002) as described in the Reassessing Methods Document (IGBST 2005).
11. The number of independent males in the population will be based on the estimated ratio of independent males to independent females (ratio = 1:1) observed during 2002–2011 and derived via stochastic modeling described in the Supplement to the Reassessing Methods Document (IGBST 2006). The number of independent females in the population will thus be multiplied by 1.0 and the resulting value represents the best estimate of the number of independent males that year.
12. The sustainable mortality limit for independent males is dependent on the population estimate of independent males (Table 1).
13. The number of cubs-of-the-year in the annual population estimate will be calculated directly from the model-averaged estimate of females with cubs-of-the-year (IGBST 2006). The number of cubs will be estimated by multiplying the model-averaged estimate of females with cubs-of-the-year by the mean litter size (litter size = 2.49; mortality adjusted estimate) observed during 2002–2011 (IGBST 2012).
14. 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 (cub survival = 0.553) observed during 2002–2011 (IGBST 2012).
15. The sustainable mortality limit for dependent young (cubs and yearlings) is dependent on the population estimate of dependent young (Table 1). Only human-caused deaths (reported known and probable) will be tallied against the threshold for dependent young.

16. Unknown and unreported mortality will not be estimated for dependent young.
17. Sustainable mortality limits will be established annually based on the data collected in that year and the calculations described here. These mortality limits will then apply the following year. Because model-averaged estimates are used, annual variability among estimates is explicitly addressed. Consequently, annual limits based on a 3-year running average, as proposed in the Reassessing Methods Document (IGBST 2005), are not used. Instead, annual sustainable mortality limits for any year will be based on the data and calculations for the previous year (as described in this protocol and the Updated Demographic Rates Document, IGBST 2012, Appendix N).
18. 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 (IGBST 2006) using updated vital rates as documented in IGBST (2012, Appendix N).
19. The objective of 48 females with cubs-of-the-year as estimated with Chao2 will be evaluated based on the model-averaged estimate of females with cubs-of-the-year (IGBST 2012).
20. In modeling the rate of change (trend) of females with cubs-of-the-year as described in the Supplement to the Reassessing Methods Document (IGBST 2006), if the AIC_c weight favors the quadratic term and corresponding $\Delta AIC_c \geq 2.0$ compared with the linear model for 3 consecutive years, a full review of the population's demographics will be undertaken to better understand its status. Given evidence of a population nearing carrying capacity and a population fluctuating around a long-term mean, this approach allows timely detection of a sustained increasing or decreasing trend (van Manen *et al.* 2016).
21. If dead bears are reported in years subsequent to actual year of mortality, they will be tallied against year of death and total mortality will be recalculated. If mortality exceeds the threshold for that year, the difference (total mortality minus threshold) will be counted against the current years' threshold.
22. For bears that are estimated to be independent of age, if sex cannot be determined, sex will be assigned randomly using ratio of 59:41 male: female as recommended in Appendix A of Schwartz and Haroldson (2001).

Table 1. Total annual sustainable mortality limits by sex and age cohorts[2] of grizzly bears in the Greater Yellowstone Ecosystem Demographic Monitoring Area (DMA) under the protocol to manage for a population at the average annual population estimate for the period 2002–2014 (using the model-averaged Chao2 estimator this average number is 674).

	Total Grizzly Bear Population Estimate*		
	≤674	675-747	>747
Total mortality rate for independent FEMALES.	<7.6%	9%	10%
Total mortality rate for independent MALES.	15%	20%	22%
Total mortality rate for dependent young.	<7.6%	9%	10%

Total mortality: 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.

*using the model-averaged Chao2 population estimate

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[2] Sustainable mortality estimates are based on the sustainable mortality percentage of the respective population segment relative to the population estimates.

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Appendix D. Existing Bear Foods and Related Monitoring Programs

Ungulate Surveys

Bison Management Plans

The Interagency Bison Management Plan (USDOI and USDA 2000; IBMP 2016) is a cooperative agreement with the goal of preserving a wild and free-ranging bison population in Yellowstone National Park and the State of Montana. The partner agencies of the IBMP annually monitor the number and distribution of bison herds and bison movements. The population objective under the IBMP is 3,000 animals at the end-of-the-winter.

Elk Management Plans

The Bison and Elk Management Plan for the National Elk Refuge and Grand Teton National Park (USFWS and NPS 2007) set forth adaptive management for the herds and their habitat in cooperation with the Wyoming Game and Fish Department. The objective of the Wyoming Game and Fish Department is approximately 11,000 elk and genetically viable population of approximately 500 bison. Of the objective, approximately 5,000 elk will over-winter on the refuge.

In Wyoming, the statewide population objective presented in the Commission’s Annual Report is based only on the 14 herds with a post hunt population objective and the 14 herds with a trend count objective (WGFD *in press*). Monitoring consists of both aerial and ground observations as well as information obtained through harvest surveys and annuli age of harvested elk. Data for each elk herd are compiled annually and available through the Wyoming Game and Fish website. Population data and status are discussed at public meetings held throughout the state annually. At these meetings Department personnel discuss current trends and management strategies both at the local and statewide scale with the public and take their comments. All harvest management strategies are routed through a public comment process, modified as needed, and then heard by the Wyoming Game and Fish Commission in order to develop annual harvest limits. The Department has quantified population information regarding elk status and management strategies dating back to 1976.

In Idaho, the statewide population objective presented in the Idaho Elk Management Plan 2014–2024 is based on 29 elk management zones (IDFG 2014). The current population estimate is approximately 107,000 animals and the objective of the plan is to "maintain or improve elk populations to meet the demand for elk hunting." Monitoring consists of aerial surveys which are then corrected to account for missed animals using a "sightability model" to obtain a population estimate. This technique has been used since the late 1980s. Idaho Department of Fish and Game is currently investigating the use of an integrated population model.

In Montana, the statewide population objective presented in the Montana Statewide Elk Management Plan is based on 44 elk management units (MFWP 2004). Trend counts are conducted each year via aerial surveys during late winter and early spring. The state management objective is to "maintain elk population numbers at levels producing a healthy and productive condition of elk, vegetation, soil, and water and that also reduces elk conflicts on private and public lands. MFWP has had an elk management plan in effect since 1978.

Cutthroat Trout Population Monitoring Programs

Since the discovery of lake trout in Yellowstone Lake in 1994, park biologists have been developing and refining control techniques for lake trout removal and for assessing potential impacts to native Yellowstone cutthroat trout. The cutthroat trout population is monitored using different methods including fish traps, spawning stream surveys, and sonar technology.

Visual Cutthroat Trout Spawning Stream Surveys

Beginning 1 May each year, 5 front country streams (Lodge Cr., Hatchery Cr., Incinerator Cr., Wells Cr., and Bridge Cr.) within or near the Lake Developed area, and 4 front country streams (Sandy Cr., Sewer Cr. Little Thumb Cr., Arnica Cr., and 1167 Cr.) within or near the Grant Village development are checked daily to detect the presence of adult cutthroat trout (Andrascik

1992, Olliff 1992). Once adult trout are found (i.e., onset of spawning), weekly surveys of cutthroat trout on these streams and on an additional 3 backcountry streams (Flat Mountain Arm Cr., 1141 Cr., and 1138 Cr.) are conducted. In each stream on each sample day, two people walk upstream from the stream mouth and record the number of adult trout observed. Sampling continues one day per week until most adult trout return to the lake (i.e., end of spawning). Counts are used to estimate the peak periods, relative magnitude and duration of spawning runs (Reinhart 1990). While making fish counts, observers record bear sign (e.g., bear sightings, fish parts, hair, scats, and tracks) and collect hair from DNA hair collection corrals. Track measurements and DNA from collected hair are used to determine the number, species, and association of family groups of bears.

Fish Trap and Sonar Surveys

Information on the numbers of upstream and downstream migrants, and the size and age class of the cutthroat trout spawning migration are collected annually from weirs with fish traps erected each spring at the mouth of Clear Creek, a tributary to Yellowstone Lake (Koel 2001). The fish weir and trap or sonar counter is generally installed during the month of May, the exact date depending on winter snow accumulation, weather conditions and spring snow melt. Fish passage, enumeration, and sampling occur through dip-netting trout that enter the upstream and downstream trap boxes, visually counting trout as they swim through wooden chutes attached to the traps, or through an electronic sonar fish. Continued operation of the Clear Creek fish weir may be used for long term monitoring of the potential impacts of lake trout on the Yellowstone Lake cutthroat trout population.

Whitebark Pine Surveys

Twenty-one whitebark pine transects are currently visited annually. Each transect contains 10 marked trees. Cones are counted on each marked tree between July 15 and August 15 depending on annual phenology. The objective is to count cones after maturation, but before cones and seeds have been collected by red squirrels (Tamiasciurus hudsonicus) and Clark's nutcrackers (Nucifraga columbiana). Data is recorded on standard field forms and sent to the IGBST. The

IGBST maintains the official ecosystem database. The presence or absence of blister rust and beetle infestations as well as grizzly bear, black bear, red squirrel, and Clark's nutcracker activity are noted for each transect.

Army Cutworm Moths

IGBST Monitoring Program

The IGBST and Wyoming Game and Fish Department currently monitor bear use of moth aggregation sites during radio tracking and annual grizzly bear observation flights. When army cutworm moths are present on the high elevation talus slopes, concentrations of grizzly bears are observed at the moth aggregation sites during these flights. The presence of bears at the aggregation sites is used as an indirect measure of the presence or absence of moths during a given year. This monitoring program does not provide direct information on the relative abundance of moths.

State of Montana Monitoring Program

Army cutworm moth larvae are agricultural pests which eat a wide range of host plants including small grains, alfalfa and sugar beets (Blodgett 1997). Moth outbreaks occur sporadically, when insect population potential is high and environmental factors are favorable to the insects' survival (Blodgett 1997). Because army cutworm moths are an agricultural pest, the State of Montana has a cutworm moth monitoring and forecasting program. The forecasting method employed by county extension agents entails trapping for army cutworm moths in agricultural areas between August and October. Extension agents set two army cutworm pheromone traps per county (G. Johnson, Montana State University, pers. commun.). Trap sites are located in agricultural areas often where soil has been tilled to seed winter wheat in the fall as moth larvae prefer such soft soils (G. Johnson, MSU, pers. commun.). Extension faculty find the amount of fall moth activity can be indicative of moth egg lay (Blodgett 1997). When trap catches exceed 800 moths during the August through October trapping period, extension agents forecast potentially damaging larvae populations may appear the following spring (G. Johnson, MSU, pers. commun.).

Many factors can affect moth larval development. Abundant precipitation from May through July is harmful for the worms and can reduce local cutworm populations (Blodgett, MSU, pers. commun.). Army cutworm moth outbreaks have been noted in warm and dry years when rainfall from 1 May through 31 July was less than 4 inches (Blodgett 1997). If serious cutworm problems are suspected, agents see crop damage by the first of April. Fewer adult moths are trapped after warm and dry weather patterns with mild winters when there is a lack of early spring snow cover to insulate and protect larvae from freezing (G. Johnson, MSU, pers. commun.). Dry weather in the fall also contributes to the mortality of moth eggs and larvae (G. Johnson, MSU, pers. commun.). Pesticides also affect larval recruitment. Warrior, a synthetic pyrethroid, is an EPA registered army cutworm moth pesticide for use on wheat crops. Currently, pesticide companies are in the process of registering this pesticide for use on barley crops as well (G. Johnson, MSU, pers. commun.).

Since 1992, a statewide army cutworm moth pheromone trapping program has been conducted in Montana. Twenty counties in Montana participated in the program in 1997 (Blodgett 19970). In fall 1998, MSU extension agents plan to coordinate with extension agents at universities in Wyoming, Colorado and Nebraska to expand the moth trapping program to include county trapping efforts in their respective States. In addition to trapping for moths, extension agents plan to gather daily weather and temperature data to improve their forecasting technique (G. Johnson, MSU, pers. commun.). The IGBST, WGF, and YNP are currently evaluating methods for incorporating State army cutworm moth monitoring programs into existing grizzly bear foods monitoring programs.

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Appendix E. Habitat Baseline 1998 and Monitoring Protocol

Introduction

The 1998 baseline reflects the best available habitat measures representing ground conditions inside the Primary Conservation Area (PCA) as of 1998. Habitat standards identified in the Conservation Strategy pertain to secure habitat, developed sites, and livestock grazing allotments. The standards demand that all three of these habitat parameters are to be maintained at or improved upon conditions that existed in 1998. The 1998 baseline represents the best estimate of what was known to be on the ground at the time and establishes a benchmark against which future improvements and/or impacts can be assessed. It also provides a clear standard for agency managers to follow when considering project effect analysis. This appendix documents estimates for baseline values so that current and future habitat conditions throughout the PCA can be evaluated for compliance with habitat standards as formalized in the Conservation Strategy. In theory, the 1998 baseline should be a static measurement bound to a single point in time. In reality, this baseline continues to evolve as more reliable information is acquired; errors in the baseline are identified and corrected; and as new geoprocessing tools are developed to more accurately model secure habitat and estimate road densities. Since the release of the 2007 Conservation Strategy, new information has become available and some errors in the 1998 baseline have been identified. Consequently, baseline values have been adjusted where necessary to more accurately reflect 1998 ground conditions. The 1998 baseline database will continue to be improved upon when and if legitimate errors are identified. Features found to be erroneously excluded from the 1998 baseline will be reviewed as to their actual status in 1998. If reliable information is made available to substantiate the existence of these features in 1998 then corrections to the baseline will be made. All corrections made to the baseline will be documented, tracked, and reported in the Interagency Grizzly Bear Study Team (IGBST) annual reports. Baseline values presented in this appendix represent the best available information at this time and will serve as a basis for monitoring and evaluating improvements in habitat conditions and identifying any need for mitigation measures in the future.

Secure Habitat and Motorized Access Route Density

Maintaining or improving secure habitat at or above 1998 levels inside the PCA is a required habitat standard. To monitor compliance with this standard, secure habitat is annually measured and compared against 1998 levels for each bear management subunit. The best estimates of secure habitat levels that existed in 1998, per subunit, constitute the 1998 secure habitat baseline (Table 1). Measurement of secure habitat is based on configuration of motorized routes. Routes that are open to the public at any time during the non-denning season (March 1–November 30) detract from secure habitat. Likewise, gated routes that are closed to the public but remain accessible to administrative personnel also detract from secure habitat. Decommissioned routes that effectively prohibit motorized use by the public and administrative personnel do not detract from secure habitat.

The density of motorized routes on the landscape is monitored inside the PCA; however, there are no mandatory standards for motorized route density. Monitoring protocol requires that open motorized access route density (OMARD) and total motorized access route density (TMARD) inside the PCA be monitored and reported against 1998 levels annually.

Secure habitat is any contiguous area greater than 10 acres in size and more than 500 meters (m) from an open or gated motorized route. OMARD is a measure of the density of motorized routes (roads and trails) that are open to the public for one or more days during the non-denning portion of the year when grizzly bears are active (March 1 – November 30). TMARD measures the density of motorized routes open to the public and/or administrative personnel for one or more days during the non-denning season. Hence, routes that are gated to the public year-round and accessible only to administrative staff contribute to TMARD but do not count toward OMARD. OMARD is reported at levels > 1.6 kilometer (km) per 2.6 square kilometer (sq km) (> 1 mile (mi) per square mile (sq mi)) while TMARD is reported at levels > 3.2 km per 2.6 sq km (> 2 mi per sq mi). State, county, and private roads occurring on federal lands are included in these calculations; however, roads occurring on private inholdings reflect 1998 conditions and are not updated in the motorized access database through time.

Calculations for percentage of secure habitat, OMARD, and TMARD are generated using the Motorized Access Model, a suite of customized geoprocessing tools compatible with ArcGIS software. Algorithms built into the model generate a 500 meter buffer around all relevant motorized features. Areas larger than 10 acres in size that fall outside this buffer are designated secure habitat. Methods for measuring route density have greatly improved with advancements in geoprocessing tools since earlier versions of the Conservation Strategy were released. Starting in 2009 a more accurate method for measuring line density was implemented into the ArcGIS software, which led to improved estimates for the 1998 baseline values of motorized route density. The new baseline measurements provide a more accurate and realistic estimate of road densities and do not reflect changes in the configuration of 1998 motorized routes. Instead, only the method from which road density is calculated has changed. Route density values are stored in a 30 m raster format and cell values correspond to densities within a 2.6 sq km (1 sq mi) moving window. In previous methods, the total length of motorized routes within the moving window was based on a simple absence or presence of motorized routes within a given cell. Cells containing one or more route segments were summed and then multiplied by 30 m (length of single cell) to get the total length of motorized routes within the moving window. This method tended to under-estimate route density in some cases, and over-estimate in others. The current algorithm instead accounts for all route segments within a cell and accurately measures the total length of routes intersecting the 2.6 sq km (1 sq mi) moving window based on actual line geometry (Figure 1).

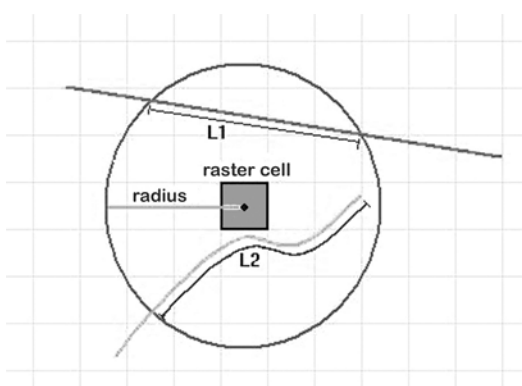

Figure 1 Measurement of route density based on total length of routes within 2.6 sq km (1 sq mi) moving window.

The most current values for 1998 baseline levels of secure habitat, OMARD, and TMARD are presented in Table 1. These values, which are based on the best methods available, supersede those presented in the 2007 Conservation Strategy and comprise the benchmark against which all future change is to be measured.

Exceptions to the 1998 Baseline for Secure Habitat

Three subunits, Gallatin #3, Henrys Lake #2, and Madison #2, were targeted in previous versions of the Conservation Strategy as needing improvement in secure habitat with respect to 1998 levels. The specific areas with potential for improvement identified in these three subunits fall within the Custer Gallatin National Forest boundary and hence, the quantity and timing of improvements was to be determined by the Gallatin National Forest Travel Management Plan (TMP; USDA Forest Service 2006*c*). A primary factor contributing to impoverished secure habitat levels in these three subunits was motorized access on private land inholdings. Since 1998, the Gallatin National Forest conducted several land exchanges under the *Gallatin Range Consolidation and Protection Act* in areas inside and outside the PCA. These land exchanges resulted in the acquisition of formerly private parcels which are now administered as part of the Gallatin National Forest. With implementation of the 2006 Gallatin TMP, many roads inherited from these exchanges have been permanently decommissioned. Non-system routes that are not maintained by the Forest Service have subsequently been closed, with a high priority given to road decommissions in the three subunits identified as in need of improvement. With full implementation of the Gallatin TMP very near completion, measurable increases in secure habitat with respect to 1998 baseline levels have been realized in the three targeted subunits. Consequently, the Custer Gallatin National Forest has proposed via a Travel Plan Amendment that the improved levels of secure habitat resulting from full implementation of the TMP constitute new baseline levels for these 3 subunits. This amendment effectively raises the bar for baseline conditions in the 3 identified subunits. These enhanced levels of secure habitat for the 3 targeted subunits will constitute new measures against which future change will be made (Table 1).

Cumulative Effects Model

With previous versions of the Conservation Strategy, the Cumulative Effects Model (CEM) was the requisite tool for estimating effectiveness and quality of habitat when evaluating project impacts. With this version of the Conservation Strategy the CEM will no longer serve as the requisite tool for evaluating impacts of competing project scenarios. Instead, the current tool for conducting project impact analyses is the Motorized Access Model which was established concurrent with the CEM.

The CEM was a computerized model designed in stages during the 1980s and 1990s as a tool for evaluating relative change in grizzly bear habitat quality due to human activities. The model led to construction of useful spatial data layers reflecting various habitat components and delineating management boundaries relevant for monitoring secure habitat. Some of these layers were subsequently incorporated into the Motorized Access Model. The CEM was considered the best available science at the time; however, the utility of the CEM has since been questioned and is no longer the endorsed protocol for reporting habitat metrics. The rationale for this change in protocol is many-fold, least not is the inability to verify or ground truth in a statistically defendable manner the validity of numerous numerical coefficients residing at the core of the model (Boyce *et al*. 2001, Borkowski 2006). Furthermore, the process for developing vegetation coefficients described by Mattson *et al*. (2004) proves to be highly technical and complex, making it difficult to interpret and implement. Therefore, updating the vast array of coefficients with any reasonable degree of reliability poses a daunting challenge as the grizzly bear population expands, broad landscape changes occur, or new information becomes available. In addition, many of the CEM geospatial datasets are approaching three decades in age and there is no operative mechanism in place to systematically update all existing data layers to reflect current conditions. Collectively, neither the vegetation spatial data nor the multitude of coefficients have proven accurate enough for site-specific project analyses, as past modeling efforts have shown (Dixon 1997). Finally, the format of GIS datasets designed to interface with the CEM are now obsolete and the program code would need to be completely re-vamped to accommodate current geospatial data formats. This is especially problematic since few members of the CEM technical modeling team remain employed in the GYE and there is no technical documentation of the underlying source code for the CEM algorithms (Dixon 1997). In short, the CEM is a high maintenance operation that is difficult to execute and interpret. The Motorized Access Model will instead continue to be used to calculate and monitor secure habitat and motorized route density inside and outside the PCA.

Developed Sites on Public Lands

Developed sites include all sites on public land developed or improved for human use or resource development. Examples of developed sites include, but are not limited to, campgrounds, trailheads, lodges, administrative sites, service stations, summer homes, restaurants, visitor's centers, and permitted resource development sites such as oil and gas exploratory wells, production wells, plans of operation for minerals activities, work camps, etc. Developed sites on public lands inside the PCA are currently inventoried and tracked in existing GIS databases. Table 2 displays the number of developed sites for each administrative unit by bear management unit (BMU) subunit as of 1998.

Activities based in statutory rights, such as oil and gas leases and mining plans of operation under the 1872 General Mining Law are also tracked as part of the developed site monitoring effort. Mining claims and or oil and gas leases do not in and of themselves constitute a site development, but have the potential to be developed sometime in the future. It is important to note that one mining claim does not necessarily mean a potential for one operating plan. In 1998, approximately 1,354 mining claims associated with 28 plans of operation had been filed throughout nine BMU subunits; however, no oil and gas leases existed inside the PCA. Claims are often staked around known mineral deposits to protect the original claim and a single operating plan can sometimes encompass hundreds of claims. Furthermore, a number of filed claims, upon detailed exploration, do not have enough mineralization to be economically developed and consequently are never acted upon. Approved operating plans associated with mining claims or claim groups are included as a separate category in the developed site baseline (Table 2). A detailed itemized list of all developed sites (names and types) compromising the 1998 baseline is documented in Table 3.

Livestock Grazing

The livestock allotment standard established in the Conservation Strategy requires that there be no net increase in the number or acreage of active commercial livestock grazing allotments or in permitted sheep animal months (AMs) inside the PCA from that which existed in 1998. Existing sheep allotments will be monitored, evaluated, and phased out as the opportunity arises with willing permittees. Sheep animal months (AMs) are calculated by multiplying the permitted number of sheep times the months of permitted use.

In 1998 there were 101 active or vacant commercial livestock grazing allotments and 23,900 permitted sheep animal months (AMs) inside the PCA (Table 4). Of these, 83 were cattle and/or horse allotments and the remaining 18 were for sheep. Operational status of allotments is categorized as active, vacant, or closed. An active allotment is one with a current grazing permit, although a "no-use" permit can be granted on a year-by-year basis when a permittee chooses not to graze livestock. Vacant allotments are those without an active permit but may be used periodically by other permittees at the discretion of the land management agency to resolve resource issues or other concerns. Reissuance of permits for vacant cattle allotments may result in an increase in the number of permitted cattle but the number and acreage of active allotments inside the PCA must remain at or below 1998 baseline levels. Combining or dividing existing allotments is allowed as long as net acreage in active allotments does not increase above 1998 levels. Any such use of vacant cattle allotments resulting in an increase in cattle numbers will only be allowed after an analysis to evaluate impacts on grizzly bears. Where chronic conflicts occur on cattle allotments inside the PCA, and an opportunity exists with a willing permittee, one alternative for resolving the conflict may be to phase out cattle grazing or to move the cattle to a currently vacant allotment where there is less likelihood of conflict.

Table 1. 1998 Baseline values (and exceptions) for percentage of open motorized access route density (OMARD), total motorized access route density (TMARD), and secure habitat for all 40 bear management unit (BMU) subunits in the Primary Conservation Area.

BMU subunit name	1998 % OMARD (> 1 mi / mi^2)	1998 % TMARD (> 2 mi / mi^2)	% 1998 Secure Habitat	Subunit area (mi^2) (excluding lakes)
Bechler/Teton	17.0	5.8	78.1	534.3
Boulder/Slough #1	3.2	0.3	96.6	281.9
Boulder/Slough #2	2.1	0.0	97.7	232.4
Buffalo/Spread Creek #1	11.5	5.3	88.3	219.9
Buffalo/Spread Creek #2	15.6	12.7	74.3	507.6
Crandall/Sunlight #1	19.3	7.2	81.1	129.8
Crandall/Sunlight #2	16.6	11.7	82.3	316.2
Crandall/Sunlight #3	19.2	10.6	80.4	221.8
Firehole/Hayden #1	10.4	1.7	88.3	339.2
Firehole/Hayden #2	9.0	1.5	88.4	172.2
Gallatin #1	3.6	0.5	96.3	127.7
Gallatin #2	9.5	4.5	90.2	155.2
Gallatin #3*	46.0*	22.9*	55.3*	217.6
Hellroaring/Bear #1	23.1	15.8	77.0	184.7
Hellroaring/Bear #2	0.1	0.0	99.5	228.9
Henry's Lake #1	49.0	31.2	45.4	191.2
Henry's Lake #2*	49.9*	35.2*	45.7*	140.2
Hilgard #1	29.0	15.3	69.8	201.2
Hilgard #2	21.0	13.6	71.4	140.5
Lamar #1	9.9	3.8	89.4	299.9
Lamar #2	0.0	0.0	100.0	180.8
Madison #1	29.5	12.5	71.5	227.9
Madison #2*	33.7*	24.0*	66.5*	149.4
Pelican/Clear #1	2.0	0.5	97.8	108.4
Pelican/Clear #2	5.4	0.4	94.1	251.6
Plateau #1	22.2	12.9	68.8	286.3
Plateau #2	8.5	3.5	88.7	419.9
Shoshone #1	1.5	1.1	98.5	122.2
Shoshone #2	1.3	0.7	98.8	132.4
Shoshone #3	3.9	2.1	97.0	140.7
Shoshone #4	5.3	2.9	94.9	188.8
South Absaroka #1	0.6	0.1	99.2	163.2
South Absaroka #2	0.0	0.0	99.9	190.6
South Absaroka #3	2.4	2.7	96.8	348.3
Thorofare #1	0.0	0.0	100.0	273.4
Thorofare #2	0.0	0.0	100.0	180.1
Two Ocean/Lake #1	3.5	0.3	96.3	371.9

BMU subunit name	1998 % OMARD (> 1 mi / mi^2)	1998 % TMARD (> 2 mi / mi^2)	% 1998 Secure Habitat	Subunit area (mi^2) (excluding lakes)
Two Ocean/Lake #2	0.0	0.0	100.0	124.9
Washburn #1	16.1	4.2	83.0	178.3
Washburn #2	7.4	1.1	92.0	144.1
Mean for PCA/Total sq. miles	**12.7**	**6.7**	**85.6**	**9025.4**

***** *Baseline values for the three subunits identified as in need of improvement (Gallatin #3, Henrys Lake #2, and Madison #2) will no longer be based on 1998 levels, but rather on improved levels based on full implementation of 2006 Travel Management Plan. See appended table below.*

Exceptions to 1998 Baseline
(baseline values based on 2006 Gallatin National Forest Travel Management Plan levels)

BMU subunit name	% OMARD (> 1 mi / mi^2)	% TMARD (> 2 mi / mi^2)	% Secure Habitat	Subunit area (mi^2) (excluding lakes)
Gallatin #3	28.6	12.7	70.7	217.6
Henrys Lake #2	41.5	30.6	51.7	140.2
Madison #2	32.0	21.6	67.5	149.4

Table 2. The 1998 baseline for numbers of developed sites on public lands in each bear management subunit in the GYE.

Subunit	Administrative units[1]	Summer home complexes[2]	Developed campgrounds[3]	Trailheads	Major developed sites and lodges	Administrative or maintenance	Other[4]	Plans of operation[5]	Total sites per subunit
Bechler/Teton	CTNF YNP GTNP	0 0 0	1 0 8	5 2 3	2 0 1	4 2 3	16 2 9	0 0 0	58
Boulder/Slough #1	CGNF	0	1	7	0	1	3	8	20
Boulder/Slough #2	CGNF YNP	0 0	0 1	0 3	0 0	2 2	0 1	0 0	9
Buffalo/Spread Creek #1	BTNF GTNP	0 0	1 1	1 7	0 2	0 1	2 3	0 0	18
Buffalo/Spread Creek #2	BTNF	1	4	3	3	5	5	1	22
Crandall/Sunlight #1	SNF CGNF	0 0	2 2	5 2	1 0	1 0	5 5	0 0	23
Crandall/Sunlight #2	SNF CGNF	0 0	5 0	4 0	1 0	2 0	5 0	1 0	18
Crandall/Sunlight #3	SNF WG&F	0 0	2 2	3 0	0 0	1 1	2 0	0 0	11
Firehole/Hayden #1	YNP	0	1	5	1	6	13	0	26
Firehole/Hayden #2	YNP	0	1	3	1	2	8	0	15
Gallatin #1	YNP	0	0	3	0	1	0	0	4
Gallatin #2	YNP	0	2	5	1	12	1	0	21
Gallatin #3	CGNF YNP	0 0	2 0	9 0	0 0	1 0	6 0	0 0	18
Hellroaring/Bear #1	CGNF YNP	0 0	4 0	11 1	0 0	3 0	8 1	8 0	36
Hellroaring/Bear #2	CGNF YNP	0 0	0 0	1 0	0 0	1 2	0 0	0 0	4
Henrys Lake #1	CTNF	2	3	1	0	3	10	1	20
Henrys Lake #2	CTNF CGNF	0 5	0 3	1 4	0 0	1 0	1 2	1 0	18
Hilgard #1	BDNF CGNF	0 0	0 0	0 6	0 1	3 2	0 2	0 0	14

Subunit	Administrative units[1]	Summer home complexes[2]	Developed campgrounds[3]	Trailheads	Major developed sites and lodges	Administrative or maintenance	Other[4]	Plans of operation[5]	Total sites per subunit
Hilgard #2	CGNF YNP	0 0	0 0	4 3	0 0	1 0	1 0	0 0	9
Lamar #1	YNP CGNF SNF	0 0 0	1 2 0	5 7 0	0 0 0	3 6 0	2 3 0	0 8 0	37
Lamar #2	YNP	0	0	0	0	4	0	0	4
Madison #1	CGNF YNP	0 0	1 0	11 0	0 0	1 0	8 0	0 0	21
Madison #2	CGNF YNP	8 0	2 0	1 1	1 0	4 2	5 1	0 0	25
Pelican/Clear #1	YNP	0	0	2	0	0	0	0	2
Pelican/Clear #2	YNP	0	1	4	1	4	3	0	13
Plateau #1	CTNF CGNF YNP	1 0 0	0 0 0	0 0 0	0 0 0	0 0 1	1 0 0	0 0 0	3
Plateau #2	CTNF YNP	0 0	0 0	1 0	0 0	1 4	1 0	0 0	7
Shoshone #1	SNF	1	2	0	0	0	6	0	9
Shoshone #2	SNF	0	0	1	1	0	0	0	2
Shoshone #3	SNF	2	0	1	1	0	0	0	4
Shoshone #4	SNF	3	3	3	6	0	8	0	23
South Absaroka #1	SNF	0	0	0	0	0	0	0	0
South Absaroka #2	SNF	0	0	0	0	2	0	0	2
South Absaroka #3	SNF	1	3	4	1	1	5	0	15
Thorofare #1	BTNF YNP	0 0	0 0	0 0	0 0	0 4	0 0	0 0	4
Thorofare #2	BTNF YNP	0 0	0 0	0 0	0 0	2 0	0 0	0 0	2
Two Ocean/Lake #1	YNP BTNF GTNP	0 0 0	2 1 0	3 0 0	1 0 0	3 0 1	2 0 1	0 0 0	14

Subunit	Administrative units[1]	Summer home complexes[2]	Developed campgrounds[3]	Trailheads	Major developed sites and lodges	Administrative or maintenance	Other[4]	Plans of operation[5]	Total sites per subunit
Two Ocean/Lake #2	YNP BTNF	0 0	0 0	0 0	0 0	2 1	0 1	0 0	4
Washburn #1	YNP	0	2	8	2	7	6	0	25
Washburn #2	YNP	0	1	6	0	1	4	0	12
Primary Conservation Area	**All**	**24**	**68**	**161**	**28**	**118**	**168**	**28**	**595**

[1] Abbreviations for administrative units: BDNF = Beaverhead-Deerlodge National Forest, BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, CGNF = Custer- Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, WG&F = Wyoming Game and Fish, YNP = Yellowstone National Park.

[2] Single permitted recreation residences are classified as other developed sites in this table.

[3] Campgrounds with trailheads are sometimes combined and treated as single developed sites.

[4] Includes developed recreation sites, as well as community infrastructure sites, dams, and other miscellaneous facilities.

[5] Includes mining claims with plans of operation. Not all sites have active projects.

Table 3. Developed sites (type and name) comprising the 1998 baseline per Bear Management Subunit inside the Primary Conservation Area.

Bear Management subunit	Admin Unit [i]	Name and type of developed sites
Bechler/Teton #1	CTNF	**Campgrounds (1):** Cave Falls. **Trailheads (5):** Coyote Meadows, Hominy Peak, South Boone Creek, Fish Lake, and Cascade Creek. **Major Developed Sites (2):** Loll Scout Camp and Idaho Youth Services Camp. **Administrative (4):** Squirrel Meadows guard station/cabin, Porcupine guard station, Badger Creek seismograph site, and Squirrel Meadows guard station/WGF cabin. **Other (16):** Grassy Lake dam, Tillery Lake dam, Indian Lake dam, Bergman Res. dam, Loon Lake dispersed sites, Horseshoe Lake dispersed sites, Porcupine Creek dispersed sites, gravel pit/target range, Boone Creek dispersed sites, Tillery Lake oil & gas camp, Calf Creek oil & gas camp, Bergman oil & gas camp, Granite Creek cow camp, Poacher's trailhead, Indian Meadows trailhead, and McRenolds Res. trailhead/wildlife viewing area/dam.
	GTNP	**Campgrounds (8):** Grassy Lake Road campsites (8 individual car camping sites). **Trailheads (3)**: Glade Creek, Lower Berry Creek, and Flagg Canyon. **Major Developed Sites (1):** Flagg Ranch complex. **Administrative (3):** Flagg Ranch Ranger Station, Flagg Ranch employee housing, and Flagg Ranch maintenance yard. **Other (9):** Upper Berry, Lower Berry, and Moose Basin patrol cabins; Hechtman Horse Camp, Warm Springs group campsite, Wilcox Point campsite #1, Warm Springs individual campsite, Flagg Ranch boat launch, and Yellowstone South Entrance boat launch.
	YNP	**Trailheads (2)**: 9K1 and Cave Falls. **Administrative or Maintenance Sites (2):** South Entrance and Bechler Ranger Stations. **Other (2):** Union Falls and Snake River picnic areas.
Boulder/Slough #1	CGNF	**Campgrounds (1):** Hicks Park. **Trailheads (7)**: Goose Lake, Upsidedown Creek, Independence, Sheep Creek, Copper Creek, Bridge Creek, and Box Canyon. **Administrative (1):** Box Canyon administrative cabin. **Other (3):** 2 recreation residences (Rasnick and Mandeville), Independence mine site (no plan of operations). **Plans of Operation (8):** Carolyn Sluice Box, Cray Sluice, East Iron Mountain Beartooth Plateau 1, East Iron Mountain Beartooth Plateau 2, Iron Mountain Idaho Construction Metal, Crescent Creek Pan Palladium, Crescent Creek Chromium Corp America, and Crescent Creek Beartooth Platinum.
Boulder/Slough #2	CGNF	**Administrative (2):** Slough Creek cabin and Buffalo Fork cabin.
	YNP	**Campgrounds (1):** Slough Creek. **Trailheads (3):** Specimen ridge, Slough Creek, and Lamar Ford. **Administrative (2):** Elk Tongue and Lower Slough patrol cabins. **Other (1):** Yellowstone River picnic area.
Buffalo/Spread Creek #1	BTNF	**Campgrounds (1):** Pacific Creek CG/TH**. Trailheads (1):** Colter Dump. **Other (2):** Teton Horseback Adventures, Shoal Creek Outfitters Base Camp
	GTNP	**Campgrounds (1)**: Lizard Creek. **Trailheads (7):** Grand View Point, Two Ocean Lake, Christian Pond, Arizona Lake, Arizona Creek #1, Arizona Creek #2, and Pilgrim Creek. **Major Developed Sites (2):** Moran Entrance Station housing and Jackson Lake employee housing. **Administrative (1):** Buffalo Fork Ranger Station. **Other (3):** Moran Post Office, Moran school, and Colter Bay storage/staging area.

Bear Management subunit	Admin Unit [i]	Name and type of developed sites
Buffalo/Spread Creek #2	BTNF	**Summer Home Complex (1):** Turpin Meadows. **Campgrounds (4):** Hatchet, Turpin Meadows, Angles CG/TH and Box Creek CG/TH. **Trailheads (3):** Turpin Meadows, Lava Creek, and Clear Creek. **Major Developed Sites (3):** Heart Six Ranch, Turpin Meadows Ranch, and Togwotee Lodge. **Administrative (5):** Buffalo Ranger District Office, Buffalo Ranger District compound (Includes a gravel pit), Enos Lake patrol cabin, Nowlin Meadows patrol cabin; Hatchet administrative site**. Other (5):** UW Forestry Walk VIS, Four Mile Picnic Area, Lost Lake information station, Togwotee Overlook, and Historic ranger station. **Plans of Operation (1):** gravel pit
Crandall/Sunlight #1	CGNF	**Campgrounds (2):** Chief Joseph and Ovis Lake Road Camp. **Trailheads (2):** Broadwater and Clarks Fork Foot. **Other (5):** Arbor Day watchable wildlife site, Kersey Lake rental cabin/boat dock, Round Lake rental cabin/warming hut, Clarks Fork fishing platform/interpretive exhibit, and 1 recreation residence (summer home).
	SNF	**Campgrounds (2):** Beartooth and Island Lake. **Trailheads (5):** Beartooth Lake, Island Lake, Clay Butte, Muddy Creek, and Morrison Jeep. **Major Developed Sites (1):** Top of the World store complex. **Administrative (1):** YNP highway maintenance site (includes 2 summer residences). **Other (5):** Island Lake Boat Ramp, Beartooth Lake Boat Ramp, Clay Butte Lookout, Pilot/Index Overlook, and Beartooth Lake picnic area.
Crandall/Sunlight #2	CGNF	**No Developed Sites**
	SNF	**Campgrounds (5):** Fox Creek, Lake Creek, Hunter Peak, Crazy Creek and Lily Lake. **Trailheads (4):** Pilot Creek, Clarks Fork, North Crandall, and Crazy Creek. **Major Developed Sites (1):** K-Z Lodge complex. **Administrative (2):** Crandall work center (2 residences, office, shop and bunkhouse), and Crandall WGF cabin. **Other (5):** Crandall waste transfer site, Clarks Fork overlook, Lily Lake boat ramp, Swamp Lake boat ramp, and Reef Creek picnic area. **Plan of Operations (1)**: Ghost Creek commercial sale gravel pit.
Crandall/Sunlight #3	SNF	**Campgrounds (2):** Dead Indian and Little Sunlight. **Trailheads (3):** Little Sunlight trailhead/corrals, Dead Indian, and Hoodoo Basin/Lamar. **Administrative (1):** Sunlight Ranger Station. **Other (2):** Sunlight picnic area, and Sunlight Bridge overlook.
	WGF	**Campgrounds (2):** WGF Sunlight Unit #1 and WGF Sunlight Unit #2. **Administrative (1):** WGF Sunlight Management complex.
Firehole/Hayden #1	YNP	**Campground (1):** Madison Junction. **Trailheads (5):** Nez Perce Creek, 7-Mile Bridge, Fountain freight Road, Lone Star, and OK5. **Major Developed Sites (1):** Old Faithful complex. **Administrative (6):** Norris employee housing /government area, Norris hot mix plant, Madison employee housing /government site, Mesa gravel pit; Mary Lake patrol cabin, and Nez Perce patrol cabin. **Other (13):** 12 picnic areas (Norris, Gibbon Meadows, Tuft Cliffs, Gibbon Falls, Madison, Buffalo Ford, Cascade, Firehole Canyon, Nez Perce, Feather Lake, Goose Lake, and Excelsior); and Norris Geyser Basin Museum.
Firehole/Hayden #2	YNP	**Campgrounds (1):** Bridge Bay. **Trailheads (3):** Divide, Beach Lake, and De Lacy Creek. **Major Developed Sites (1):** Lake complex. **Administrative (2):** Lake government area and Bridge Bay Marina. **Other (8):** Gull Point, Sand Point, and 6 additional lakeshore picnic areas.

Bear Management subunit	Admin Unit [i]	Name and type of developed sites
Gallatin #1	YNP	**Trailheads (3):** Black Butte (WK2), Specimen Creek (WK3), and Bighorn Pass (WK6). **Administrative (1):** Daly Creek patrol cabin.
Gallatin #2	YNP	**Campgrounds (2):** Mammoth and Indian Creek**. Trailheads (5):** Rescue Creek, Lava Creek, Golden Gate, Bunsen Peak, and Fawn Pass. **Major Developed Sites (1):** Mammoth complex. **Administrative (12):** Stephens Creek employee residence, Gardiner gravel crusher/asphalt site, Lower Mammoth employee housing area, YCC employee housing area, Indian Creek gravel pit, Deaf Jim patrol cabin, North Entrance Ranger Station, Fawn Pass patrol cabin, Winter Creek patrol cabin, Bunsen Peak radio repeater site, and Mt Holmes fire lookout. **Other (1):** Sheepeater picnic area.
Gallatin #3	CGNF	**Campgrounds (2):** Tom Miner and Red Cliff. **Trailheads (9):** Buffalo Horn, Sphinx Creek, Elkhorn, Wilson Draw, Tom Miner, Tom Miner Horse Facilities, Sunlight, Twin Cabin, and Tepee Creek. **Administrative or Maintenance (1):** Buffalo Horn cabin. **Other (6):** Corwin Spring fishing /boat access, Yankee Jim fishing access/boat ramp, Elkhorn River Ford horse access, Windy Pass rental cabin, Yankee Jim picnic area, and Porcupine Creek recreation residence.
	YNP	**No Developed Sites**
Hellroaring/Bear #1	CGNF	**Campgrounds (4):** Eagle Creek, Bear Creek, Timber Camp, and Canyon. **Trailheads (11):** Cedar Creek, La Duke, Little Trail Creek, Pine Creek, Palmer Mt. (3 trailheads), North Fork Bear Creek, Joe Brown, Bear Creek, and Sixmile. **Administrative (3):** OTO Ranch, Blanding Station house/barn/horse facility, and Hayes/McPherson property. **Other (8):** Eagle Creek horse facility, La Duke picnic area, La Duke bighorn sheep watchable wildlife site, 1 recreation cabin, Lonesome Pond camping area, McConnell fishing and boat access, watchable wildlife/big game winter range site, and watchable wildlife/fish site. **Plans of Operation (8):** Counts, Mineral Hill Mine (5 distinct plans), Independence, and Livingston.
	YNP	**Trailheads (1):** Crevice. **Other (1):** Crevice cabin
Hellroaring/Bear #2	CGNF	**Trailheads (1):** West Fork Mill Creek. **Administrative (1):** Hellroaring cabin/tack shed.
	YNP	**Administrative (2):** Buffalo Plateau and Hellroaring patrol cabins.
Henrys Lake #1	CTNF	**Summer Home Complexes (2):** Big Springs North, Big Springs South. **Campgrounds (3):** Big Springs, Flat Rock, and Upper Coffee Pot. **Trailheads (1):** Howard Creek. **Administrative (3):** Sawtelle Peak Electronics Site, Keg Springs Seismograph Site, Big Springs Fire Tower. **Other (10):** Big Springs Interpretive Trail, Big Springs Bridge Fish Viewing, Johnny Sack Cabin, Big Springs Boat Ramp, Big Springs Snow Park/Warming Hut, Macks Inn Water Treatment Plant, Macks Inn Substation, County/State Sheds Complex, FAA Maintenance Sheds, Cold Springs Substation. **Plans of Operation (1):** Willow Creek Mining Site.
Henrys Lake #2	CGNF	**Summer Home Complexes (5):** Clark Springs (8 lots), Rumbaugh Ridge (5), Romsett (9), Lonesomehurst A, Lonesomehurst B. **Campgrounds (3):** Lonesomehurst, Cherry Creek, Spring Creek. **Trailheads (4):** Basin, Watkins Creek, Targhee Pass, West Denny Creek. **Other (2):** Basin rental cabin, and Lonesomehurst boat ramp.
	CTNF	**Trailheads (1):** Targhee Creek. **Administrative (1):** Defosses Cabin. **Other (1):** Howard Springs Family Picnic/Wayside Area. **Plans of Operation (1):** Turquoise Mountain Mine
Hilgard #1	BDNF	**Administrative (3):** McAtee Cabin, Indian Creek Cow Camp and Shedhorn Cow Camps.
	CGNF	**Trailheads (6):** Upper Buck Ridge, Cinnamon, Meadow Creek Cutoff, Cache Creek, Lower Buck Ridge, and Taylor Falls/Lightning Creek. **Major Developed Sites (1):** Covered Wagon Ranch complex. **Administrative (2):** Cinnamon cabin and Cinnamon Mountain lookout. **Other (2):** Yellow Mule rental cabin and Buck Creek recreation residence.

Bear Management subunit	Admin Unit [i]	Name and type of developed sites
Hilgard #2	CGNF	**Trailheads (4):** Eldridge, Wapiti, Lower Wapiti/Albino Lake, and Sage/Elkhorn. **Administrative (1):** Eldridge Cabin. **Other (1):** Wapiti rental cabin.
	YNP	**Trailheads (3):** WK1, WK5, and WK4.
Lamar #1	CGNF	**Campgrounds (2):** Soda Butte and Colter. **Trailheads (7)**: Abundance Lake/Upper Stillwater, Republic Creek;, Lower Lady of Lake, Lady of Lake #1, Woody Pass, Daisy Pass and Wolverine Pass. **Administrative (6):** Cooke City guard station/warehouse, 2nd Forest Service warehouse, highway borrow pit, mine tailings repository, old mine buildings, and mine reclamation pond. **Other (3):** Cooke City dump (SUP), Beartooth Highway interpretive site, and Cooke City burn pile. **Plans of Operation (8)**: Cray Placer and 7 distinct New World mines.
	SNF	**No Developed Sites**
	YNP	**Campgrounds (1):** Pebble Creek. **Trailheads (5):** 3K1, 3K3, 3K4, Trout Lake, and Lamar Ford. **Administrative (3):** Northeast Entrance Ranger Station (and supporting government operation), Lamar Buffalo Ranch Ranger Station/Institute, and the Cache Creek patrol cabin. **Other (2):** Warm Creek picnic area and Buffalo Ranch/Lamar River picnic area.
Lamar #2	YNP	**Administrative (4):** Calfee Creek, Upper Miller Creek, Cold Creek, and Lamar Mountain patrol cabins.
Madison #1	CGNF	**Campgrounds (1):** Cabin Creek. **Trailheads (11)**: Potamogeton, West Fork Beaver Creek, Whits Lake, Johnson Lake, Tepee Creek, Red Canyon, Kirkwood, Cub Creek, Fir Ridge, Hebgen Mountain and Cabin Creek. **Administrative (1):** Building destruction site. **Other (8):** gravel pit, Tepee Creek snowmobile parking area, Beaver Creek watchable wildlife site, Beaver Creek rental cabin, Cabin Creek rental cabin, Hebgen Dam fishing access and administrative site, Yellowstone Holiday picnic area, and North Shore picnic area.
	YNP	**No Developed Sites**
Madison #2	CGNF	**Summer Home Complexes (8):** California (2 lots), Lakeshore A (6 lots), Lakeshore B (8 lots), Lakeshore C (3 lots), Lakeshore E (19 lots), Baker's Hole (3 lots), Railroad (3 lots), and Horse Butte (2 lots). **Campgrounds (2):** Rainbow Point and Bakers Hole (includes watchable wildlife site). **Trailheads (1):** Rendezvous Ski Trail complex. **Major Developed Sites (1):** Madison Arm Resort. **Administrative (4):** West Yellowstone Ranger Station, WY Interagency Fire Center (Includes crew quarters IAFCC, fire control center and mixing site), Bison capture facility (SUP), and Game Warden Residence. **Other (5):** Solid Waste Transfer Station (SUP), Madison picnic area/boat ramp, Rainbow Point picnic area/boat ramp, Horse Butte lookout/picnic site, and South Plateau shooting range.
	YNP	**Trailhead (1):** Cable Car. **Administrative (2):** West Entrance Ranger Station/housing complex and Cougar Creek patrol cabin. **Other (1):** Madison River picnic area.
Pelican/Clear #1	YNP	**Trailheads:** Lower Falls and Sour Creek.
Pelican/Clear #2	YNP	**Campgrounds (1):** Fishing Bridge RV Park. **Trailheads (4):** Pelican Valley, 9-mile, Clear Creek, and Avalanche Peak. **Major Developed Sites (1):** Fishing Bridge store/gas station/employee housing/museum. **Administrative (4):** East Gate Ranger Station/housing complex; Fern Lake, Pelican Cone, and Pelican Springs patrol cabins. **Other (3):** Steamboat Point, Lake Butte, and Sylvan Lake picnic areas.
Plateau #1	CGNF	**No Developed Sites.**
	CTN	**Summer Home Complexes (1):** Moose Creek. **Other (1):** Lucky Dog Lodge/TNC/SUP
	YNP	**Administrative (1):** South Riverside patrol cabin.

Bear Management subunit	Admin Unit [i]	Name and type of developed sites
Plateau #2	CTNF	**Trailheads (1):** Moose Creek/Trail Canyon. **Administrative (1):** Warm River Springs GS/Cabin. **Other (1):** Snow Creek Pond disperse sites
	YNP	**Administrative (4):** Cove, Outlet, Buffalo Lake, and 3 Rivers patrol cabins**.**
Shoshone #1	SNF	**Summer Home Complexes (1):** Moss Creek (7 lots). **Campgrounds (2):** Newton Creek and Rex Hale. **Other (6):** Summer lot E, Fire Memorial, Robbers Roost cabin/cow camp, and Newton Springs picnic area, Blackwater Pond Picnic/Fishing Area, and Palisades interpretive site**.**
Shoshone #2	SNF	**Trailheads (1):** Blackwater. **Major Developed Sites (1):** Blackwater Lodge Complex.
Shoshone #3	SNF	**Summer Home Complexes (2):** Eagle Creek (8 lots) and Kitty Creek (14 lots). **Trailheads (1):** Kitty Creek**. Major Developed Sites (1):** Buffalo Bill Boy Scout Camp Complex.
Shoshone #4	SNF	**Summer Home Complexes (3):** Grinnell Creek (2 lots), Pahaska (2 lots), and Mormon Creek (13 lots). **Campgrounds (3):** Eagle Creek, Three Mile, and Sleeping Giant. **Trailheads (3):** Fishhawk North, Eagle Creek, and Pahaska. **Major Developed Sites (6):** Elephant Head Lodge, Absaroka Mountain Lodge, Shoshone Lodge, Crossed Sabres Lodge, Goff Creek Lodge, and Pahaska Tepee. **Other (8):** Sleeping Giant ski area, WY Game and Fish cabin, Wayfarers Chapel, summer home isolated lot C, summer lot A, summer home lot B, West Gateway Interpretive Site, and Cody Peak Interpretive Site.
South Absaroka #1	SNF	**No Developed Sites.**
South Absaroka #2	SNF	**Administrative (2):** Venus Creek Cabin and Needle Creek Administrative site (2 cabins).
South Absaroka #3	SNF	**Summer Home Complexes (1):** Pinnacles (20). **Campgrounds (3):** Brooks Lake, Pinnacles (23) and dispersed campground (23 sites) near Brooks Lake. **Trailheads (4):** Long Creek/Dunoir, Brooks Lake, Pinnacles Trailhead, and Bonneville. **Major Developed Sites (1):** Brooks Lake Lodge. **Administrative (1):** Wolf Creek. **Other (5):** Brooks Lake boat ramp, transfer corral/Bud Betts, Transfer Corral/Paul Gilroy, Pinnacles Transfer Corral/Bridger Teton Outfitter on Brooks Lake Creek, and Winter Cabin/warming hut.
Thorofare #1	BTNF	**No Developed Sites.**
	YNP	**Administrative (4):** Cabin Creek, Howell Creek, Trail Creek, and Thorofare patrol cabins.
Thorofare #2	BTNF	**Administrative (2):** Hawk's Rest patrol cabin (USFS) and **WGF patrol cabin.**
	YNP	**No Developed Sites.**
Two Ocean/Lake #1	BTNF	**Campgrounds (1):** Sheffield Creek Campground/Trailhead.
	GTNP	**Administrative (1):** Snake River gravel pit. **Other (1):** Snake River Picnic Area.
	YNP	**Campgrounds (2):** Lewis Lake and Grant Village. **Trailheads (3):** Shoshone Lake, Heart Lake, and Riddle Lake. **Major Developed Sites (1):** Grant Village. **Administrative (3):** Heart Lake patrol cabin, Harebell patrol cabins, and Mt Sheridan fire lookout. **Other (2):** West Thumb warming hut and Frank Island picnic area.
Two Ocean/Lake #2	BTNF	**Administrative (1):** Fox Park Patrol Cabin. **Other (1):** Huckleberry Lookout Historic Site.
	YNP	**Administrative (2):** Peale Island patrol cabin and Fox Creek patrol cabin.

Bear Management subunit	Admin Unit [i]	Name and type of developed sites
Washburn #1	YNP	**Campgrounds (2):** Tower (includes store, parking and overlook) and Canyon Village. **Trailheads (8):** Lower Blacktail, Upper Blacktail, Blacktail Plateau Rd/ski trail, Hellroaring, Wraith Falls, Mount Washburn, Dunraven Pass, and Howard Eaton trail. **Major Developed Sites (2):** Canyon Village and Roosevelt Lodge complex. **Administrative (7):** Frog Rock gravel pit, Grebe Lake gravel pit, Tower Ranger Station, Mount Washburn fire lookout; and Upper Blacktail, Lower Blacktail, and Observation Peak patrol cabins. **Other (6):** Lava Creek, Antelope Creek, Dunraven Pass, Dunraven, and Howard Eaton picnic areas; and Yanceys Hole cookout site.
Washburn #2	YNP	**Campgrounds (1):** Norris (and Ranger Station). **Trailheads (6):** Bighorn Pass, Winter Creek, Solfatara Creek, Grizzly Lake, Grebe Lake, and Washburn Ice Lakes. **Administrative (1):** Ice Lake gravel pit. **Other (4):** Apollinaris Springs, Beaver Lake, Norris Junction, and Virginia Meadows picnic areas.

[i] Administrative unit abbreviations: BDNF = Beaverhead-Deerlodge National Forest, CGNF = Custer Gallatin National Forest, CTNF = Caribou-Targhee National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, WGF = Wyoming Game and Fish, YNP = Yellowstone National Park.

Table 5. Number and acreage of commercial livestock grazing allotments and number of sheep animal months inside the Yellowstone Primary Conservation Area (PCA) in 1998.

Administrative unit	Cattle Allotments		Sheep Allotments		Sheep AMs
	Active	Vacant	Active	Vacant	
Beaverhead-Deerlodge NF	3	2	0	0	0
Bridger-Teton NF	9	0	0	0	0
Caribou-Targhee NF	11	1	7	4	14,163
Custer-Gallatin NF	23	10	2	4	3,540
Shoshone NF	25	0	2	2	5,387
Grand Teton NP	1	0	0	0	0
Total number in PCA	72	13	11	10	23,090
Total area in PCA (acres)	**660,845**	**67,893**	**148,368**	**77,665**	**NA**
Total area in PCA (km^2)	**2,674**	**275**	**600**	**312**	**NA**

Note: Tables in this appendix represent the most current baseline information available and supersede comparable tables in the appendices of the 2007 Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007); Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests, Final Environmental Impact Statement (USDA Forest Service 2006a); and the 2006 Forest Plan Amendment Record of Decision (USDA Forest Service 2006b).

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Appendix F. Lead Agencies for Actions under this Conservation Strategy

AGENCY LEADS AND PARTICIPANT AGENCIES HABITAT AND POPULATION MONITORING				
TASK	**LEAD AGENCY**	**PARTICIPANT AGENCIES**	**TASK LEADER**	**ANNUAL REPORT LEADER**
Secure Habitat/OMARD and TMARD (GIS runs and database updates)	USFS	YNP, GTNP	USFS	USFS
Cutthroat trout spawners	YNP	IGBST	YNP	YNP
Ungulate numbers	NPS, WY, MT, ID	NPS, WY, MT, ID	NPS, WY, MT, ID	NPS, WY, MT, ID
Whitebark cone transects	IGBST	YNP, USFS	IGBST	IGBST
Moth presence	WY	IGBST/WY	IGBST/WY	IGBST/WY
Mortality reduction	WY, MT, ID, NPS, USFS, FWS/LE	WY, MT, ID, NPS, USFS, FWS/LE	Cooperative	Cooperative
Developed Sites and Livestock Grazing	USFS	NPS	USFS	IGBST
TASK	**LEAD AGENCY**	**PARTICIPANT AGENCIES**	**TASK LEADER**	**ANNUAL REPORT LEADER**
Unduplicated females w/cubs	IGBST	WY, YNP, MT, ID, GTNP	IGBST	IGBST
Mortality	IGBST	MT, WY, ID, YNP, GTNP, FWS/LE	IGBST	IGBST
Distribution	IGBST	WY, YNP, MT, ID, GTNP	IGBST	IGBST

AGENCY LEADS AND PARTICIPANT AGENCIES HABITAT AND POPULATION MONITORING				
Maintaining 25 adult females with collars	IGBST	WY, YNP, MT, ID, GTNP	IGBST	IGBST
Monitoring genetic diversity	IGBST	IGBST, USFWS	IGBST	IGBST
Control action and conflict reporting	YNP	WY, YNP, MT, ID, GTNP	YNP	YNP/IGBST
Public outreach and information	All	WY, YNP, MT, ID, GTNP, USFS, FWS/LE	To be selected	To be selected

Appendix G. The Relationship between the Five Factors in Section 4(a)(1) of the ESA and the Existing Laws and Authorities

The relationship between the five factors in Section 4(a)(1) of the Endangered Species Act and the existing State and Federal laws and regulations is important to assure that the existing laws and authorities can address all the factors necessary to assure recovery under the Endangered Species Act. This table presents the State and Federal laws and authorities and which of the five factors are addressed by that law or authority.

Sec. 4. (A) General. - (1) The Secretary shall by regulation promulgated in accordance with subsection (b) determine whether any species is an endangered species or a threatened species because of any of the following factors:

A. the present or threatened destruction, modification, or curtailment of its habitat or range;
B. overutilization for commercial, recreational, scientific, or educational purposes;
C. disease or predation;
D. the inadequacy of existing regulatory mechanisms;
E. other natural or manmade factors affecting its continued existence.

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
The Act of Congress March 1, 1872 - Set Yellowstone National Park as a Public Park	X	X		X	X
National Park Service Organic Act of 1916, 16 U.S.C. 1, 39 Stat. 535	X	X		X	X
Lacey Act of 1900, as amended, 16 U.S.C. 701, 702; 31 Stat. 187, 32 Stat. 285; Criminal Code Provisions, as amended, 18 U.S.C. 42-44, 62 Stat. 87				X	
Fish & Wildlife Coordination Act of 1934, as amended, 16 U.S.C. 661-666c; 48 Stat.401	X	X		X	X
Federal Aid in Wildlife Restoration Act 1937, 16 U.S.C. 669-669i, 50 Stat. 917	X	X			X
The Act of Congress September 14, 1950 - Expansion of Grand Teton National Park to include Jackson Hole National Monument	X			X	
Sikes Act, 1960, as amended, 16U.S.C. 670a-670o; 74 Stat. 1052, Pub. L. 86-797	X	X			X
Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. 528-531, 74 Stat. 215, P.L. 86-517	X	X			X
National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321, 83 Stat. 852, Pub. L. 91-190	X	X			X
The Act of Congress August 25, 1972 - Establish John D. Rockefeller, Jr. Memorial Parkway	X	X			
Endangered Species Act of 1973, as amended, 16 U.S.C. 1531-1543; 87 Stat. 884	X	X	X	X	X
Forest and Rangeland Renewable Resources Planning Act, 1974, Pub. L. 93-378	X	X		X	X
National Forest Management Act of 1976, U.S.C. 1600 et. seq., Pub. L. 94-588	X	X			X
Federal Land Policy and Management Act of 1976, as amended,43 U.S.C. 1701 et. seq., Pub. L. 94-579, 90 Stat. 2744		X			X
Fish & Wildlife Improvement Act of 1978, 16 U.S.C. 742 l, 92 Stat. 3110				X	
Fish and Wildlife Conservation Act of 1980, 16 U.S.C. 2901-2904; 2905-2911; 94 Stat. 1322, Pub. L. 96-366	X	X		X	X
National Wildlife Refuge System Improvement Act of 1997 Publ. L. 105-57	X	X		X	X
36 CFR 1.5 (a)(1) – authority to establish use limits within national parks		X		X	
36 CFR 1.7(b) – compilation of public use restrictions; and 2.10(d) – camping & food storage restrictions				X	X
36 CFR 1.7(b) – compilation of public use restrictions; and 7.13 (l) – commercial vehicle restrictions in Yellowstone National Park		X		X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
36 CFR 2.2 – wildlife protection in national parks		X		X	X
36 CFR 2.10 – camping and food storage restrictions				X	X
36 CFR 219 – national forest system land management planning		X			X
36 CFR 219.19 – definitions related to the ESA	X			X	
36 CFR 219.27 (a)(6) – special designations	X			X	X
36 CFR 261.50 (a), (b) and (c) – authority to issue area closure orders on national forests				X	X
36 CFR 261.53 (a) and (e) – authority to issue "special" closures to protect threatened and endangered species, other sensitive resources				X	X
36 CFR 261.58 (e), (s) and (cc) – prohibition of activities that are contrary to an order				X	X
WYOMING STATE STATUTES					
23-1-101 (a)(xii) – definition of "Trophy Game" includes grizzly bear				X	
23-1-103 – ownership of wildlife		X		X	
23-1-302 (a)(ii) – powers and duties, trophy game zones		X		X	
23-1-302 (p) – competitive raffle license issuance, includes trophy game licenses				X	
23-1-502 (d) – commission to submit annual budget request for general funds to maintain grizzly bear management program	X	X	X	X	X
23-1-703 – limitation on no. trophy game licenses issued; 75% of available licenses reserved for residents; once-in-a-lifetime restriction on grizzly bear license				X	
23-1-705 (k) – reissuance of license to veteran with disabilities, waiver of once-in-a-lifetime limitation				X	
23-1-901 – damage claims				X	X
23-1-1001 – grizzly bear relocation		X		X	
23-2-101 (e) & (j) – application fees set aside to compensate for damage & grizzly bear license fees				X	X
23-2-102 – age restriction to hunt big or trophy game				X	
23-2-104 – commission authority to set archery seasons, archery equipment specifications for big or trophy game				X	
23-2-303 (d) – trapping rules & specifications				X	X
23-3-102 – prohibition against take without a license, penalties		X		X	X
23-2-401 – nonresidents must be accompanied by a licensed guide to hunt big or trophy game in designated wilderness areas				X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
23-2-407 – persons providing guiding or outfitting services for the purpose of taking big or trophy game must be licensed				X	X
23-3-106 – transportation of big or trophy game animal				X	X
23-3-107 – wanton destruction of big or trophy game animal		X		X	X
23-3-109 – dogs injuring big or trophy game animal		X		X	X
23-3-111 – commission authority to establish firearm and ammunition specifications for taking big & trophy game		X		X	X
23-3-112 – firearm prohibition & restriction		X		X	X
23-3-301 – importation, sale of wildlife prohibited				X	X
WYOMING GAME AND FISH COMMISSION REGULATIONS					
Chapter I – Access to Records				X	
Chapter II – General Hunting Regulations				X	
Chapter III – Black Bear Hunting Seasons Section 6 – Areas Closed to Black Bear Baiting; Section 7 – Reporting Use of a Bait by a Grizzly Bear	X	X		X	X
Chapter XXVIII – Big or Trophy Game Damage Claims		X		X	X
Chapter XXXIII – Issuance of Scientific Research Permits		X		X	
Chapter XXXII – Regulation Governing Legal Firearm Cartridges and Archery Equipment				X	
Chapter XLIII – Areas Closed to the Taking of Specified Wildlife		X		X	X
Chapter XLIV – Issuance of Licenses Section 5(f) – Trophy Game, Grizzly Bear Licenses		X		X	
Chapter LIV – Wildlife Violator Compact		X		X	
Chapter LVI – Regulation Governing Lethal Take of Wildlife		X		X	
Chapter LVIII – Notification of Grizzly Bear Relocation				X	
Chapter LXVII – Grizzly Bear Management Regulation		X		X	
Big and Trophy Game Hunting Regulation Brochures – Precautions When Hunting in Areas Occupied by Grizzly Bears		X		X	X
IDAHO STATE STATUTES					
I.C. 36-103 (a) – State Wildlife Policy		X		X	X
I.C. 36-103 (b) – Commission authority to administrator 36-101 (a)				X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
I.C. 36-104 (b) – Commission authority to restrict season, location, boundaries, limits, gender, age, method of take; includes automatic closure, mandatory check/report, and tag limits		X		X	
I.C. 36-105 (3) – Public notice and publication requirements for season setting				X	
I.C. 36-106 (e)(6) – Directory authority for emergency season closure upon written order		X		X	X
I.C. 36-201 – Commission authority to classify wildlife		X		X	X
I.C. 36-401 – Requirement for license and tag		X		X	
I.C. 36-408 (1)(2) – Commission authority to restrict hunter effort (e.g., controlled hunts, tag limits)		X		X	
I.C. 36-409 (c) – Requirement for license and tag		X		X	
I.C. 36-412 (a) – Hunter education mandatory for those born after 1/1/1975		X		X	
I.C. 36-501 – Sale and purchase of wildlife restrictions		X		X	
I.C. 36-502 – Possession, transportation, sale and use of wildlife restrictions		X		X	
I.C. 36-701 (a), (d), 703, 704, 706, 707, 709, 710 – Captive wildlife restrictions		X	X	X	
I.C. 36-1101 (a) – non take without statutory/Commission/Director authorization		X		X	
I.C. 36-1107 – Permit required for response to depredation unless self-defense/defense of others/defense of property under threat to human life or domestic animals		X		X	X
I.C. 36-1404 (a), (c), (d), (e), (g) – Penalties including license revocation in states participating in Wildlife Violator Compact		X		X	X
Title 67 Chapter 52 – Requirements for public notice, comments, and legislative review				X	
Title 74 – Open meeting requirements				X	
IDAHO FISH AND GAME COMMISSION RULES AND SEASON PROCLAMATIONS					
IDAPA 13.01.02.100 – Additional bear identification materials and exam are recommended and available on-line		X		X	
IDAPA 13.01.06.100.01 (e) – Grizzly bear classified as big game animal		X		X	
IDAPA 13.01.06.300.01 (e) – Game species may be taken only in accordance with Idaho law and rules established by the Idaho Fish and Game Commission		X		X	

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
IDAPA 13.01.08.260.04 – Take of grizzly bear restricted to once-in-a-lifetime				X	
IDAPA 13.01.08.300.01 (e) – Prohibition against take of adult grizzly bear accompanied by young, or young grizzly bear accompanied by an adult grizzly bear		X		X	
IDAPA 13.01.08.320.01 – Tag requirement		X		X	
IDAPA 13.01.08.350.01 – Evidence of sex requirement		X		X	
IDAPA 13.01.08.410 – Unlawful methods of take (e.g., no use of electronic calls, bait, dogs, snares, traps, radio telemetry tracking)		X		X	
IDAPA 13.01.08.420-422 – Five-day mandatory check and 24-hour mandatory report of kill requirements for grizzly bear hunters		X		X	
IDAPA 13.01.10.100, 101, 200, 400, 700.01 – Permits, requirements for import, export, transport, release and sale of living wildlife		X	X	X	
IDAPA 13.01.10.300 – Recovery, possession and sale of wildlife parts		X		X	
Idaho Fish and Game Season Proclamations issued pursuant to Idaho Code 36-104(b)		X		X	X
MONTANA STATE STATUTES					
87-1-201 (1) – Powers and duties of Montana Fish, Wildlife and Parks – The department shall supervise all the wildlife, fish, game, game and nongame birds, waterfowl, and the game and fur-bearing animals of the state. The department possesses all powers necessary to fulfill the duties prescribed by law and to bring actions in the proper courts of this state for the enforcement of the fish and game laws and the rules adopted by the department.		X	X	X	X
87-2-201 (2) – The department shall enforce all the laws of the state regarding the protection, preservation, management, and propagation of fish, game, fur-bearing animals, and game and nongame birds within the state.	X	X	X	X	X
87-2-201 (8) MCA – The department is authorized to promulgate rules relative to tagging, possession, or transportation of bear within or outside the state.		X		X	X
87-1-201 (9)(a) – The department shall implement programs that: (i) manage wildlife, fish, game, and nongame animals in a manner that prevents the need for listing under 87-5-107 or under the federal Endangered Species Act, 16 U.S.C. 1531, et seq.	X	X	X	X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
87-1-301. – Powers of commission. (1) the commission: (a) shall set the policies for the protection, preservation, management, and propagation of the wildlife, fish, game, fur-bearers, waterfowl, nongame species, and endangered species of the state and for the fulfillment of all other responsibilities of the department related to fish and wildlife as provided by law; (b) shall establish the hunting, fishing, and trapping rules of the department.	X	X	X	X	X
87-1-301 (3) – The commission may divide the state into fish and game districts and create fish, game, or fur-bearing animal districts throughout the state. The commission may declare a closed season for hunting, fishing, or trapping in any of those districts and later may open those districts to hunting, fishing, or trapping.		X		X	X
87-1-301 (4) – The commission may declare a closed season on any species of game, fish, game birds, or fur-bearing animals threatened with undue depletion from any cause.		X		X	X
87-1-301 (5) – The commission may authorize the director to open or close any special season upon 12 hours' notice to the public.		X		X	X
87-1-304. – Fixing of seasons and bag and possession limits. The commission may: (a) fix seasons, bag limits, possession limits, and season limits; (b) open or close or shorten or lengthen seasons on any species of game, bird, fish, or fur-bearing animal as defined by 87-2-101; (c) declare areas open to the hunting of deer, antelope, elk, moose, sheep, goat, mountain lion, bear, wild buffalo or bison, and wolf by persons holding an archery stamp and the required license, permit, or tag and designate times when only bows and arrows may be used to hunt deer, antelope, elk, moose, sheep, goat, mountain lion, bear, wild buffalo or bison, and wolf in those areas; (d) restrict areas and species to hunting with only specified hunting arms, including bow and arrow, for the reasons of safety or of providing diverse hunting opportunities and experiences; and (e) declare areas open to special license holders only and issue special licenses in a limited number when the commission determines, after proper investigation, that a special season is necessary to ensure the maintenance of an adequate supply of game birds, fish, or animals or fur-bearing animals.		X		X	X
87-2-101. – Definitions. (4) "Game animals" means deer, elk, moose, antelope, caribou, mountain sheep, mountain goat, mountain lion, bear, and wild buffalo.		X		X	X
87-2-701. – Special licenses. (1)(2) grizzly bear—resident, $150 ; nonresident, $1,000.		X		X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
87-2-701 (2) – If a holder of a valid special grizzly bear license who is 12 years of age or older kills a grizzly bear, the person shall purchase a trophy license for a fee of $50 within 10 days after the date of the kill. The trophy license authorizes the holder to possess and transport the trophy.		X		X	X
87-2-702. – Restrictions on special licenses – availability of bear and mountain lion licenses. (3) Except as provided in 87-2-815, a person may take only one grizzly bear in Montana with a license authorized by 87-2-701.		X		X	X
87-5-103. – Legislative intent, findings, and policy. (2) The legislature finds and declares all of the following: (a) that it is the policy of this state to manage certain nongame wildlife for human enjoyment, for scientific purposes, and to ensure their perpetuation as members of ecosystems; (b) that species or subspecies of wildlife indigenous to this state that may be found to be endangered within the state should be protected in order to maintain and, to the extent possible, enhance their numbers.		X		X	X
87-5-301. – Grizzly bear – findings – policy. (1) The legislature finds that: (a) grizzly bears are a recovered population and thrive under responsive cooperative agreement; (b) grizzly bear conservation is best served under state management and the local, state, tribal, and federal partnerships that fostered recovery; and (c) successful conflict management is key to maintaining public support for conservation of the grizzly bear. (2) It is the policy of the state to : (a) manage the grizzly bear as a species in need of management to avoid conflicts with humans and livestock; and (b) use proactive management to control grizzly bear distribution and prevent conflicts, including trapping and lethal measures.		X	X	X	X
87-5-302. – Commission regulations on grizzly bears. (1) The commission may regulate the hunting of grizzly bears, including the establishment of tagging requirements for carcasses, skulls, and hides; and (b) establish requirements for the transportation, exportation, and importation of grizzly bears.		X	X	X	X
87-5-3-2. – Commission regulations on grizzly bears. (2) When special grizzly bear licenses are to be issued pursuant to 87-2-701, the commission shall establish hunting season quotas for grizzly bears that will prevent the population of grizzly bears from decreasing below sustainable levels.		X		X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
87-6-413. – Hunting or killing over limit. (1) A person may not attempt to kill, take, shoot, or capture or kill, take, hunt, shoot, or capture more than one game animal of any one species in any license year unless the killing of more than one game animal of that species has been authorized by regulations of the department. (2) If a person is convicted or forfeits bond or bail after being charged with hunting or killing over the limit of: (a) mountain sheep, moose, wild buffalo, caribou, mountain goat, black bear, or grizzly bear, the person shall be fined not less than $500 or more than $2,000 or be imprisoned in the county detention center for not more than 6 months, or both. In addition, the person shall forfeit any current hunting, fishing, recreational use, or trapping license issued by this state and the privilege to hunt, fish, or trap in this state for 30 months from the date of conviction or forfeiture unless the court imposes a longer period.		X		X	X
87-6-404. – Unlawful use of dog while hunting. (1) A person may not chase any game animal or fur-bearing animal with a dog.		X		X	X
ADMINISTRATIVE RULES OF MONTANA					
ARM 12.9.103. Grizzly Bear Policy – Now, therefore, in order to promote the preservation of the grizzly bear in its native habitat, the commission establishes the following policy guidelines for the Montana Department of Fish, Wildlife, and Parks action when dealing with grizzly bears.	X	X	X	X	X
Grizzly Bear Hunting Regulations (2016) – Commission Rule		X		X	X
MONTANA DEPARTMENT OF STATE LANDS					
Title 75, Chapter 1 MCA - Montana Environmental Policy Act	X				
Title 76, Chapter 14, MCA - Montana Rangeland Resource Act	X				
Title 77, Chapter 1 MCA - Administration of State Lands	X				X
Title 87, Chapter 5, MCA - Nongame and Endangered Species Conservation Act	X			X	X
Montana Constitution. Article IX - Environment and Natural Resources. Section 1 - Protection and Improvement	X				
Montana Constitution. Article X - Education and Public Lands. Section 4 - Board of Land Commissioners.	X				
FEDERAL PLANS AND GUIDELINES - NATIONAL PARK SERVICE					
NPS-77, Natural Resource Management Guidelines, May 16, 1991		X			X
Final Environmental Impact Statement, Grizzly Bear Management Program, Yellowstone National Park, July, 1983	X	X	X	X	X

FEDERAL AND STATE LAWS AND REGULATIONS	Five Factors				
	A	**B**	**C**	**D**	**E**
Yellowstone National Park Annual Bear Management Plan		X			X
Grand Teton National Park Human/bear Management Plan, 1989	X	X	X	X	X
U.S. FOREST SERVICE (Regions 1,2, and 4)				X	
Beaverhead-Deerlodge NF Land and Resource Management Plan (2009)	X			X	X
Bridger-Teton NF Land and Resource Management Plan with Amendments and Corrections (2015)	X		X	X	X
Custer NF and Grasslands Land Resource Management Plan (1987)	X		X		
Gallatin NF Plan (1987) as amended through November 2014	X		X	X	X
Shoshone NF Land Management Plan (2015)	X		X	X	
1997 Revised Forest Plan - Targhee National Forest	X		X	X	X
OTHER DOCUMENTS					
Grizzly Bear Compendium. National Wildlife Federation, Washington, D.C. 1987					X
Interagency Grizzly Bear Committee Taskforce Report, Grizzly Bear/Motorized Access Management. 1994. Revised 1998.				X	
Yellowstone Grizzly Bear Investigations				X	X
Public Information and Involvement Strategy for IGBC.				X	X
Tri-State MOA – Allocation of Discretionary Mortality of Grizzly Bears in the Greater Yellowstone Ecosystem among WY, MT, & ID (2016)		X		X	X
Grizzly Bear Recovery Plan Supplement: Revised Demographic Recovery Criteria for the Yellowstone Ecosystem (2016)		X			X
1993 Grizzly Bear Recovery Plan	X	X	X	X	X
Wyoming Grizzly Bear Management Plan (2016)	X	X	X	X	X
Wyoming Grizzly Bear Annual Job Completion (Monitoring) Reports		X	X	X	X
Wyoming Bear Wise Program	X	X		X	X
Grizzly Bear Management for SW Montana (2013)	X	X	X	X	X
Grizzly Bear Final Management Plan for Western Montana (2006)	X	X	X	X	X
Idaho Yellowstone Grizzly Bear Management Plan to Accompany HCR 62	X	X		X	X

Appendix H. Grizzly Bear Management Plan for Southwestern Montana

GRIZZLY BEAR

Management Plan for Southwestern Montana
2013

FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Prepared by:

Montana Fish, Wildlife & Parks

December 2013

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ACKNOWLEDGEMENTS

Many people participated in development of this plan but Montana Fish, Wildlife and Parks would specifically like to thank Mark Haroldson of the Interagency Grizzly Bear Study Team for his time and assistance in document preparation and review.

INTRODUCTION

Process for Plan Development

Montana Fish, Wildlife & Parks (FWP) developed the original grizzly bear management plan and programmatic environmental impact statement (EIS) for grizzly bear management in southwest Montana in 2002. The management plan and EIS was effective for a ten year period (2002-2012). At that time, the process involved a series of meetings with affected agencies, governments, and interested persons. FWP initiated the scoping process with discussion of potential issues and alternatives with biologists, wardens, and representatives from Idaho and Wyoming during the summer of 2000. Following those preliminary efforts, FWP held a series of 13 public scoping meetings in southwestern Montana. A draft plan was released for public comment in April, 2002. Formal public hearings were conducted and public comment was also accepted in writing for 90 days. All comments were used to assist in preparing the final plan. Development of the plan was further guided by recommendations of a group of citizens referred to as the Governors' Roundtable. The Roundtable was able to reach unanimous agreement on 26 recommendations that guide grizzly management to this day. FWP's southwest Montana grizzly bear management EIS was finalized and published in 2002.

Since development of that EIS the *Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (CS)* has been published (2007) and numerous policies and Montana Codes have been adopted, altered, or removed relative to grizzly management. Public involvement was inherent in development of these guiding documents and policies, and as such, public comment and input has been a part of grizzly bear management since the first EIS. FWP did not deem it necessary to conduct formal scoping for development of this revision of the 2002 EIS. Public scoping in essence is a continual part of grizzly bear management as managers must address new and ever changing environments, biological states, and social tolerance in routine decision making.

The purpose of the CS is to "describe and summarize the coordinated efforts to manage the grizzly bear population and its habitat to ensure continued conservation in the Greater Yellowstone Area (GYA); specify the population, habitat, and nuisance bear standards to maintain a recovered grizzly bear population for the foreseeable future; document the regulatory mechanisms and legal authorities, policies, management, and monitoring programs that exist to maintain the recovered grizzly bear population; and document the commitment of the participating agencies" (CS 2007). This EIS document works from the standards and commitments within the strategy providing state specific information or guidance where appropriate. Guidance within this state plan does not differ from the standards and guidance provided within the CS.

Montana Fish, Wildlife and Parks Goals for the Grizzly Bear

FWP has statewide goals for most wildlife resources. This plan specifically deals with the goals for managing grizzly bear resources in southwestern Montana. These goals are:

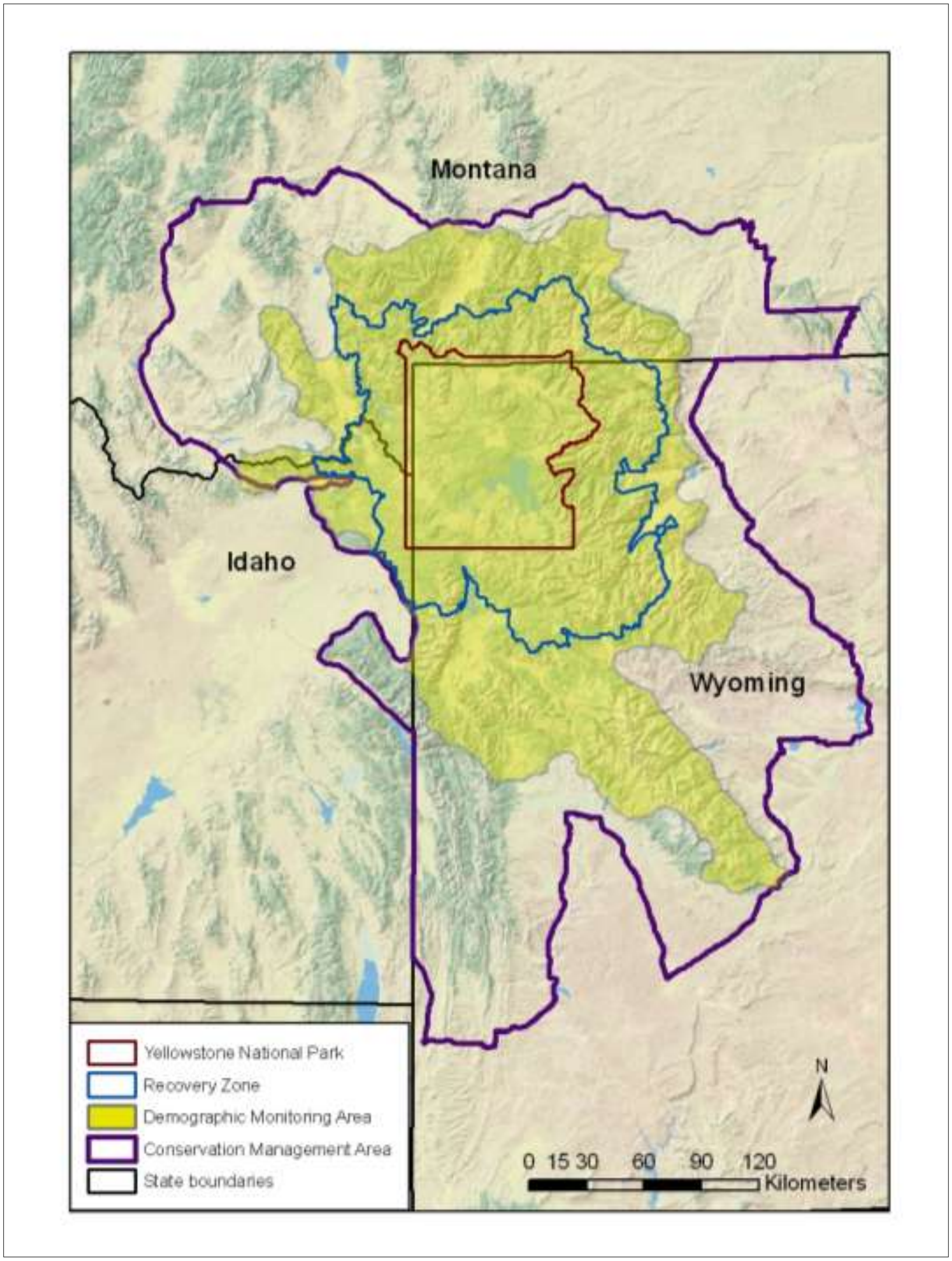
1. To protect, perpetuate, enhance, and regulate the wise use of wildlife resources for public benefit now and in the future.
2. To manage for a recovered grizzly bear population in southwestern Montana and to allow for grizzly populations in areas that are biologically suitable and socially acceptable. This should allow FWP to achieve and maintain population levels that support managing the bear as a game animal along with other species of native wildlife. These efforts will provide some regulated hunting when and where appropriate while maintaining a recovered population under the required demographic criteria for grizzly bears in the Greater Yellowstone Ecosystem.
3. To provide the people of Montana and visitors with optimum outdoor recreational opportunities emphasizing the tangible and intangible values of wildlife, and the natural and cultural resources in a manner that:
    a. Is consistent with the capabilities and requirements of the resources,
    b. Recognizes present and future human needs and desires, and,
    c. Ensures maintenance and enhancement of the quality of the environment.

These goals will be achieved by addressing the following: population management, future distribution, habitat and restrictions on human use of bear habitat, human safety, nuisance bear management, livestock conflicts, property damage, hunting of grizzlies, enforcement, education and outreach, and funding. The success of grizzly bear management in Montana will be contingent upon FWP's ability to address these issues in a way that builds and maintains tolerance for grizzlies.

The recommendations originally developed by the Governor's Roundtable are still pertinent today and support continued management of the proposed Primary Conservation Area (PCA), or Recovery Zone plus a 10 mile buffer area, as a secure "core" area for grizzly bears within the Yellowstone Ecosystem (Figure 1). The group also recommended that the states of Wyoming, Idaho and Montana develop management plans for the areas outside the PCA to:

1. Ensure the long-term viability of bears and avoid the need to relist the species under the Endangered Species Act (ESA),
2. Support expansion of grizzly bears beyond the PCA in areas that are biologically suitable and socially acceptable,
3. Manage the grizzly bear as a game animal including allowing regulated hunting when and where appropriate.

Figure 1. Greater Yellowstone Area depicting the original Recovery Zone for the Yellowstone grizzly bear, the Conservation Management Area (no longer being used for management per publication of this draft but shown as reference) and the Demographic Monitoring Area where the grizzly population is intensely monitored. The Primary Conservation Area is the Recovery Zone plus a 10 mile buffer.



Purpose and Need

The need for an update to the 2002 grizzly bear management plan was precipitated by changes in bear management in the Yellowstone Ecosystem during the 1980-90's, that resulted in increasing numbers and an expanding distribution of grizzly bears. In 2007, after the initial delisting of the Yellowstone grizzly bear, the United States Fish and Wildlife Service (USFWS) amended the recovery plan and CS to monitor grizzly bear population dynamics and mortalities in the area known as the Conservation Management Area (CMA) Figure 1). The CMA includes the areas beyond the original recovery line and the USFWS suitable habitat line. In the last decade, an increase in grizzly bear population and distribution, along with land management, wildlife management, and recreation management within the CMA have led to established populations of bears outside the core area and throughout what is currently the CMA.

Since publication of the first draft of this document, the USFWS has revised the demographic criteria within the Recovery Plan for the GYA. As part of this revision the area beyond the suitable habitat line and out to the CMA boundary has become irrelevant to management decisions. Therefore, this final plan, discusses management only along the Demographic Monitoring Area (DMA) line and the Recovery Zone line. (USFWS, Supplement to the Demographic Recovery Criteria of the Greater Yellowstone Grizzly Bear in *draft* to be published in 2014,)

It is FWP's objective to maintain existing renewable resource management and recreational use where possible and to develop a process where FWP, working with local publics, can respond to grizzly/human conflicts with appropriate and timely management actions. Maintaining existing uses while allowing people to continue their lifestyles, economies, and feelings of well being builds support and increases tolerance for grizzly bear populations.

In the 2002 EIS, the Governors' Roundtable produced a recommendation to allow grizzly bears to inhabit areas that are "biologically suitable and socially acceptable." This recommendation has been followed since implementation of that EIS and FWP will continue this approach with the current responsible management program. The level of social acceptance of grizzlies in historical habitat changes based on how the issues are approached, the density of the bear population and how much faith people have in wildlife managers. To maximize the area of Montana that is "socially acceptable" grizzly bear range, the state planning and management effort has used an adaptive learning process to develop innovative, on-the-ground management. By demonstrating that grizzly bear conservation can be integrated with broad social goals, public faith in management can be enhanced and human tolerance of grizzly bears is developed and maintained. This approach already has demonstrated success in the GYA as well as in northwestern Montana, where bear populations have also increased and bears have reoccupied habitats from which they had been absent for decades.

In 2000, the Interagency Grizzly Bear Study Team (IGBST) began a process to reevaluate and update methods to determine the status of the GYA grizzly bear population, estimate population size, and determine the sustainable level of mortality in the GYA. In 2007, the USFWS supplemented the 1993 federal Grizzly Bear Recovery Plan with revised demographic criteria for the GYA population (72 FR 11376, March 13, 2007) and in 2013, the USFWS proposed to designate a new 'demographic monitoring area'(DMA) within which population and mortality data (i.e., demographic criteria) would be assessed. There is consensus among scientists and statisticians that the area within which mortality limits apply should be the same area used to estimate population size. The previous CMA within which grizzly bear mortalities were counted against annual sustainable limits, was substantially larger than the area within which female grizzly bears with cubs of the year were surveyed and used to estimate population size. This meant researchers were counting mortalities in areas where bears weren't being monitored for population size or trend. The revised DMA addresses this known bias so that mortalities and population health and size will be monitored within the same area. This proposed change, if finalized, would be appended to the Yellowstone chapter of the Grizzly Bear Recovery Plan (U.S. Fish and Wildlife Service 1993, p. 44) and the Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area.

Overtime grizzly bears from the Yellowstone area are expected to inhabit areas throughout the DMA however not all areas are biologically suitable or socially acceptable for grizzly bear occupancy. Mortalities outside of the DMA would continue to be recorded and reported but would not count against the sustainable mortality limits for that year. Grizzly bear occupancy would not be actively discouraged outside the DMA, rather management emphasis would be on conflict response. Grizzly bears would not be removed from the population just because they are outside the DMA but, as is the case anywhere within southwest Montana, they may be removed from the population or relocated if there are conflicts. Grizzly bears may also be preemptively relocated to avoid conflicts, but their potential contribution to connectivity with other grizzly bear populations would be considered in any such preemptive moves. Preemptive moves would not be counted against a bear as a management conflict capture would.

Significance of grizzly bear management to the people of Montana is highlighted by the fact that the state contains all or portions of four of the six distinct populations identified by the USFWS plan for grizzly recovery in the lower 48 states. The species is Montana's "State Animal," and there is specific policy directing management of the species. Grizzly bear populations have increased to USFWS recovery levels in the Yellowstone and the Northern Continental Divide area. The small population of grizzly bears in the Cabinet-Yaak area of Montana appears to be slowly increasing. Only one grizzly bear has been documented in the Bitterroot ecosystem since 2002.

This plan deals directly with that portion of Montana known as the GYA and adjacent lands in southwestern Montana and includes our management programs within the PCA. The GYA has been defined in many different ways by different people depending on their purposes. For the purpose of this plan, the GYA is defined very broadly for southwestern Montana to include lands that may be accessed by grizzly bears in the near future.

Before discussing the different issues and alternatives this plan addresses, it is important to keep the following perspectives in mind.

- Public support and tolerance for grizzlies is the key to their long-term recovery and re-occupancy of suitable habitats, and this support is contingent on local involvement and active local participation in plan development and implementation.
- All of the biological and social issues are interrelated, and no one part of the plan can function effectively without the others.

- This plan does not presuppose habitat problems exist with bear re-occupancy, but instead approaches the issues with the perspective of making sure local people are involved and given sufficient tools to respond to management changes as need arises.
- The key to a broader recovery lies in bears utilizing lands that are not managed solely for them but in which their needs are adequately considered along with other uses. The plan also recognizes the pivotal role private landowner support will play in a broader recovery.
- Preventative measures are much better than simply responding to problems; however, a great deal is unknown about how bears will utilize some of the available habitats.
- This plan and its implementation must respond as changes occur and be open to public scrutiny and input.

Other Agencies that have Jurisdiction or Responsibility

At present, the USFWS is responsible for grizzly bear recovery and management activities. Federal laws, rules and regulations provide guidance. When grizzlies are delisted and management authority is transferred to the State of Montana, state law becomes the primary regulatory and legal mechanism guiding management. Two titles within Montana statutes describe the legal status and management framework for grizzly bears. Title 87 pertains to all fish and wildlife species and oversight by FWP. Title 81 pertains to the Montana Department of Livestock (MDOL) and its responsibilities for predatory animal control. Montana statutes assign joint responsibility to FWP and MDOL for managing wildlife that cause property damage, i.e. injury or loss to livestock, through a cooperative agreement with MDOL. Wildlife Services (WS) conducts field investigations and management activities in cases of property damage caused by wildlife such as black bears, grizzly bears and wolves. Grizzly bear depredations to livestock are cooperatively investigated and managed by WS and FWP.

The U.S. Forest Service (USFS), the National Park Service (NPS), the Bureau of Land Management (BLM), USFWS, or other federal jurisdictions administer federally owned lands. These agencies manage these lands according to their enabling legislation, agency mission, and relevant federal laws, rules, and regulations. FWP coordinates with federal agencies on wildlife and habitat issues of mutual interest but has no legal jurisdiction over how those lands are managed. NPS has jurisdiction for wildlife within national parks.

Montana’s Native American tribes have jurisdictional authority for wildlife conservation and management programs within reservation boundaries. FWP coordinates with tribal authorities on issues of mutual interest.

Recent History of Bears in the Greater Yellowstone Area

Grizzlies were never eliminated from Montana, but their numbers probably reached their lowest levels in the 1920s. At that time, changes were made out of concern for the future of the species including designating grizzlies a "game animal" in 1923, the first such designation of the species in the lower 48 states. This change, along with the early prohibitions on the use of dogs to hunt bears, outlawing baiting (both in 1921), closing seasons, etc., had the effect of allowing grizzlies to survive in portions of western Montana.

The degree of protection and the sophistication of management practices have grown steadily. In the 1940s, the importance of protecting fish and wildlife habitat began to emerge as a key public issue in wildlife management. Through all of the previous years, wildlife conservation was the goal, and was sought through the restriction and regulation of hunters and anglers. Although partially effective, the regulations and laws failed to address a more fundamental issue: the protection of fish and wildlife habitat.

Habitat protection under state authority began with winter game range acquisitions in the 1940s and stream preservation in the early 1960s. Generally, concern for and protection of habitat appeared in state laws dealing with controlling natural resource development. These laws usually addressed specific resource issues such as surface mining and siting of major industrial facilities. An exception to this specific approach was the Montana Environmental Policy Act (MEPA) adopted in 1971. Montana MEPA law mirrored in large part the National Environmental Policy Act (NEPA) adopted by Congress in 1969.

High mortality rates resulting from closure of the remaining open dumps in Yellowstone National Park (YNP), raised concerns over the status of the grizzly population in the greater Yellowstone area during the late 1960s and early 1970s. This population, along with other grizzly populations in the lower 48 states, was listed as threatened under the ESA in 1975. As a result of this listing, many management changes were made to benefit grizzlies. A federal recovery plan was prepared and approved in 1982 and revised in 1993. The success of recovery efforts is evident in the estimates of bear numbers in the area, increasing from approximately 230 in the late 1960s to a minimum of 600 bears today. This has set the stage for delisting of the population segment and a return of this population to state and national parks management.

Recent Litigation History

March 2007 – The USFWS announced that the GYA population of grizzly bears was recovered effectively removing the species from the Federal list of threatened and endangered species.

September 2009 – The Federal District Court in Missoula issued an order vacating the delisting of the GYA grizzly population. In compliance with this order, the Yellowstone grizzly population was once again designated a threatened population under the ESA. The District Court ruled that the USFWS was arbitrary and capricious in its evaluation of white bark pine and that the regulatory mechanisms identified in the final rule were not adequate because they were not legally enforceable.

November 2011 – The 9th Circuit Court of Appeals issued an opinion affirming in part and reversing in part the district court's decision vacating the final rule delisting GYA grizzly bears. The Appellate court affirmed the USFWS's determination that existing regulatory mechanisms are adequate to protect grizzlies in the Yellowstone area while ruling that the USFWS had failed to adequately explain its conclusion that the loss of whitebark pine was not a threat to the population. In compliance with this order, the GYA population of grizzly bears remains federally listed as "threatened" under the ESA while more recent scientific data is considered.

Policy and Statute

MEPA rules provide for the preparation and distribution of an environmental analysis evaluating state actions, programs or policies that affect the quality of the human environment (MCA 12.2.428). Grizzly bear management in Montana is being addressed within the framework of MEPA and its requirements.

The Montana Fish and Wildlife Commission (Commission) is the policy making body for FWP's fish and wildlife programs. Section 87-1-301(1), Montana Codes Annotated (MCA) requires the Commission to "set the policies for the protection, preservation, and propagation of the wildlife, fish, game, furbearers, waterfowl, nongame species, and endangered species of the state for the fulfillment of all other responsibilities of FWP as provided by law."

The legislature has given specific policy direction to the Commission on the issue of grizzly bears through the following rules:

87-2-101. Definitions. As used in Title 87, chapter 3, and this chapter, unless the context clearly indicates otherwise, the following definitions apply: (4) "Game animals" means deer, elk, moose, antelope, caribou, mountain sheep, mountain goat, mountain lion, bear, and wild buffalo.

87-5-301. Grizzly bear -- findings -- policy. (1) The legislature finds that:
(a) grizzly bears are a recovered population and thrive under responsive cooperative management;
(b) grizzly bear conservation is best served under state management and the local, state, tribal, and federal partnerships that fostered recovery; and
(c) successful conflict management is key to maintaining public support for conservation of the grizzly bear.
(2) It is the policy of the state to:
(a) manage the grizzly bear as a species in need of management to avoid conflicts with humans and livestock; and
(b) use proactive management to control grizzly bear distribution and prevent conflicts, including trapping and lethal measures.

87-5-302. Commission regulations on grizzly bears. (1) The commission may:
(a) pursuant to subsection (2), regulate the hunting of grizzly bears, including the establishment of tagging requirements for carcasses, skulls, and hides; and
(b) establish requirements for the transportation, exportation, and importation of grizzly bears.
(2) When special grizzly bear licenses are to be issued pursuant to 87-2-701, the commission shall establish hunting season quotas for grizzly bears that will prevent the population of grizzly bears from decreasing below sustainable levels and with the intent to meet population objectives for elk, deer, and antelope. The provisions of this subsection do not affect the restriction provided in 87-2-702(3) that limits a person to the taking of only one grizzly bear in Montana.

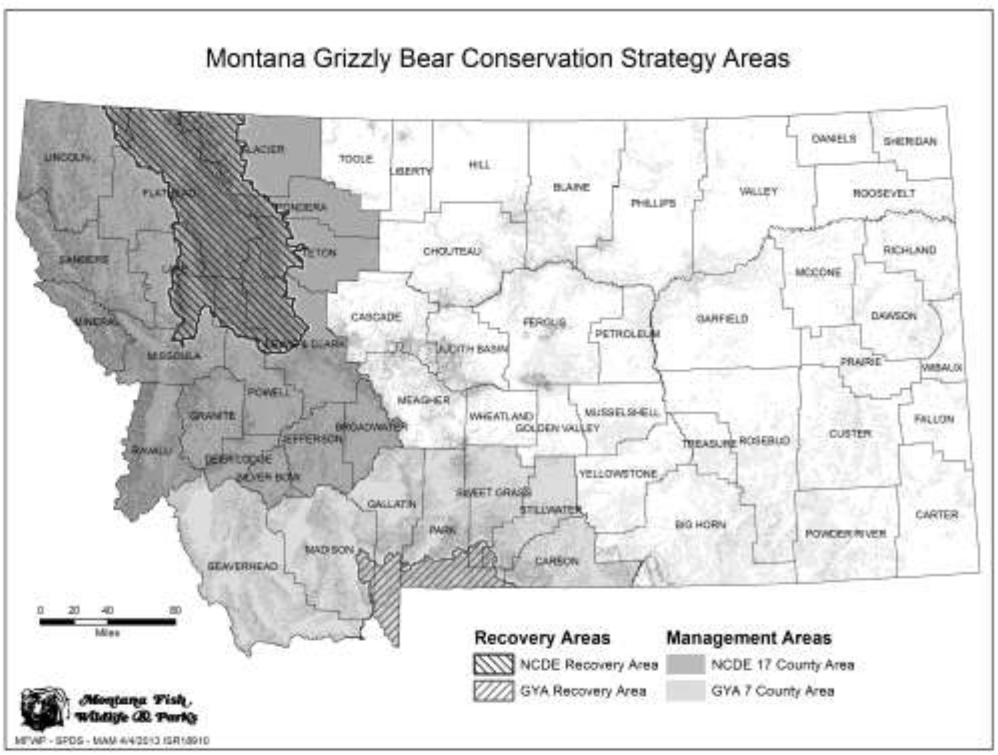
Within this legal framework, the Commission developed a grizzly bear policy in Section 12.9.103, Annotated Rules of Montana, "Whereas, the Montana fish and game commission has management authority for the grizzly bear, a resident wildlife species, and is dedicated to the preservation of grizzly bear populations within the state of Montana;" That policy addresses the need to protect grizzly bear habitat, the need to pursue grizzly bear research, the role of regulated hunting in grizzly bear management, depredations and the appropriate FWP response to depredations, and requires compliance with federal regulations relating to grizzly bears. It is within this framework, and that described by the ESA (16 U.S.C. Sec. 1531, et seq.), that specific FWP goals for the grizzly bear were developed.

87-1-217. Policy for management of large predators -- legislative intent. (1) In managing large predators, the primary goals of the department, in the order of listed priority, are to:
(a) protect humans, livestock, and pets;
(b) preserve and enhance the safety of the public during outdoor recreational and livelihood activities; and
(c) preserve citizens' opportunities to hunt large game species.
(2) With regard to large predators, it is the intent of the legislature that the specific provisions of this section concerning the management of large predators will control the general supervisory authority of the department regarding the management of all wildlife.
(3) For the management of wolves in accordance with the priorities established in subsection (1), the department may use lethal action to take problem wolves that attack livestock if the state objective for breeding pairs has been met. For the purposes of this subsection, "problem wolves" means any individual wolf or pack of wolves with a history of livestock predation.
(4) The department shall work with the livestock loss board and the United States department of agriculture Wildlife Services to establish the conditions under which wolf carcasses or parts of wolf carcasses are retrieved during wolf management activities and when those carcasses or parts of carcasses are made available to the livestock loss board for sale or auction pursuant to 2-15-3113.
(5) The department shall ensure that county commissioners and tribal governments in areas that have identifiable populations of large predators have the opportunity for consultation and coordination with state and federal agencies prior to state and federal policy decisions involving large predators and large game species.
(6) As used in this section:
(a) "consultation" means to actively provide information to a county or tribal government regarding proposed policy decisions on matters that may have a harmful effect on agricultural production or livestock operations or that may pose a risk to human health or safety in that county or on those tribal lands and to seek information and advice from counties or tribal governments on these matters;
(b) "large game species" means deer, elk, mountain sheep, moose, antelope, and mountain goats; and
(c) "large predators" means bears, mountain lions, and wolves.

DESCRIPTION OF THE GRIZZLY BEAR MANAGEMENT AREA FOR SOUTHWESTERN MONTANA

Grizzly bears currently occupy or have been documented in suitable habitats in the seven southwestern and south-central Montana counties adjacent to or near YNP (Carbon, Stillwater, Sweet Grass, Park, Gallatin, Madison, and Beaverhead counties, Fig. 2). The proposed action of this document is to create and adapt a management plan for this area. The following section briefly describes the geographic and human environment of this seven-county area with respect to geography, size, human population, land ownership, special management areas, agricultural interests, and recreation. Not all portions of these counties are suitable grizzly bear habitat as the above attributes affect the distribution and survival of grizzly bears. Aided by management programs, grizzly bears have expanded distribution beyond the seven-county area recognized in 2002. Expansion is occurring in Montana from the Northern Continental Divide Ecosystem and the Yellowstone Ecosystem. For purposes of this plan, the counties adjacent to but outside of this seven county area fall under management programs described by the Grizzly Bear Management Plan for Western Montana (2006) (Figure 2). The success of these programs rests on coordinating and cooperating with all affected counties, surrounding states and federal agencies. FWP will continue to work with these entities so that the needs of the public and bear population as a whole are met.

Figure 2. The seven counties of the Greater Yellowstone Area that fall under management of the Southwest Montana grizzly plan and the 17 counties of the Northern Continental Divide Ecosystem area that fall under management of the Western Montana grizzly plan. Grizzly bear recovery areas are shown for both ecosystems.



General Description

Each of the seven counties named above is characterized by one or more major river valleys divided by rugged mountain ranges. Elevations range from 12,799 ft. at Granite Peak (Montana's highest point) to about 3,330 ft. on the Yellowstone River near Park City. Major river drainages include the Clark's Fork of the Yellowstone, Stillwater, Boulder, Shields, Yellowstone, Gallatin, Madison, Red Rock, Ruby, Bighole, Wise, Beaverhead, and Jefferson rivers. Several rivers in the western portion of this area flow together to form the Upper Missouri River, beginning at Three Forks. Lower elevation habitats (below 6,000 ft.) vary greatly, including large areas of short-grass/sagebrush prairie, mountain foothills, intensively cultivated areas (grain and hay field agriculture), natural wetlands/lakes, riparian plant communities ranging from narrow stream bank zones to extensive cottonwood river bottoms, man-made reservoirs, small communities, and sizeable cities.

The mountainous portion of this seven-county area (above 6,000 ft.) contains all or portions of 18 mountain ranges including the Beartooth, Absaroka, Crazy, Bridger, Gallatin, Spanish Peaks, Madison, Henry Lake, Centennial, Gravelly, Snowcrest, Ruby, Tobacco Root, Highland, East Pioneer, West Pioneer, Tendoy, Beaverhead, and Anaconda-Pintler. Mountainous habitats are dominated by coniferous forest (Douglas fir, lodgepole pine, Engleman spruce, whitebark pine, limber pine, ponderosa pine, juniper), and rocky subalpine/alpine communities found above timberline.

Geographic Size and Human Population

The seven-county area encompasses approximately 12,865,088 acres or 20,102 square miles of southwestern and south-central Montana (Table 1). Roughly 14.8% of Montana's human population lives within this area. County population size ranges from 3,600 (Sweet Grass) to 91,000 people (Gallatin). Population density ranges from 1.7 persons per square mile (Beaverhead County) to 34.4 persons per square mile (Gallatin). Major population centers include Bozeman, Livingston, Belgrade, Dillon, Red Lodge, Big Timber, Three Forks, West Yellowstone, and Big Sky.

The population in this seven county area grew by 25% between 2000 and 2011 while the overall population of Montana grew by only 11%. Gallatin County was the fastest growing county, increasing by 43% from 2000-2011 while Park County actually decreased in population by 3%.

Table 1. Selected size, population, and agricultural attributes of the seven counties in the grizzly bear conservation area.

County	Pop.[1]	Size (Sq. Mi.)	People/Sq. Mile	# Cattle[2]	# Sheep[3]	Acres Harvested[4]
Carbon	10,028	22,049	4.9	60,000	5,100	141,887
Stillwater	9,131	1,795	5.1	47,000	7,400	100,258
Sweet Grass	3,623	1,855	2.0	38,000	5,400	51,319
Park	15,469	2,803	5.6	41,000	1,800	60,300
Gallatin	91,377	2,603	34.4	51,000	2,700	155,842
Madison	7,660	3,587	2.1	74,000	3,200	86,550
Beaverhead	9,198	5,542	1.7	110,000	14,600	121,277
Totals	**146,486**	**20,234**	**8.0**	**421,000**	**40,200**	**717,433**
Change since 2002 EIS	**+25%**	**0%**	**38%**	**-16%**	**-37%**	**+3%**

[1]Based on 2011 population estimate (Montana Census Bureau, http://quickfacts.census.gov).
[2]Based on inventory estimates of all cattle and calves for 2012 (Montana Agricultural Statistics www.nass.usda.gov).
[3]Based on inventory estimates of all sheep and lambs for 2012 (Montana Agricultural Statistics).
[4]Based on estimates of irrigated and non-irrigated acres harvested in 2007, (Montana Agriculture Statistics).

Land Ownership

The majority of the mountainous habitat (above 6,000 ft.) is within publicly owned National forests. All or portions of the Custer, Gallatin, and Beaverhead-Deerlodge National Forests occur within this seven-county area. A small portion of mountainous habitat is in Montana Department of Natural Resources and Conservation (DNRC), FWP, BLM, and private ownership, including private subdivisions, ranches, ski resorts, and timber company lands.

Low-elevation river valleys (below 6,000 ft.) are largely privately owned with only a small percentage in state (DNRC, FWP) and federal (BLM, USFS, and U.S. National Wildlife Refuges) ownership (Figure 3). The largest amount of low-elevation land lies within privately owned ranches and farms. Small, medium and large-sized communities also occupy several thousand acres of low-elevation river-valley habitat.

Special Management Areas

Several federal and state special management areas are located in the seven-county area. In large part, these areas are protected from human development and provide long-term habitat for a variety of wildlife species, including grizzly bears. Portions of four National Wilderness Areas lie within mountain ranges in the seven-county area: the Absaroka-Beartooth Wilderness, Lee Metcalf Wilderness, Bear Trap Canyon Wilderness and Anaconda-Pintler Wilderness. National Forest Wilderness Areas have the greatest restrictions on human use and development resulting in the least disturbed habitats available and are important in ensuring long-term grizzly bear survival.

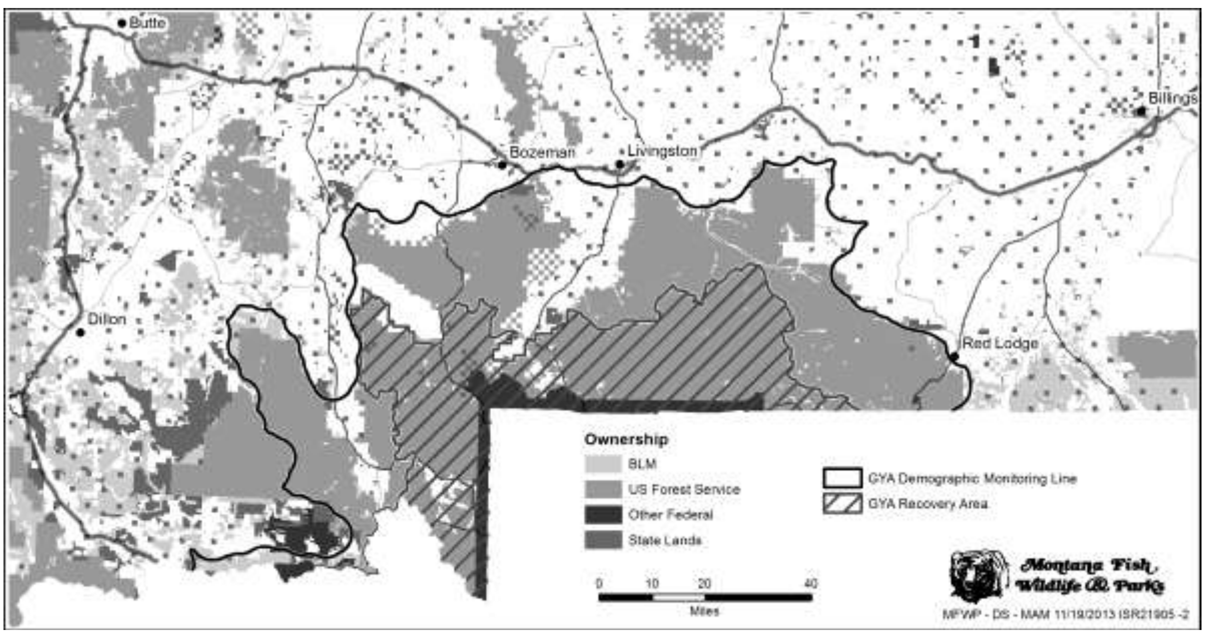
Other special management areas include Red Rock Lakes National Wildlife Refuge and eight FWP Wildlife Management Areas. Over half, 6.6 million acres, of the seven county area is in public ownership of some type (Table 2). FWP manages 63,000 of those acres and the USFS has management authority for the majority with 4.4 million acres.

Table 2. Percent of private versus public land, by county, for each of the seven counties covered by this plan.

County	Private property	Public property
Carbon	47%	53%
Stillwater	22%	78%
Sweet Grass	29%	71%
Park	55%	45%
Gallatin	47%	53%
Madison	53%	47%
Beaverhead	31%	69%

Based on land ownership statistics of the Montana State Library:
http://geoinfo.montanastatelibrary.org/geography/geography-facts/montana-county-land-ownership/

Figure 3. Southwest Montana with public lands (shaded), the GYA Recovery Zone boundary, and the Demographic Monitoring Area boundary.



Agricultural Interests

The seven-county area supports a large agricultural economy. The most common activity of these farms and ranches is raising beef cattle and growing forage (hay). In some areas, small grain crops such as wheat, oats, and barley are intensively grown. Horses, sheep, hogs and dairy cattle are also raised but in smaller numbers on ranches and farms in southwestern and south-central Montana. Beef cattle and sheep are grazed on privately owned grassland and on publicly owned (USFS, BLM, DNRC) grazing allotments. Some of these allotments occur in higher elevation habitats occupied by grizzly bears.

Based on Montana agricultural statistics for 2012, there were an estimated 421,000 head of cattle (all cattle and calves) in the seven-county area, a decrease of 16% since 2002 (Table 1). Beaverhead County had the most cattle (110,000) while Sweet Grass had the lowest number (38,000 head). Beaverhead County ranked #1 in the state for cattle production. In 2012, there were an estimated 40,200 sheep (adults and lambs) in the seven-county area, a decrease of 37% since 2002 (Table 1). Beaverhead County had the largest number of sheep (14,600) while Park County had the fewest (1,800). Beaverhead County ranked #3 in the state for sheep production. In 2007, an estimated 698,275 acres of irrigated and non-irrigated crops were harvested in the seven-county area (Table 1). Number of acres harvested ranged from 51,319 in Sweetgrass County to 155,842 in Gallatin County.

Recreational Opportunities

Outdoor recreation and tourism is a major component of the economy in this seven-county area. Southwestern and south-central Montana is nationally known for its high quality fishing, hunting, camping, hiking, river floating, skiing, snowmobiling, wildlife viewing and sightseeing opportunities. Nearby, YNP attracts large numbers of people to the area every year. Many of these outdoor activities are made possible by public ownership of large tracts of mountainous habitat and additional access provided by private landowners. Recreationists have largely unhampered access to millions of acres of undeveloped land. Much of this land is currently or will be occupied by grizzly bears based on documented trends of increasing distribution. As bear numbers and distribution increase along with increased public use of bear habitat, contact and interaction between bears and people will increase.

SUMMARY OF GRIZZLY BEAR BIOLOGY

(modified from the 2002 Programmatic Environmental Impact Statement (Mincher, B. J., 2000 and Schwartz et al. 2002), new information is cited)

Grizzly bears in this area come in many sizes and colors. The most prevalent color has medium to dark brown underfur, brown legs, hump, and underparts, light to medium grizzling on the head and part of the back, and a light-colored girth band or patch behind the forelegs, but many other variations exist. The size of male and female grizzly bears varies substantially with males about 1.2-2.2 times larger than females. Differences in body mass between males and females are influenced by age at sexual maturity, reproductive status, differential mortality, and season of sampling. During late summer and fall, grizzly bears gain weight rapidly, primarily as fat when they feed intensively prior to denning. Pre-denning weight gain is essential for reproduction and survival because bears rely solely on their stored energy reserves during hibernation. Peak body mass generally occurs in fall just prior to hibernation. Bears metabolize fat and muscle during the denning period.

Habitat

As with any wildlife population, bear density in the Yellowstone area will eventually be limited by geographic area and food resources. Food resources and population density dependence controls wildlife population limits. Yet, grizzly bears are extremely adaptable and exploit a wide variety of habitats and foods throughout their range indicating relatively broad environmental limits. Individual bears may exhibit individual preferences and tolerances. Most key grizzly foods in the GYA occur seasonally and somewhat unreliably. However, grizzly adaptability often compensates for the lack of some forage thought to be critical. Such a generalized approach to survival necessitates a solitary and mobile lifestyle. Individual grizzlies forage over vast areas and have large spatial requirements. The active season for grizzlies is compressed to a 5-7 month period, during which they must gain sufficient weight to supply their energetic needs for the next denning cycle. Bears tend to concentrate their activity in the most productive habitats available because of these high energetic needs.

In general, GYA home ranges are larger than those of other grizzly bear populations. This larger range possibly indicates low environmental productivity in the GYA and increased foraging requirements to meet their nutritional needs or it may be caused more by the wide distribution of favorite foods at different times of the year. Individual ranges of both sexes overlap, but do not appear to be defended, even for adult males. Subadult bears, especially males, disperse from their natal ranges to establish new home ranges, and these spatial requirements probably limit ultimate population density.

As with other bear species and populations, male grizzly home ranges in the GYA are usually larger than female ranges. The Interagency Grizzly Bear Study Team (IGBST) reported mean range sizes from 1975-1987 of 874 km^2 for adult males and 281 km^2 for adult females. Females with new cubs used slightly less area, and those with yearlings used more. New estimates of home range have been calculated for radio-tracked grizzlies in the GYA and indicate some decrease in home range from these earlier estimates (Table 3, IGBST, unpublished data).

Table 3. Minimum convex polygon range estimates (km^2) for grizzly bears radio-tracked in the GYA during 1989-2012. Range estimates were only included for bears that had at least one location during June or earlier in the calendar year, ≥ 10 locations for the active season, and at least one location during September. Individuals that had been transported due to conflicts were excluded after their initial transport.

					95% Confidence Interval (km^2)	
Class	N	Mean (km^2)	Std. Deviation (km^2)	Std. Error (km^2)	Lower Bound	Upper Bound
Subadult F	31	139	132	24	91	188
Adult F with COY	57	154	151	20	114	194
Other adult F	122	127	98	9	109	144
Subadult M	45	545	613	91	361	729
Adult M	104	376	364	36	306	447

In the GYA, the pattern of seasonal elevation use is similar to that found for other populations occupying interior western mountains. Grizzlies utilized carrion and rodents prior to spring green-up, and foraged extensively on grasses, sedges and herbs in season, and berries, nuts and fish in the post-growing season. The most widely used foods were grasses and sedges, which constituted more than half of the diet.

Long-term studies of Yellowstone grizzly bear food habits have revealed large year-to-year variations in diet as grizzlies exploited foods that were only infrequently available. Examples of specialty foods included ants, pondweed and sweet cicely. The early season diet was dominated by ungulates, both scavenged and as neonate prey, notably elk calves, mid-season by grasses and sedges, and late-season by pine seeds, large mammal carcasses and roots. The annual percentage of energy obtained from the ungulate meat is considerably higher in the GYA than for other interior populations although herbaceous foods remain important because they are more predictable. Grizzly bears at high densities and in some circumstances can impact the ungulate prey base. However, in this area the ungulate prey base is also impacted by other factors such as mountain lions, wolves, hunting, and winter severity. Yellowstone grizzlies have 234 species of 179 genus of vegetative, insect and vertebrate food sources, including the high caloric cyclic crops of army cutworm moths, whitebark pines seeds, and large mammal meat (Gunther et al, 2012).

Yellowstone area grizzlies prefer open grasslands adjacent to cover for most of their feeding activities. While grizzlies depend on fertile grasslands for their predictable supply of forage, seasonally abundant foods are exploited as available. These foods include whitebark pine seeds and carrion.

Whitebark pine seeds are heavily utilized because they are available during the hyperphagic period prior to denning. Many bears feed on pine seeds almost exclusively at that time. Large amounts of cones are obtained by raiding squirrel caches, which the bears exhume. After good production years, seeds that survive the winter are also used the following spring. Historically, there was a relationship between whitebark pine seed abundance and the number of bears in conflict management situations. During good years, bears move to high-elevation, whitebark pine habitats. But in poor years, grizzlies are found foraging throughout larger areas that may bring them near roads and developed sites more frequently where they encounter unsecured anthropogenic foods. Many whitebark pine stands in the northwest have been infected and killed by whitebark pine blister rust. Whitebark in the GYA has been infected by this disease and by pine beetle infestations during 2003-2009. The Interagency Whitebark Pine Monitoring Program annually surveys and reports the extent of whitebark pine tree loss.

The army cutworm moth is a second, high-fat food source for a segment of the Yellowstone grizzly population during the early hyperphagic period. Moths collect under rocks in alpine areas in late summer and fall. To date, there have been 37 confirmed and 17 possible moth sites observed with grizzly bear feeding activity in the Yellowstone Ecosystem. All of these sites are located in the eastern side of the ecosystem. No moth sites have been documented in Montana's portion of the ecosystem.

During the fall season, bears seek out meat sources associated with big game hunting seasons in the states surrounding YNP.

Anthropogenic foods (i.e. garbage, livestock feed, pet food, bird seed, human foods, garden crops, honey) are opportunistically used by grizzlies wherever humans and bears coexist, and most often in years when important natural foods fail. In the GYA, considerable effort has gone into eliminating the availability of anthropogenic foods and these efforts have been largely successful in reducing incidents of bear-human conflicts. In the past 15 years, there have been increases in county and state ordinances and laws regulating food storage and the feeding of wildlife. There has also been an expansion of food storage rules on USFS public lands to include the entire Gallatin National Forest, Beaverhead National Forest, and on FWP wildlife management areas (WMA). Community efforts have also resulted in a number of local programs to secure garbage sources from bears.

In summary, grizzlies are opportunistic omnivores that are able to take advantage of a wide variety of locally important foods. Home range size seems determined by food abundance and population density dependence. Many individuals are able to abandon, or overlap, their ranges to exploit concentrated food aggregations such as pine seeds, moths, fish, carrion, fruits or garbage. Much of this behavior seems influenced by experience and habit. This adaptability has obvious survival advantages, but also results in large spatial requirements that complicate grizzly management.

Habitat for Denning

Yellowstone grizzlies can spend four to seven months a year in dens. In general, bears den by mid-November, although pregnant females den somewhat earlier. Their emergence from wintering dens occurs from mid-February to late March for males, followed by single females, and lastly by females with new cubs, which can emerge as late as mid-April.

Dens typically are found on steep slopes at high elevation (≥6500 feet) and in all cover types in the GYA. Dens are usually excavated, although natural shelters such as caves and hollow trees are also used. The availability of denning habitat is not thought to be limiting for the GYA bears.

Security at den sites appears to be an important management consideration, especially if human disturbance occurs near the time of den entry. There has been some concern of the possible effects that snowmobiles may have on denning bears as snowmobiling does have the potential to disturb bears while in their dens and after emergence in the spring. Because grizzly bears are easily awakened in the den (Schwartz et al. 2003) and have been documented abandoning den sites after seismic disturbance (Reynolds et al., 1986), the potential impact from snowmobiling should be considered. There are no studies in the literature specifically addressing the effects of snowmobile use on any denning bear species and the information that is available is anecdotal in nature (USFWS 2002). Known den locations in areas of snowmobile use are monitored within the GYA when possible to determine if snowmobile activity is having any adverse effect on grizzly bears. At this time, there is no evidence of disturbance (K. Frey, pers. comm.).

Habitat for Security

All current grizzly bear habitat in the continental United States is characterized by extensive timber cover, and most day beds are found in timber. This implies that security cover is an important habitat component, possibly due to social pressure from other large carnivores, human avoidance or summer heat avoidance.

It has long been speculated that female grizzlies with cubs avoid other carnivores such as wolves and adult male bears due to their aggressive and occasionally cannibalistic nature.

In the GYA, the only indication of sexual segregation through habitat use is in years of poor pine seed production where females were found more often near roads and areas used by humans.

The Interagency Grizzly Bear Committee (IGBC) considers the presence of even lightly used roads to cause a loss in useful bear habitat. Roads are incorporated in cumulative effects models (CEM) of habitat quality as the presence of a road tends to increase human activity in an area. Some researchers have concluded that grizzly bears habituate to roads and human presence as required to meet their caloric energy needs. Human presence can lead to grizzly bear moralities, whether due to legal hunting, if allowed, to poaching, or to kills by humans in self-defense situations.

In summary, grizzly habitat requirements are determined by their omnivorous foraging behavior, their need for winter den sites and security cover, and their occasional aggressive social behavior. Large roadless areas are ideal as year round grizzly habitat. However, grizzly bears can and do survive in roaded areas if human tolerance for their presence is high and if a diversity of habitat types is present.

Population Dynamics

Grizzly bears are long-lived animals that range over large geographic areas making it difficult to census and assess population levels. Generally, researchers agree that grizzlies have low reproductive rates and that grizzly populations are very susceptible to human impacts. Grizzly populations are also very sensitive to changes in female survival rates. Age at first reproduction for females is generally between 4-7 years old and male bears reach sexual maturity around 5 years of age. The average litter size for bears in the Yellowstone area is two cubs (range 1-4) and females typically produce cubs every third year. Breeding occurs in late spring with cubs born in the den the following winter.

As with all other bear populations in the world, it is not possible to determine definitively the actual numbers of bears in the GYA. Therefore, any figure is a result of some form of estimation. Using garbage dump census data collected by the Craighead team, and a census efficiency determined by ratios of collared to uncollared mortalities inside and outside YNP, the pre-dump closure bear population was estimated at 312 animals. The population declined to about 230 bears following the closures but began increasing in the late 1980s. After that time researchers calculated that the grizzly population grew 4-7% per year for an average growth rate of 4.6% per year, up until the late 1990's or early 2000's.

These rates of change are calculated as a function of the number of unduplicated females with cubs of the year (COY). Females with COY are readily visible and uniquely identifiable. However, these counts are influenced by counting effort, seasonal cover, and the total number of animals. A standardized and conservative counting approach has been adopted to avoid duplication of females counted. These records have been maintained by the IGBST since 1973. The female with COY count has been steadily increasing since the late 1980s. The population estimation protocol used until 2007 indicated rates of increase between 4% and 7% from 1983-2001.

New population estimation techniques were adopted in 2007 following considerable analyses (IGBST 2005, 2006). The new technique is still a function of delineating unique females with COY but results in a population *estimate* rather than the earlier conservative *index* of population size. First an estimate for the total number of females with COY present in the population is derived by applying the Chao2 estimator to the sighting frequencies of each unique female with COY (IGBST, 2012.) Then vital rates (for survival and reproduction) are used to estimate the stable age structure and the proportion of females with COY in the population. From these an estimate for the annual population size is produced.

Analysis of the 2002-2011 data during a 2012 IGBST demographic workshop indicates that since 2002, the overall rate of growth of the bear population in the GYA has stabilized or slowed.

The analysis looked at the overall population by zones, revealing that the increase in bear numbers is due primarily to growth and survivorship of bears outside YNP but within the Recovery Zone, as well as bears outside the Recovery Zone. Population growth within YNP had actually slowed or leveled off. The analysis revealed that mean annual adult male bear survivorship rates had increased from 0.87 during 1983-2001 to 0.95 during 2002-2011; thus accounting for more male bears in the population. Adult female bear vital rates remained nearly constant over the same time periods. The population estimate for 2012 was 610 grizzly bears using the 2007 estimation techniques. The new vital rates derived from 2002 to 2011 data, result in a new estimate of 716 grizzlies for 2012 (IGBST, 2012), primarily because of the increase in male survivorship.

These new data sets and analyses came from the 2012 IGBST workshop to further refine protocols for estimating population size of the GYA grizzlies, evaluate mortality limits and discuss the possibility of zoning the ecosystem for mortality limits given the expanding population (IGBST 2012). Efforts like this will continue to ensure use of the best available science in grizzly bear management and to ensure demographic criteria are met. The USFWS 1993 Recovery Plan established demographic criteria for recovery, including females with COY, mortality limits, and occupancy requirements. Current information on these parameters and their relationship to recovery plan goals are shown in Tables 4 and 5. All of the regional demographic criteria are currently being met for this population.

Table 4. Population estimates and annual evaluations of mortality limits for independent aged (≥ 2 years-old) female and male grizzly bears identified in the Greater Yellowstone Ecosystem during 2007-2012 (See IGBST 2006 and Haroldson and Frey 2008).

Population estimates				Evaluation of mortality limits: Independent females (≥2 years old)					Evaluation of mortality limits: Independent males (≥2 years old)				
Year	Population point estimate	Lower 95% CI	Upper 95% CI	Population segment point estimate	Count of known and probable mortalities	Estimated total mortality (reported plus unreported)	Annual mortality limit	Year result	Population segment point estimate	Count of known and probable mortalities	Estimated total mortality (reported plus unreported)	Annual mortality limit	Year result
2007	571	513	629	240	11	20	22	OK	153	7	13	23	OK
2008	596	535	656	251	14	30	23	Exceeded	159	23	41	24	Exceeded
2009	582	523	641	245	9	20	22	OK	156	11	20	23	OK
2010	602	541	663	253	13	21	23	OK	161	26	47	24	Exceeded
2011	593	533	652	248	16	32	26	Exceeded	157	16	24	24	Exceeded
2012	610	549	672	257	11	15	23	OK	163	18	34	24	Exceeded

Table 5. Bear Management Units in the Greater Yellowstone Ecosystem occupied by females with young (cubs-of-the-year, yearlings, 2-year-olds, or young of unknown age), as determined by verified reports, 2007-2012.

Bear Management Unit	2007	2008	2009	2010	2011	2012	Years occupied
1) Hilgard	X	X	X	X	X	X	6
2) Gallatin	X	X	X	X	X	X	6
3) Hellroaring/Bear		X	X	X	X	X	5
4) Boulder/Slough	X	X	X	X	X	X	6
5) Lamar	X	X	X	X	X	X	6
6) Crandall/Sunlight	X	X	X	X	X	X	6
7) Shoshone	X	X	X	X	X	X	6
8) Pelican/Clear	X	X	X	X	X	X	6
9) Washburn	X	X	X	X		X	6
10) Firehole/Hayden	X	X	X	X	X	X	6
11) Madison	X	X	X	X	X		5
12) Henry's Lake	X	X	X	X	X	X	6
13) Plateau	X	X	X	X		X	5
14) Two Ocean/Lake	X	X	X	X	X	X	6
15) Thorofare	X	X	X	X	X	X	6
16) South Absaroka	X	X	X	X	X	X	6
17) Buffalo/Spread Creek	X	X	X	X	X	X	6
18) Bechler/Teton	X	X	X	X	X		5
Totals	17	18	18	18	16	16	

ALTERNATIVES IDENTIFIED AND CONSIDERED

Alternative I. *FWP's preferred alternative for managing grizzly bears in southern MT is to manage grizzlies in a manner that allows for a sustainable, adequately distributed population that is secure and stable enough to meet the provisions of the GYA CS (2007) and remain out of federal ESA protections. This approach is summarized in the approval of this proposed Grizzly Bear Management Plan for Southwest Montana.*

FWP's current approach of management and that implemented since publication of the 2002 EIS has been sufficient to maintain grizzly populations while also maintaining social tolerance for grizzlies. FWP recognizes the dynamic nature of wildlife populations, ecosystems and human populations and acknowledges the need for equally dynamic and adaptive management strategies that keep the original goals in mind.

FWP's preferred approach maintains proactive programs to minimize and prevent grizzly/human conflict and responsive programs that adequately address conflicts when they do arise. It is critical for the maintenance of social acceptance of bears on the landscape that management of grizzly/human conflicts remains a priority for FWP. It is also critical to monitor bear numbers and habitats to ensure CS criteria are being met and adequate suitable habitat is available.

Alternative II. *A "No Action" alternative is not a viable option as FWP is mandated to manage wildlife and failure to do so by FWP would likely result in the maintenance of a 'threatened' ESA classification for the species within the state. FWP wildlife management works most effectively under approved state plans. Failure to continue active management would contradict the following statute:*

87-5-301 (1b) Grizzly bear conservation is best served under state management and the local, state, tribal, and federal partnerships that fostered recovery; and (c) successful conflict management is key to maintaining public support for conservation of the grizzly bear.
(2) It is the policy of the state to: (a) manage the grizzly bear as a species in need of management to avoid conflicts with humans and livestock.

A 'no action' alternative would be deemed by the USFWS as a lack of adequate regulatory mechanisms to maintain grizzly bears in Montana. A failure to delist grizzlies because of this would remove local management authority ability, the ultimate goal of implementing the ESA and recovering species. ESA listing status removes options for regulated take, results in conservative action to resolve conflict situations, and gives broad authority to those who do not live, work and recreate in Montana.

The cost of a 'no action' alternative could prove burdensome and costly on those who *do* live and work in Montana. Recreation opportunity in grizzly habitat could be more limited under this alternative to ensure the public's safety and the conservative approach to conflict bear removal would likely result in more livestock or property loss. In addition, the 'no action' alternative would more often force FWP to act with more costly, responsive methods, rather than using proactive approaches to conflict management.

Over time it is believed that the 'no action' alternative would erode support for grizzlies in an increasingly larger geographic area limiting the ability of grizzlies to naturally disperse and potentially link to other ecosystems.

ISSUES IDENTIFIED AND CONSIDERED

The 2002 EIS identified and discussed eight critical issues surrounding grizzly bear management in Montana. These issues are still relevant and presented again in this document along with one new issue, climate change. Background information is presented along with FWP's preferred management approach relative to tracking issue impacts or minimizing negative impacts of the issue to humans or bears. Anticipated consequences of preferred management approaches are considered.

This section concludes with a brief discussion of anticipated secondary and cumulative impacts of the preferred management alternatives along with a discussion of irreversible/irretrievable commitments of resources.

Population Monitoring

Preferred methods to monitor grizzly populations:

- Estimate grizzly densities using the best available data from research, distribution changes, DNA samples, and more.
- Cooperatively monitor unduplicated females with cubs within the original PCA and outside.
- Monitor bear mortalities including timing, location and causes and gather survivorship data in cooperation with the IGBST.
- Use verified sightings, DNA samples, photographs and tracks to document changes in bear distribution.
- Conduct research in cooperation with the IGBST to obtain more detailed population information.
- Coordinate monitoring with other states, YNP and the IGBST. Present information collected within the demographic monitoring area as part of annual reporting for Montana population and within annual IGBST reports.
- Use population demographics, in combination with habitat conditions, location and frequency of grizzly/human conflicts, social tolerance, and research findings, to guide population management decisions.

The 18 bear management units (BMU's) established for the original PCA are used to focus intensive management. Additional units have been established outside the original PCA to delineate survey areas for the collection of demographic and occupancy data on grizzly bears by geographic area. Units can be modified when bear activity outside the PCA indicates a change is needed. Units were created and will be created as needed solely for the collection of demographic data and will not of themselves generate any new habitat restrictions.

In order to maintain consistency in data collection and compare grizzly bear population parameters in the BMUs outside of the original 18 units, monitoring protocols have been established. Monitoring of unduplicated females with young is used as an index to assess population trend or abundance over time. The data are currently used to estimate a known minimum and total population size within the demographic monitoring area. The number of unique female bears is determined each year and using the revised demographic recovery criteria (see IGBST annual reports for methods) an adult female minimum population estimate is calculated from the unique female data. It should be noted that this is still a conservative approach to assessing this population parameter. This minimum adult female population estimate is the base for establishing yearly mortality thresholds of all sex/age groups of bears for all known causes of mortalities. These data, along with new methods that are currently under review, may be used to generate a more accurate total population estimate. The IGBST continually evaluates different statistical approaches and monitoring techniques that allow agencies increased confidence in the estimated total population size for this population of bears. FWP continues to review this information and use it and other data for ongoing management.

The following monitoring techniques are employed in southwestern Montana to track the grizzly bear population:

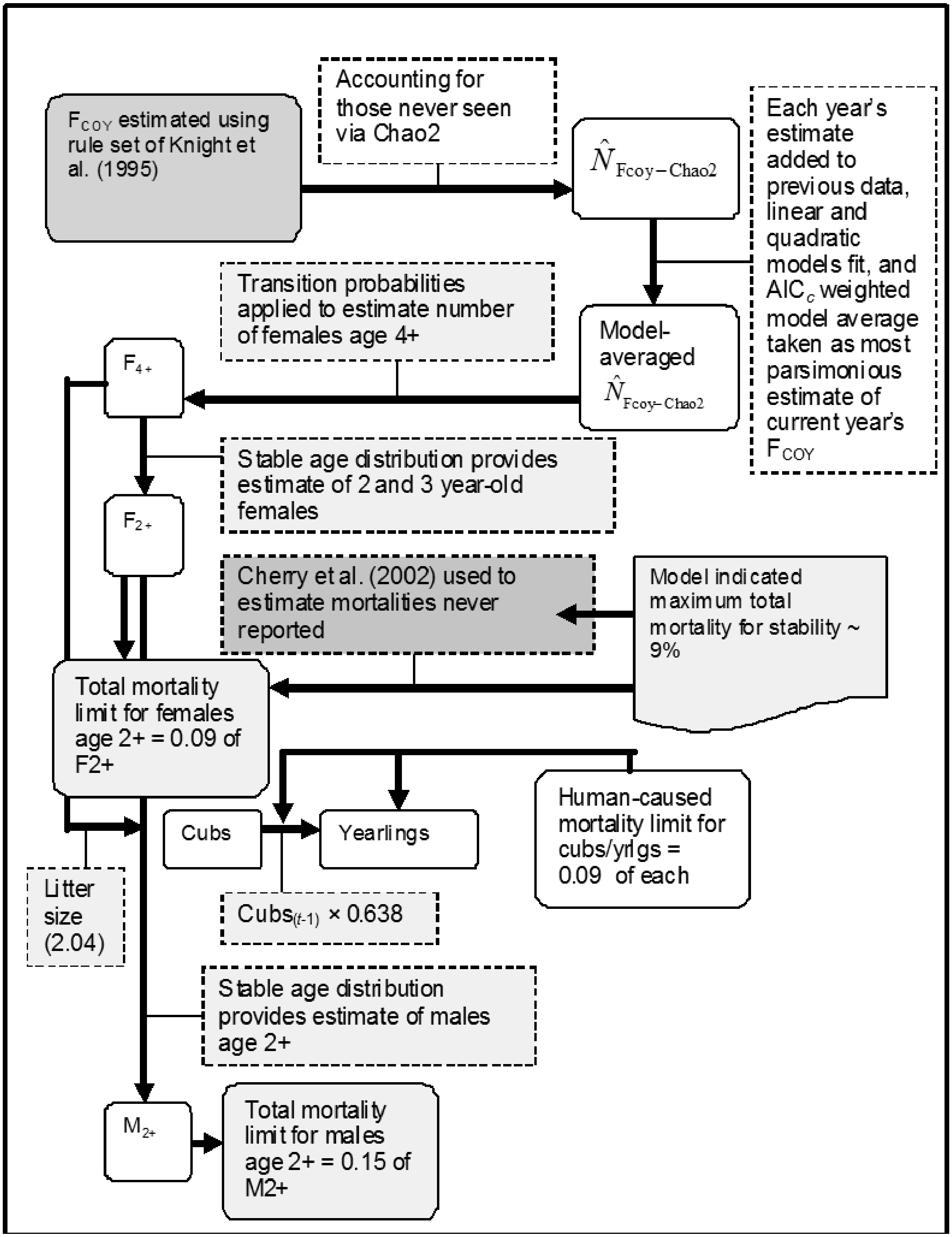
Monitoring of unduplicated females:

Monitoring of unduplicated females with COY will likely always be used as an index to assess population trend or abundance over time. The data are currently used to determine an annual point estimate of the total population size for the GYA (Table 6). Since 2007 the number of unique females with COY are calculated annually and the Chao2 estimator correction is applied along with linear and quadratic regressions of ln(Chao2) to derive the annual total population estimate and mortality limits of each population segment (Figure 4). It should be noted that this is a conservative approach to assessing this population parameter. The IGBST continually investigates different statistical approaches and monitoring techniques that allow agencies to estimate total population size for this population of bears. FWP will continue to review this information and use it and other data in the ongoing management programs.

Table 6. Minimum counts of unique female grizzly bears with cubs of the year (FCOY) identified in the GYA with mean litter size during initial observations of families during 2002-2012. Also provided are effort corrected (Chao2) estimates for FCOY and model averages estimates (using linear and quadratic regressions of 1n(Chao2) with year for 2002-2012; See IGBST 2006, Harris et al. 2007, Haroldson 2008).

Year	Minimum count FCOY	Mean Litter size	Effort Corrected FCOY (Chao2)	Model averaged Chao2
2002	52	2.0	58	43
2003	38	2.0	46	45
2004	49	2.0	58	47
2005	31	1.8	31	48
2006	47	2.0	45	50
2007	50	2.2	53	52
2008	44	1.9	56	53
2009	42	2.1	44	55
2010	51	2.0	56	57
2011	39	1.9	47	56
2012	49	1.9	59	58

Figure 4. Flow chart of the protocols in place since 2007 for estimating the number of grizzly bears in the Greater Yellowstone Ecosystem and assessing sustainable mortality limits.



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Management/research trapping and radio collaring:

Management/research trapping and radio collaring provide necessary data on grizzly distribution, movements, home ranges and overall demographics. Data collected with this technique include estimation of seasonal, annual, and lifetime home ranges, identification of important seasonal habitats and foods, potential travel and linkage corridors, extent of occupation, mortality information, and location of denning sites. Distribution of bears can also be informed with other methods such as DNA sampling, observation flights, telemetry flights, nuisance bear activity, and verified sightings.

Estimates of survival:

Survivorship data has been obtained, via aerial and ground telemetry of radio-collared bears and mortality investigations. These data are used to determine average life expectancy by gender and age class, causes of mortality, etc., for bears that inhabit different portions of the ecosystem. All known reported and unreported mortalities (detected via radio-telemetry) are investigated by FWP personnel to determine cause of death. These mortalities are recorded and the information used, along with other mortality data, to manage the population. Survivorship information is fundamental to addressing the potential differences in survivorship of grizzly bears in the original PCA where there are extensive habitat protections, versus bears that live on multiple use areas outside the original PCA.

Non-invasive sampling:

Many researchers in Canada and the United States are focusing on "hair-snaring" techniques to estimate number and density of grizzly bears. With this procedure, bears are attracted to sampling stations with a scent lure. At each sampling station, barbed wire is strung between trees and when the bear passes under the wire, a small tuft of hair is snagged. The follicles from these hair samples contain DNA, which can be used to identify individual animals. This technique is conceptually similar to techniques developed to identify bears based on photos taken when bears trip cameras. Advantages of the DNA and camera techniques include reduced need to mark bears or see them from aircraft. However, these techniques are labor-intensive, expensive, and typically have problems identifying the area inhabited by the estimated population. The assumptions of a ‘closed’ population with these techniques creates difficulties in estimating density where ever the technique is used. Kendall et al. (2008) calculated grizzly density for an area in and around Glacier National Park using rub tree hair snares.

Current approach:

FWP recognizes that no one factor can provide the needed information to assess population size and trend. All assessment methods ultimately result in some level of estimation and extrapolation for management purposes. Estimation and extrapolation are used to successfully manage other species of wildlife but for grizzlies in particular FWP also considers the following when making management decisions.

1. Federal laws and regulations that may have major influence on the bear population.
2. Public opinions and perceptions.
3. Results of population and habitat research. Specifically, changes in age structure, reported and unreported mortality trends, population densities, habitat use, and habitat quality are considered.

4. Major changes in human use within management areas.
5. Population status within YNP and Grand Teton National Park as monitored annually through IGBST cooperative efforts.
6. Documentation of grizzly bear range expansions or contractions.
7. Changes in management areas or management unit boundaries.
8. The number of control actions as reported annually. The management program is evaluated annually and adjustments can be made to ensure the population is not being excessively impacted.
9. Grizzly bear management policies in Montana, Wyoming and Idaho as described in the GYA Conservation Strategy.
10. Mortality statistics as collected annually through IGBST cooperative efforts:
    a. Male/female sex ratio and median age.
    b. Total mortality: trends in total number of bear mortalities are annually evaluated in conjunction with population estimates and/or demographics to determine if changes in mortality quotas are needed.
    c. Annual estimates of cub litter sizes as reported throughout the ecosystem.
11. If a hunt was to occur, hunter effort, success, location of hunt, and other metrics would be monitored and considered to aid interpretation of population statistics.

Population data are collected in a manner that provides the most statistically accurate population estimates. Overall population fluctuations are monitored annually through IGSBT cooperative efforts. The most recent analysis indicates that the adult male bear segment of the population is increasing, the adult female bear segment is stable and the sub-adult bear segment is decreasing. (IGBST, 2012). These are indications of a population that is being regulated by density dependence and related food availability.

FWP has considered the collection of population data in a manner that would provide statistically precise population estimates. However, fine scale population fluctuations for a slow reproducing species such as the grizzly bear are difficult and expensive to detect, and more importantly, unnecessary. An overall population trend informed by diverse types of data is adequate to inform FWP's management decisions. The calculation of precise population estimates would be very costly and ultimately provide little additional information to support management decision making.

Trend of grizzly bear mortalities in Southwest Montana

Grizzly bear mortalities have remained nearly constant in Montana since the 2002-2012 EIS was written. There were 40 known documented grizzly bear mortalities (Table 7) during the ten year period prior to 2002. During the eleven year period (2002–2012) since, there have been 45* documented grizzly bear mortalities (Table 8) in Montana's portion of the GYA. Considering the expansion in overall distribution and increase in the overall grizzly bear population since 2001, Montana's management program has been relatively successful in keeping annual grizzly bear mortalities low.

Table 7. Grizzly bear mortalities in southwest Montana, 1992-2001.

CAUSE:	YEAR											% of
	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	Total	Total
Natural	1	0	0	0	0	1	0	1	0	0	3	8
Livestock Depredation	0	0	0	0	0	0	2	0	0	0	2	5
Unknown	0	1	0	0	1	0	0	0	1	0	3	8
Illegal	1	0	2	1	0	2	0	0	0	0	6	15
Self-Defense/Hunting	0	1	1	2	1	2	0	0	2	0	9	22
Roadkill	0	0	0	0	0	0	0	0	0	0	0	0
Unnatural Food	1	0	3	5	4	0	0	0	1	3	17	42
Total	3	2	6	8	6	5	2	1	4	3	40	

Unnatural food related mortalities have decreased from 42% of the total mortalities during the period of 1992–2001, to 29% of the total mortalities during the period of 2002-2012. This decrease is partially attributed to a significant effort to improve sanitation on private and public land. Defense of life and property (DLP) mortalities have risen slightly from 22% to 29% of the total from the first 10 year period to the most recent 11 years.

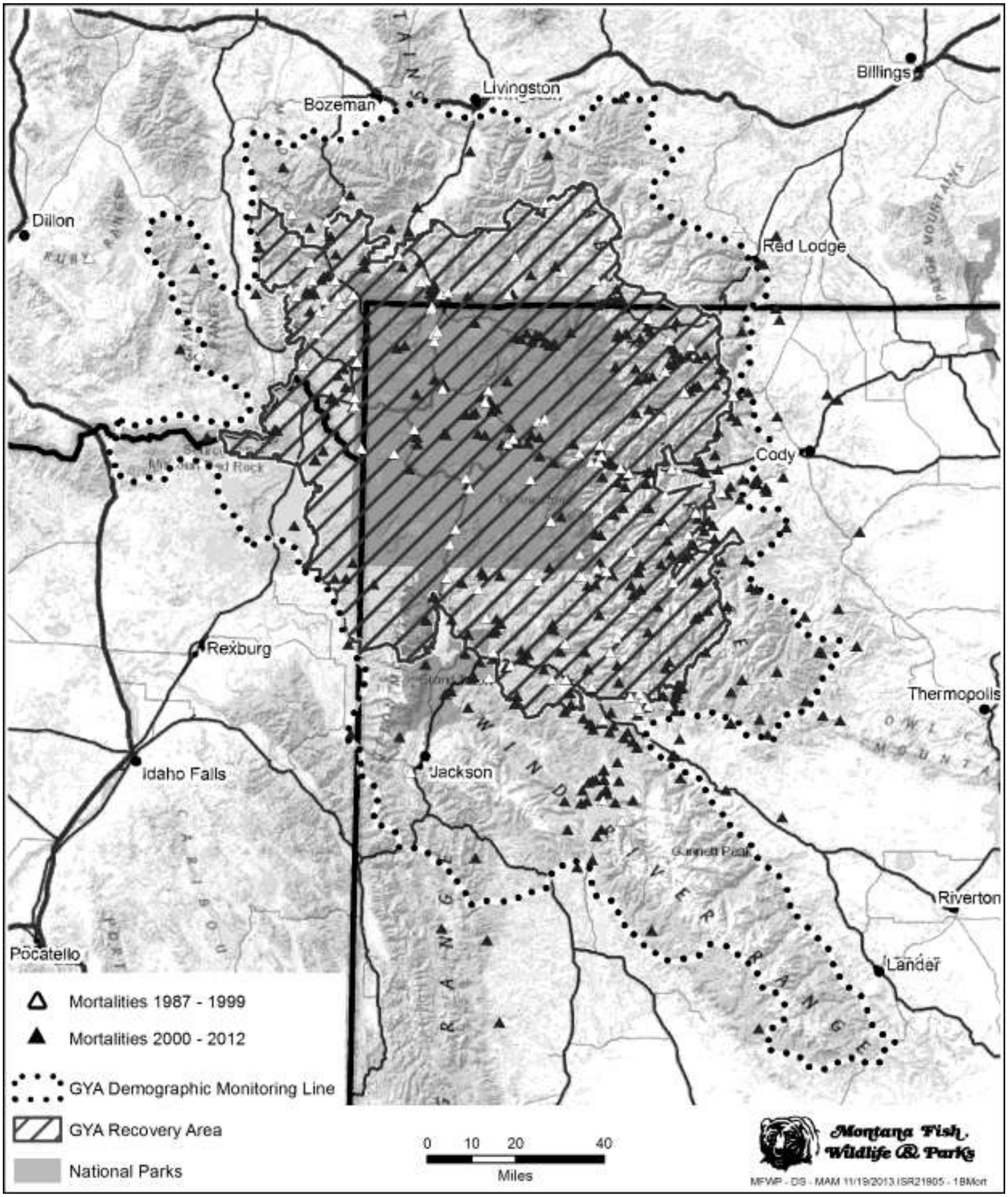
Table 8. Grizzly bear mortalities in southwest Montana, 2002-2012.

CAUSE:	YEAR												% of Total
	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	Total	
Natural	1	0	0	0	0	0	0	0	0	0	0	1	2
Livestock Depredation	0	0	0	0	0	0	0	0	1	2	2	5	12
Unknown	0	0	0	0	2	0	0	1	0	0	0	3	7
Illegal	0	0	0	1	0	0	1	0	1	1	1	5	12
Self-Defense/Hunting	0	1	0	0	0	2	3	2	2	1	1	12	29
Roadkill	0	0	0	1	0	0	1	1	0	0	0	3	7
Unnatural Food	4	0	1	0	1	0	3	0	2	1	0	12	29
Total	5	1	1	2	3	2	8	4	6*	5	4	41*	

* = There are four additional mortalities associated with the 2010 human maulings and one human fatality in the Soda Butte Campground near Cooke City. These four mortalities were not included in the two time period comparisons, due to the reason for removal of the bears. They are noted previously in the documented total mortalities (45) for 2002-2012.

Livestock depredation related mortalities and backcountry DLP mortalities have been slightly increasing in recent years. This should be expected as bear distribution increases, putting people, livestock and bears into more situations of potential conflict (Figure 5). Often there are human injuries associated with the DLP mortalities. Since 2007, 20 people have received minor to severe (1 fatal) injuries from encounters with grizzly bears in Montana's portion of the GYA. A large effort has been made by FWP and the USFS to post information, post news releases and make personal contacts to reduce human (mostly hunters) injuries and bear mortalities. However, due to the random nature of close encounter situations, they are nearly impossible to alleviate or predict.

Figure 5. Distribution of grizzly bear mortalities by two time periods, 1987-1999 and 2000-2012. Mortalities recorded outside of the Demographic Monitoring Area line will not count against sustainable mortality limits (IGBST data).



Habitat/Habitat Monitoring/Human Use of Bear Habitat

Preferred management approaches to provide suitable and adequate habitat:

- Cooperate with other members of the IGBST in a coordinated effort to collect and analyze habitat data.
- Work with land management agencies to monitor habitat changes in a manner consistent with the overall approach to habitat monitoring for other managed species.
- Identify and monitor whitebark pine, moth aggregation sites, and other key foods such as ungulate population levels.
- Continue to use statewide habitat programs to conserve key wildlife habitats in southwestern Montana.
- Recommend that land-management agencies manage for an open-road density of one mile or less per square mile of habitat consistent with FWP's statewide Elk Management Plan guidelines.
- Support the maintenance of existing inventoried roadless areas and work with local groups and land managers to identify areas where roads could be reclaimed.
- Work with the Department of Transportation (DOT) to address wildlife crossing needs on their projects.
- Monitor coal bed methane activities, and other oil and gas projects, and address grizzly bear needs in permitting processes as necessary and when appropriate.
- Monitor mining activities, timber harvest and public lands livestock grazing and address grizzly bear needs in permitting processes as necessary and when appropriate.
- Continue to work with local communities, counties, and developers to limit negative impacts of new development on grizzly bears.
- Work with local community groups to identify and promote habitat characteristics that benefit bears.
- Review all new trail proposals or adjustments to trails on FWP lands through the MEPA process. Negative impacts to grizzly bears will be avoided while designing new trails or trail use restrictions.
- Review and comment on federal trail projects when appropriate.
- Evaluate winter use programs to ensure they avoid impacting grizzly bears during denning periods, including den entrance and emergence when appropriate.
- Consider grant applications for the state trails program only after MEPA or NEPA process has been completed to include consideration of grizzly bear habitat needs as appropriate (this will be managed by Montana State Parks, a division of FWP).
- Increase resource stewardship within grizzly bear habitat through recreationists education and regulations compliance.
- Monitor changes to habitat or bear behavior suspected to be climate change related and mitigate when possible. For example, education campaigns could be implemented to warn hunters that later denning dates due to warmer autumns mean bears are active later than in the past.

FWP views fish and wildlife habitat on public land, as valuable property that preferably remains open to hunters, anglers, and other public users. Accessibility to public lands will be balanced with the year-round requirements of fish and wildlife, while maintaining a functioning road system. By implementing this program, FWP can maintain grizzly bears while still providing for other appropriate uses.

Reasons for the decline of grizzly bears in North America are excessive human-caused mortality and habitat loss. Habitat loss can result from conversion of native vegetation to agriculture, disturbance, displacement from human developments and activities (roads, mines, subdivisions), and fragmentation of habitat into blocks that are inadequate to maintain viable populations and connectivity.

This management plan recommends a coordinated approach to the monitoring of major grizzly bear food sources and to addressing land management issues related to grizzly bear habitat protection, disturbance, and mitigation. It is important to note that these efforts benefit many species in addition to bears.

Grizzly Bear Foods

Because grizzly bears are omnivorous and opportunistic they are able to survive in a variety of habitats and utilize a variety of foods. As grizzly bear expansion and population increase has occurred, food and habitat monitoring has occurred in an increasingly larger area. Three major food sources used by bears inhabiting the GYA are whitebark pine seeds, army cutworm moths (*Euxoa auxiliaris*) at insect aggregation site, and ungulates, including use of winter kill (primarily elk and bison), predation (mostly on neonates), and usurping wolf killed ungulate carcasses. These major foods are important and can either be monitored directly, or bear use of the resource can be monitored such as bear use of army cutworm moths aggregation sites. Although these are the major food sources in the GYA, grizzly bears are known to consume at least 234 species within 179 genera from 4 kingdoms. Of all foods consumed, 75 species were frequently used by bears and 153 species were used opportunistically (Gunther et al., 2012).

FWP works directly with the IGBST to monitor the major grizzly bear foods as part of ecosystem wide monitoring. Whitebark pine stands are monitored for seed production, tree health (evidence of blister rust, *Cornartium ribicola*), infestations of mountain pine beetle (*Dendroctonus ponderosea*) and evidence of bear use. Identified moth aggregation sites are monitored for use by bears, although no sites with documented grizzly bear use are currently known to occur within the Montana portion of the GYA. Ungulate populations are monitored during routine FWP big game population and trend surveys. The IGBST reports on the condition of food sources within the GYA each year in the annual report. Monitoring intensity can be increased if concerns arise about any food source due to a changing environment or decline in grizzly population numbers. FWP will implement more specific monitoring protocols as needed in coordination with the IGBST and land management agencies.

Habitat Availability and Security

Grizzly bear habitat can be impacted by a reduction of security cover as the direct or indirect result of recreational development, road use, road restrictions, motorized trails, human presence, oil and gas development, logging, forest fires and other natural events. FWP recognizes the need to minimize negative impacts from these factors whenever feasible. FWP considers impacts to grizzlies on FWP managed properties such as Wildlife Management Areas or State Parks and designs grazing, logging, and farming plans for these areas with grizzly use in mind. While FWP is not the decision maker on federal or State School Trust lands, FWP works closely with these land management agencies to minimize negative impacts on all fish and wildlife.

The intermountain valleys between major mountain ranges of southwestern Montana are primarily private land. These private lands are vital to the area's agricultural economy and provide important habitat for a variety of fish and wildlife. As agricultural land, they also provide a wide range of opportunities for wildlife to live and travel between mountain ranges.

While FWP has no jurisdiction over private land uses, it does have strong private land habitat initiatives. Most are funded through earmarked accounts including Montana's Migratory Bird Stamp (dollars directed toward wetland riparian areas), Upland Game Bird Habitat Enhancement Program (dollars go primarily towards enhancing shrub/grassland communities) and Habitat Montana. Habitat Montana specifically allows FWP to conserve habitat on private lands via lease, conservation easement or fee title acquisition. This program is not directed towards specific species but rather towards conserving Montana's most threatened habitats, i.e. wetlands/riparian areas, shrub/grasslands, and intermountain foothills. Since 2002 Habitat Montana funds have been used within the GYA to purchase lands adjacent to the Dome Mountain WMA to offer greater use of the area by wildlife, including grizzlies.

Efforts to conserve habitat in Montana will continue to be a FWP priority. FWP completed 'Recommendations for Subdivision Development: A Working Document' in 2012 (MFWP, 2012). This document is intended to guide FWP biologists in responding to developer and local government request for comment on subdivision applications. It also provides local planners, local government officials, developers and development project teams with planning tools, approaches, and design recommendations.

Roads, Trails, and Developed Site Management

Radio telemetry studies have identified roads as significant factors in habitat deterioration and increased mortality of grizzly bears. Excessive clearing widths, increased speeds, increased traffic volume, and widened roads are known to cause increased road mortality and/or reduce habitat connectivity (Proctor 2003, Clevenger et al. 2002). The distance at which bears appear to be displaced by roads varies in different areas and seasons, but generally, bears living near roads have higher probability of human-caused mortality as a consequence of illegal shooting, control actions resultant from attraction to unnatural food sources, or by being mistakenly identified as a black bear by hunters. As major highways bisect most of the intermountain valleys, FWP works with the Montana DOT and land management agencies on mitigating barriers to wildlife crossing roads and maintaining secure habitat for grizzlies in addition to other species.

Many examples of collaborative approaches to safe road crossings exist along US Highway 93 in western Montana and monitoring by the Montana DOT has shown an increase in grizzly bear use of underpass structures since construction (P. Basting, pers comm.). Long-term monitoring will provide useful information to southwestern Montana biologists and transportation planners when opportunities arise to construct underpasses with the hopes of aiding wildlife movement. Some specific multi-species work has been completed or is underway already to include highway fencing projects and road kill surveys along Bozeman Pass and in the Madison Valley. These projects have involved cooperative efforts of DOT, FWP, and the Craighead Institute (www.mdt.mt.gov). FWP will continue to engage in exploratory studies to identify areas of conflict and work to develop mitigations to reduce grizzly bear highway mortalities.

The 2002 EIS stated that FWP would pursue an MOU or other agreement with DOT to provide guidelines that would enhance the ability of bears and other wildlife to cross roads. In the 10 years since publication of that document, FWP and the DOT have worked closely to seek ways to minimize wildlife mortalities on highways. This partnership will continue as FWP reviews DOT proposals and offers guidance on habitat use and movement patterns of animals. The increased tracking of grizzlies has allowed FWP to share real movement data with DOT that they can use to improve their highway designs.

FWP supports the maintenance of road densities of one mile or less per square mile of habitat as the preferred approach. This is the goal of the FWP statewide elk plan and it seeks to meet the needs of a variety of wildlife while maintaining reasonable public access. Within the 2007 GYA Conservation Strategy, all roads fall under the rule set for motorized access routes. Additional restrictions could be designed as needed through coordinated decision making by FWP, land management agencies, transportation planners and local input.

Restricted roads and motorized trails are important factors in evaluating habitat potential for and mortality risk to grizzly bears (Mace et al. 1996). Grizzly bear researchers and managers generally agree that secure habitat, defined as those areas more than 500 meters from a motorized access route during the non-denning period, are especially important to the survival and reproductive success of grizzly bear, especially adult females (IGBC 1998).

Since publication of the first EIS (2002) major changes to trail management have been implemented with the importance of secure habitat for grizzlies in mind. The biggest change was the prohibition of motorized, wheeled cross-country travel on National Forest lands. The purpose of this restriction is to protect riparian areas, wetlands, crucial wildlife habitat, threatened or endangered species, soils and vegetation, aquatic resources, and/or to reduce user conflicts. The policy affects any motorized, wheeled vehicle, but not snowmobiles. Motorcycles may use a single-track trail or road if it is open to motorized vehicles, but ATVs and other four-wheeled vehicles cannot use single-track roads or trails. Cross-country travel will continue to be allowed for military needs, fire suppression, search and rescue, or emergency response. Forest users can also drive cross-country to campsites within 300 feet (90 m) of most existing roads or trails, after locating their campsite in a non-motorized fashion.

All motorized trails fall under the rule set for Motorized Access Routes Database in the 2007 CS. Non-motorized trails are not counted against area calculations of secure habitat but fall under the rules set for secure habitat. This rule set ensures the percent of secure habitat within each bear management subunit within the PCA is maintained at or above levels that existed in 1998. Temporary and permanent changes are allowed under specific conditions identified in the CS (2007). Permanent changes in secure habitat are only allowed if any loss of secure habitat is replaced by secure habitat of equal amount and equivalent quality within the same BMU.

Within the 2007 CS a trailhead is considered a developed site and as such falls under the developed site standards. Developed sites are known to displace grizzly bears and this has some direct effect on habitat effectiveness. The primary concern related to developed sites is mortality connected to food conditioning and bear habituation. Impacts to bears as a result of new or expanding developed sites could result from increases in human capacity at the site, temporary or permanent loss of habitat, increased length of time of use, increased access to surrounding areas or backcountry trails, and increases in unsecured attractants. Within the PCA, the number of sites will remain at or below the 1998 levels with some exception (CS 2007).

Other developed sites include, but are not limited to, campgrounds, lodges, administrative sites, and permitted resource development sites such as oil and gas exploratory well or production wells within the PCA to include on FWP lands. These developed sites are capped at 1998 levels.

National forests will continue to identify areas where more detailed local travel plans should be developed. FWP staff will continue to comment on changes to federal trails policy while continuing to evaluate state policies. Montana State Parks currently administers three trail grant programs: the federally funded Recreational Trails Program, the state funded Off-Highway Vehicle Program and the Snowmobile Grant Programs. Regardless of whether an FWP funded trails project is on federal, state, or private lands, it must comply with the Montana Environmental Policy Act (MEPA). On federal lands, trail projects must also comply with USFS Travel Plans, BLM Unit Plans, and the National Environmental Policy Act (NEPA). The FWP trails grant program requires documentation of NEPA or MEPA compliance as part of any grant application. In this way FWP has assurances that wildlife have been considered in project planning and public input has been a part of the process. More information on the Montana trails program can be found in the Montana State Trails Plan (Montana FWP, 2011).

It is FWP's opinion that expanding the current level of habitat restriction and programs to bear-occupied areas outside the PCA would not generate social acceptance for the bear nor is expansion of habitat restrictions necessary for population recovery. Incorporating the grizzly as another component of FWP's ongoing programs for all wildlife is a more productive approach. In addition, the approach outlined in this plan does allow FWP to modify the program, if necessary, and adapt the program in the future as more is learned. FWP recognizes that habitat changes in the PCA (e.g., loss of whitebark pine) could result in increased importance of habitats outside the PCA and will respond to those changes if they occur.

General Guidelines for Habitat Management

The following guidelines are considered when evaluating the effects of existing and proposed human activities in identified seasonally important habitats for a variety of wildlife species including grizzlies on federal and State lands.

1. Identify and evaluate, for each project proposal, the cumulative effects of all activities, including existing uses and other planned projects. Potential site-specific effects of the project being analyzed are a part of the cumulative effects evaluation which will apply to all lands within a designated "biological unit". A biological unit is an area of land which is ecologically similar and includes all of the year-long habitat requirements for a sub-population of one or more selected wildlife species.
2. Evaluate activities or combinations of activities, on seasonally important wildlife habitats that may result in an adverse impact on the species or reduce long-term habitat effectiveness.
3. Base road construction proposals on a completed transportation plan which considers important wildlife habitat components and seasonal-use areas in relation to road location,

construction period, road standards, seasons of heavy vehicle use, road management requirements, and more.

4. Use minimum road- and site-construction specifications based on projected transportation needs. Schedule construction times to avoid seasonal-use periods for wildlife as designated in species-specific guidelines.
5. Locate roads, drill sites, landing zones, etc., to avoid important wildlife habitat components based on a site-specific evaluation.
6. Close or reclaim roads that are not compatible with area management objectives, and are no longer needed for the purpose for which they were built. Native plant species will be used whenever possible to provide proper watershed protection on disturbed areas. Wildlife forage and/or cover species will be used in rehabilitation projects where appropriate.
7. Impose seasonal closures and/or vehicle restrictions based on wildlife, or other resource needs, on roads that remain open and enforce and prosecute illegal use of off-road vehicles.
8. Direct efforts towards improving the quality of habitat in site specific areas of habitually high human-caused bear mortality. Increase or implement sanitation measures, seasonal road closures, trail closures, etc., as appropriate.
9. Evaluate impacts of road, trail, and development projects through the NEPA and MEPA processes.

Climate Change

Climate change may result in a number of changes to grizzly bear habitat in the foreseeable future, including a reduction in snowpack levels, shifts in denning times, shifts in the abundance and distribution of some natural food sources, and changes in fire regimes. Yet, most grizzly bear biologists in the U.S. and Canada do not expect habitat changes predicted under climate change scenarios to directly threaten grizzly bears (Servheen and Cross 2010). These changes may even make habitat more suitable and food sources more abundant. However, these ecological changes may also affect the timing and frequency of grizzly/human interactions and conflicts (Servheen and Cross 2010).

The western U.S. is predicted to experience milder, wetter winters with warmer, drier summers and an overall decrease in snowpack (Leung et al. 2004). While some climate models do not demonstrate significant changes in total annual precipitation for the western U.S. (Duffy et al. 2006), an increase in "rain on snow" events is predicted by others (Leung et al. 2004; McWethy et al. 2010). The amount of snowpack and the timing of snowmelt may also change, with an earlier peak stream flow each spring (Cayan et al. 2001; Leung et al. 2004; Stewart et al. 2004). Although there is some disagreement about changes in the water content of snow under varying climate scenarios (Duffy et al. 2006), reduced runoff from decreased snowpack could translate into decreased soil moisture in the summer (Leung et al. 2004). However, Pederson et al. (2011) found that increased spring precipitation in the northern Rocky Mountains is buffering total annual stream flow thus far from these expected declines in snowpack.

The timing of den entry and emergence is at least partially influenced by food availability and weather (Craighead and Craighead 1972; Van Daele et al. 1990). Less snowpack would likely shorten the denning season as foods remain available later in the fall and become available earlier in the spring. In the GYA, Haroldson et al. (2002) reported later den entry times for male grizzlies corresponding with increasing November temperatures from 1975 to 1999. This increased time outside of the den could increase the potential for conflicts with humans (Servheen and Cross 2010).

Climate change could create temporal and spatial shifts in grizzly bear food sources (Rodriguez et al. 2007). Changes in plant community distributions have already been documented, with species' ranges shifting further north and higher in elevation due to environmental constraints (Walther et al. 2002; Walther 2003; Walther et al. 2005), outbreaks of insects, or disease (Bentz et al. 2010). Decreased snowpack could lead to fewer avalanches thereby reducing avalanche chutes, an important habitat component to grizzlies, across the landscape. On the other hand, increases in "rain on snow" events may decrease the stability of snowpack resulting in increases in avalanches. Changes in vegetative food distributions also may influence other mammal distributions, including potential prey species like ungulates. While the extent and rate to which individual plant species may be impacted is difficult to foresee with any level of confidence (Walther et al. 2002; Fagre et al. 2003), there is general consensus that grizzly bears are flexible enough in their dietary needs that they will not be impacted directly by ecological constraints such as shifts in food distributions and abundance (Servheen and Cross 2010).

Fire regimes can impact the abundance and distribution of some vegetative bear foods (e.g., grasses, berry producing shrubs). Fire frequency and severity may increase with late summer droughts predicted under climate change scenarios (Nitschke and Innes 2008; McWethy et al. 2010). Grizzly bears in the lower 48 States evolved with frequent fires but effective fire suppression policies over most of the 20th century negatively affected grizzly bear foods by reducing early successional stages (LeFranc et al. 1987). Increased fire frequency actually has the potential to improve grizzly bear habitat, but these fires must be low or moderate in severity to be advantageous. High intensity fires may reduce grizzly bear habitat quality in the short term by decreasing hiding cover and delaying regrowth of vegetation. However, even wide-spread, high intensity fires like the 1988 wildfires in Yellowstone may not have detectable impacts to grizzly bear foraging strategies (Blanchard and Mattson 1990). Federal and state agencies are currently under direction to reduce wildfire management costs, including restoring natural fire regimes to reduce the risk of high intensity wildfires. Overall, we do not anticipate altered fire regimes will have significant negative impacts on grizzly bear survival and reproduction.

The best way to mitigate potential negative impacts from climate change is through well-connected populations of grizzly bears. Connectivity among grizzly populations also mitigates genetic erosion and increases resiliency to demographic and environmental variation.

Future Distribution

Preferred management approaches to manage future grizzly distribution:

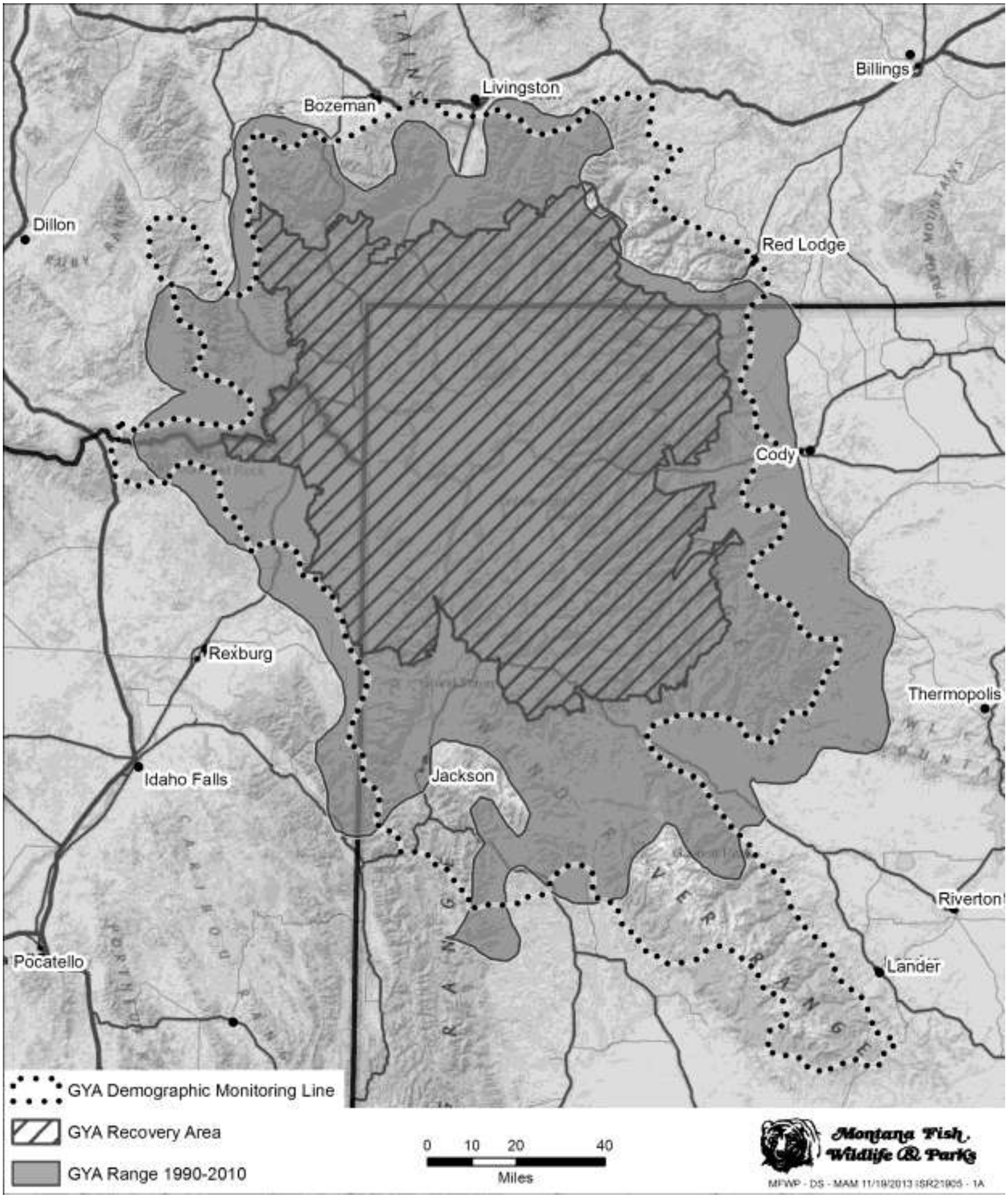
- Continue to monitor grizzly bear expansion from historically occupied areas along with changes in population numbers.
- Continue to address grizzly/human conflicts in areas outside the core recovery area in a manner that considers overall grizzly conservation as well as human safety and social tolerance.
- Continue to work with Idaho, Wyoming, and the Interagency Grizzly Bear Committee to address the issue of linkage between grizzly recovery areas and follow the goal set forth in the IGBC work plan to promote linkage between the GYA and the NCDE grizzly populations.

- Implement habitat programs that provide for wildlife needs to include working with the DOT to address issues of wildlife movement across roads (especially Interstates 90 and 15; and Highways 287, 191, 89, and 20).

FWP will work with landowners and private interests to promote programs that provide for wildlife access to private lands. The IGBST documented an increase of the GYA grizzly bear population, growing from approximately 200-350 bears in the mid-1980s (Eberhardt and Knight 1996) to at least 600 in 2012. Results from a 2011 IGBST Workshop (IGBST, 2012) however indicate the GYA grizzly bear population trajectory has changed and the population growth rate for the recent period is now stable to slightly increasing. This corroborates results indicated by previous regression analyses, and is in contrast to estimated growth rates of 4-7% per year during the decades of the 1980s and 1990s (Schwartz et al. 2006). These changes in population growth are hypothesized to be attributed to 1) density-dependent effects, 2) declines in key food resource such as whitebark pine seeds, or 3) a combination of density-dependent effects and resource decline (IGBST, 2012).

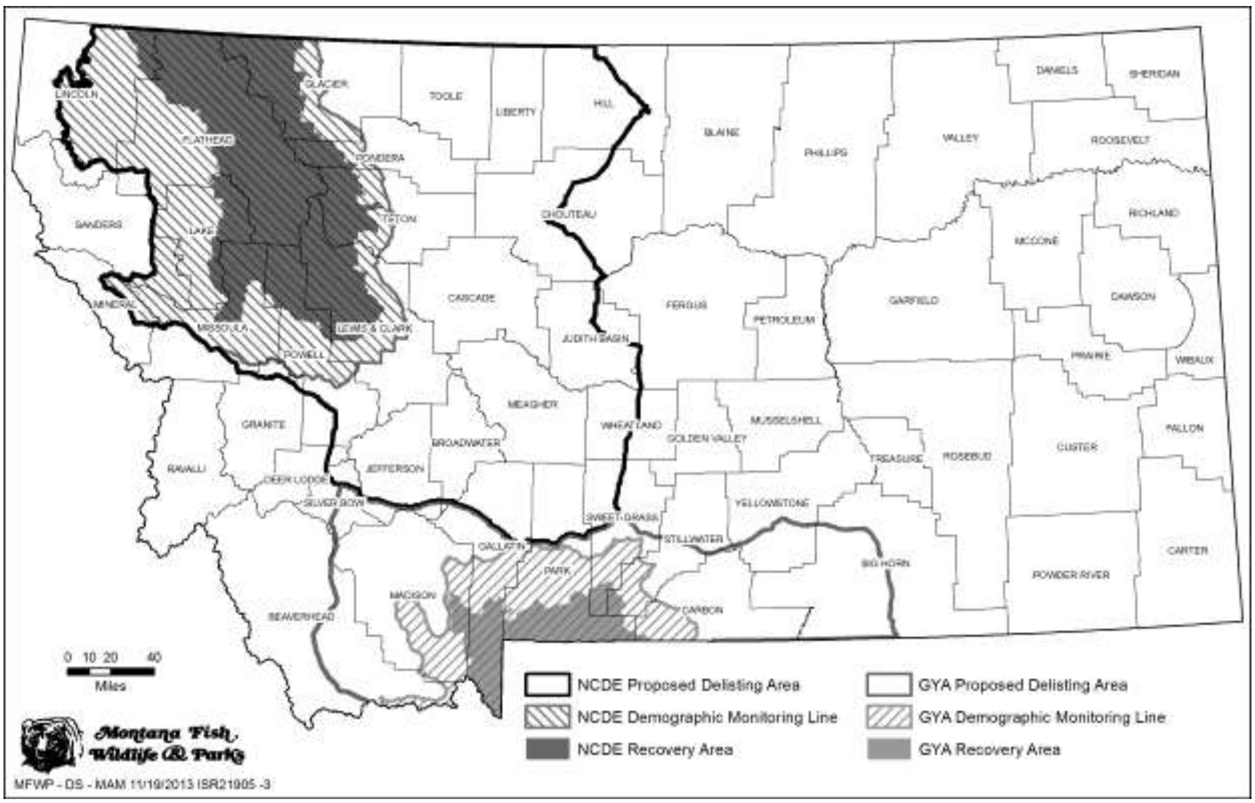
FWP suspects grizzly bears within or close to the original Recovery Zone in Montana's portion of the GYA are experiencing this same leveling of population growth. Moreover, FWP continues to find bears well outside the original Recovery Zone in areas previously unoccupied since initiation of recovery. In the grizzly bear recovery plan, the Recovery Zone is defined as the area "within which the population and habitat criteria for achievement of recovery will be measured" (U.S. Fish and Wildlife Service 1993:17). Whereas this may be true, maintenance of an increased bear population in numbers and distribution outside the Recovery Zone helps ensure long-term viability of this population. There is valuable habitat outside the Recovery Zone on public land and grizzly bears currently occur in many of these areas (Figure 6).

Figure 6. Distribution of grizzlies from 1990-2010 showing a large area of grizzly bear occupancy (gray shaded polygon) outside the original Recovery Zone (IGBST data).



Management of non-conflict grizzly bears in areas between the NCDE management area and the DMA of the GYA (Figure 7) will be compatible with maintaining some grizzly occupancy. Maintaining presence of non-conflict grizzly bears in areas between the NCDE management area and the demographic monitoring area of the GYA, such as the Tobacco Root and Highland Mountains, would likely facilitate periodic grizzly movements between the NCDE and GYA. Conflict management and removal of problem grizzly bears will remain a priority within these areas like the rest of Montana. Human safety will always be prioritized over facilitation of grizzly movement for genetic connection between the ecosystems.

Figure 7. Southwest Montana showing proximity of the GYA Demographic Monitoring Area to the NCDE Demographic Monitoring Area. The demographic monitoring areas within each ecosystem represent the areas where grizzly population demographics, i.e. population size, trend, and mortalities, will be monitored. The delisting lines shown for both ecosystems represent the proposed boundaries the US Fish and Wildlife Service would use to delist grizzly bears within each ecosystem.



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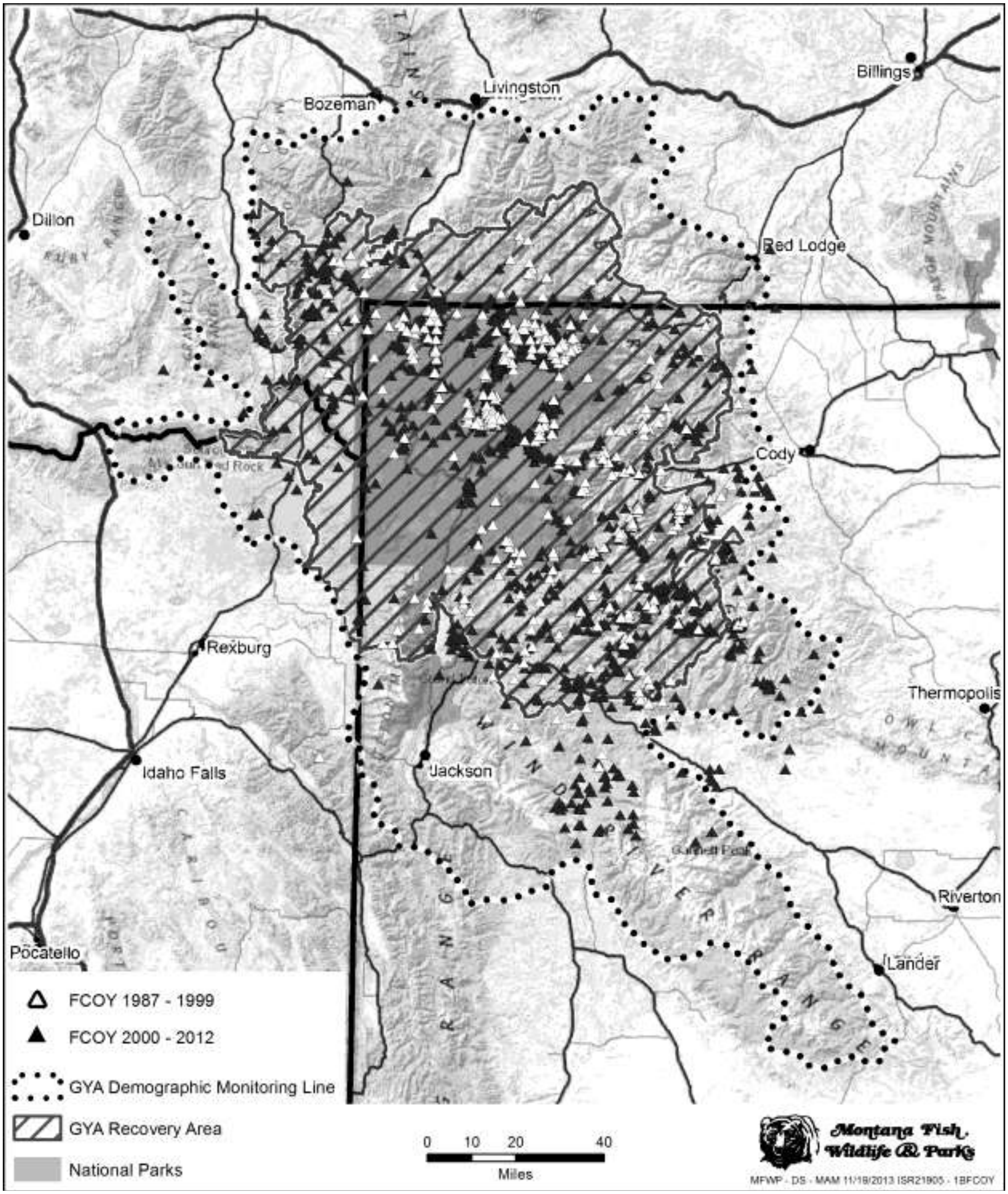
Grizzly bear distribution in southwest Montana has dramatically changed over time (Figure 8). A comparison of the current distribution to previously published distribution maps shows an approximate increase in occupied habitat of 36% between 2002 and 2012 (Bjornlie et al., 2013). This is compared to the increase in distribution of 34% from 1980 to 1990. It should be noted that the boundaries used for these calculations are approximations. Additional supportive evidence is considered when making judgments about occupied habitat near the edge. Management decisions always take into account the habitat suitability and social tolerance in any area where a grizzly may appear. Bears found far outside of the original recovery area often receive less consideration for capture and relocation after killing livestock, becoming habituated to humans or becoming food habituated. At the same time, a grizzly found far outside the original recovery area is left alone by managers when exhibiting natural, socially acceptable behaviors.

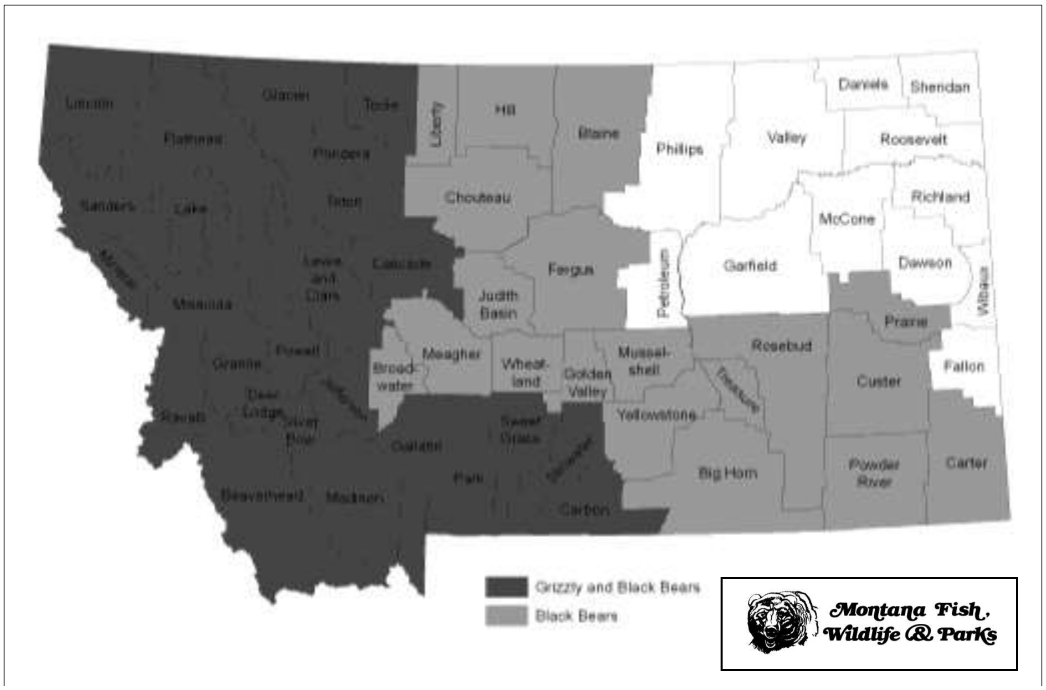
Based on current programs, both within and outside of the recovery area, it is expected that expansion will continue. It is FWP's intent to implement this management plan in a way that allows future expansion consistent with the approach used for most other species that FWP manages.

Figure 8. Distribution of females with cubs of the year by two time periods, 1987-1999 and 2000-2012, showing the increase in distribution of grizzlies over time. Black triangles on the edges of the Recovery Zone represent the increase in distribution of grizzly bears within the past decade (IGBST data).



Finally, there has been and continues to be debate on the potential for linking the different grizzly bear populations in Montana. The potential for this to occur is demonstrated by various assessments of habitat, which are ongoing and, evidenced by the information our agency provides the public on areas, where today there is the possibility of encountering a grizzly bear (Figure 9).

Figure 9. Map to be used in the 2014 black bear regulations indicating where hunters may encounter black bears *and* grizzly bears (dark gray shading) versus areas where hunters will likely encounter only black bears (light gray shading).



There have been a number of papers and models developed on this linkage concept and the impacts of fragmentation and rural development on grizzly bear connectivity. In 2004, the IGBC Public Lands Wildlife Linkage Taskforce presented findings of the 2003 Linkage report (Servheen, 2003) to the IGBC. The report was intended to be used as a tool by public land managers for developing and revising land and resource management plans. By using this tool, land managers can ensure that their plans will maintain wildlife linkage so far as public lands are concerned. The report specifically presented the results of wildlife linkage assessments in three high priority areas in northern Idaho and western Montana. Some of these results would be generally applicable to the GYA.

The 5- year work plan of the IGBC includes the following vision: Identify and achieve biologically effective linkage between all the large blocks of important habitat within and among the grizzly recovery areas. Maintain and enhance linkage with Canadian populations and between Canadian populations adjacent to the US/Canada border. Implement linkage as a transboundary interagency response mechanism to climate change in addition to the genetic and demographic benefits. IGBC partners will seek to enhance the habitat security of public lands in key landscape-scale linkage through: 1) appropriate motorized access management; 2) maintenance of visual cover; 3) limitations on new site developments such as campgrounds; 4) avoidance of road paving on public lands; 5) no increases in motorized access route density in linkage areas; and 6) sanitation enhancement. IGBC will also work to expand cooperative approaches that produce secure movement areas for grizzly bears and other wildlife through easement opportunities and acquisition where possible. Finally, IBGC partners will work closely with transportation departments to assist in identifying areas where wildlife would benefit through application of crossing structure placement or enhancement of existing structures in combination with appropriate fencing to direct wildlife to these locations. Specific subcommittee goals for the GYA and the NCDE include: 1) Promote assessment of linkage opportunities on public lands in land management planning, 2) Promote outreach with private land owners, local governments, and land conservation groups to enhance awareness and opportunities for providing linkage, and 3) Promote cooperative efforts with transportation agencies to enhance linkage across transportation corridors.

In 2008, FWP initiated a project to identify crucial wildlife areas and corridors. The intent of this effort was to provide information to developers and planners on the most critical habitats for wildlife to allow them to make smarter development choices with wildlife in mind. Results of this effort include a web based mapping program, i.e., Crucial Areas Planning System ‘CAPS’, that identifies crucial habitats for use in project planning and web based maps depicting connectivity layers for different species. FWP also developed a set of recommendations for subdivision development in 2012 intended to help local planners, local government officials and developers make informed decisions related to wildlife. The recommendations are currently being used by FWP biologists when providing comments on new subdivisions. These efforts by FWP are intended to limit the impacts of development on grizzlies in their current habitats while also considering the potential impacts of development to grizzlies in areas that they may someday occupy.

Schwartz et al. (2012) found that even extremely low densities of residential development created sink habitats and suggest that conserving grizzly bear source habitat will likely require a landscape-scale approach. Securing important linkage habitats through purchase or easement offers significant protection for linkage areas and implementation of 'bear smart' community programs can reduce the impacts of development on grizzlies and other wildlife. Proctor et al. (2012) similarly suggest that regional inter-jurisdictional efforts to manage broad landscapes that allow grizzly movement are necessary to maintain healthy populations. Genetic linkage is the movement of genetic material as males move between ecosystems and breed successfully. Populations eventually connect demographically with continuous low densities of female occupancy between them.

As documented from sightings, captures, and mortalities in the past decade, grizzly bears from the GYA and the NCDE are expanding their distribution and there is considerable potential for these populations to connect. It is a long-term goal of FWP to allow the grizzly bear populations in southwest and western Montana to reconnect through the maintenance of non-conflict grizzly bears in areas between the ecosystems. FWP anticipates that successful implementation of this plan, along with adequate local involvement, can allow this to occur. FWP will continue to address land-use patterns that promote or hinder bear movement.

Management of non-conflict grizzly bears in areas between the NCDE management area and the DMA of the GYA (Figure 7) will be compatible with maintaining some grizzly occupancy. Maintaining presence of non-conflict grizzly bears in areas between the NCDE management area and the demographic monitoring area of the GYA, such as the Tobacco Root and Highland Mountains, would likely facilitate periodic grizzly movements between the NCDE and GYA. Conflict management and removal of problem grizzly bears will remain a priority within these areas like the rest of Montana. Human safety will always be prioritized over facilitation of grizzly movement for genetic connection between the ecosystems.

FWP did not consider an alternative to limit grizzly bear distribution to just the recovery area. In FWP's opinion, this approach is logistically impossible and biologically undesirable. In order to maintain resiliency in the population bears need to be allowed to occupy a broader landscape. Also, bears cannot be confined to the Recovery Zone because there are no barriers to contain them, and it is impossible to know the location of every animal all the time. As previously stated in this document, grizzly bear issues or conflicts occurring in new habitat areas will be addressed under current program methods.

Human Safety

Preferred management approaches to manage grizzlies in the interest of human safety:

- Lethally remove bears displaying predatory behavior that kill/injure/attack people.
- Consider lethal removal for bears that kill/injure/attack people in a surprise encounter situation on a case by case basis.
- Consider lethal removal for bears displaying bold, aggressive behavior resulting in a threat to human safety on a case by case basis.
- Consider preemptively relocating a grizzly bear to avoid conflicts when there is a demonstrated threat to human safety.

- Focus efforts on programs to educate people about safety measures to prevent conflicts with grizzlies. FWP will provide annual information in poor natural food years alerting the public of the increased potential for conflicts.
- Continue to provide information on safety in bear country in the big game hunting regulations, during hunter education courses, through mailings to license holders, and on trailhead informational signs.
- Continue to be actively involved with expansion and enforcement of food-storage ordinances including food storage orders on FWP Wildlife Management Areas.
- Continue to work with city and county governments on requirements of bear-resistant garbage containers for homeowners in bear country. (More information about nuisance bear management and education/outreach efforts are included in later sections.)

Grizzly bears are large, powerful animals and, on rare occasions, can threaten human safety and human lives. FWP grizzly bear management programs work to minimize threats to human safety, however, threats to human safety cannot be totally eliminated. Unfortunately, serious encounters between grizzly bears and people occur, sometimes resulting in human injuries/death and bear mortalities. Actively responding to these situations and determining causes for the situation are crucial steps to a successful management program and for meeting the needs of the public and bears. Grizzly bears in the GYA are expanding into new habitats outside the historical suitable habitat line. As many of these habitats are already occupied by people living, working, and recreating it is expected that the number of grizzly/human conflicts will increase.

Under Montana Statute 87-6-106 , a citizen may legally kill a grizzly bear while acting in self-defense if the bear "…is attacking, killing, or threatening to kill a person…" In Montana during the period 1992-2002 and 2003-2012, respectively 9 and 12 grizzly bears were killed by individuals acting in self-defense. With the potential for increasing grizzly/human encounters, safety for both humans and bears is a critical issue.

One of the goals of this management plan is to create an environment that minimizes the potential for grizzly/human conflicts that could lead to injury or loss of human life, or human-caused grizzly mortality while maintaining traditional residential, recreational and commercial uses of the areas into which the grizzly is expanding. It is possible that certain types of human use may require modification to protect people, protect bears, reduce conflicts, and/or manage habitat. This is the same program FWP uses for other large carnivore species such as mountain lions or black bears.

Although there are a variety of situations that can result in a grizzly/human conflict, the primary categories are: 1) Food related -- improper food storage or sanitation in either a backcountry (e.g., hunter camp, hiker or other recreationist), rural (e.g., farm/ranch, cabin, church camp) or urban/suburban setting (e.g., subdivision, town); 2) Surprise encounters -- females defending cubs, bears defending a kill/carcass, bears surprised in close quarters; 3) Human encroaching on a bear's space -- photographer, tourist, etc., approaching a bear close enough to elicit a defensive reaction; 4) Bears responding to a noise attractant -- bears attracted to a hunter attempting to bugle or cow-call an elk or call in predators, or bears associating gunshots with a food source (carcass or gut pile), etc.

This plan recommends that any bears that have killed a human be removed from the population if they can be reasonably identified. FWP will use all available evidence from the incident to identify the bear(s) involved before removal. However, there are times where it may not be possible to determine this absolutely before management actions occur. One alternative considered was to not lethally remove bears that have killed people in response to some natural situation, such as a female defending her cubs. In FWP's judgment, allowing bears that have been known to purposely kill a human to remain in the population will jeopardize overall support for existence of grizzly bears. Education programs for hunters, recreationists, and homeowners will hopefully limit the number of these incidents and the need to remove bears.

Strategies to minimize or resolve grizzly/human conflicts include:

1. Inform and educate the public
2. Facilitate securing attractants
3. Enforce food storage rules/regulation
4. Use of deterrents and/or aversive conditioning methods
5. Appropriate, and when necessary, aggressive management actions to address conflict situations

<u>Hunting To Address Human Safety Concerns</u>

Hunting of large carnivores may play a role in addressing human safety issues and hunting should be considered as a tool in wildlife management programs. Properly conducted hunting programs can impact the behavior of the hunted population, selecting against those animals less wary of humans and/or animals that are comfortable in the vicinity of human activities. This can result in a more wary population over time. Responsible management hunting can help promote tolerance and acceptance of potentially dangerous animals by those directly impacted by the presence of grizzly bears. While the avoidance behaviors of hunted animals may be unfamiliar to some people, the long history of hunting has shown these behaviors are real. These avoidance behaviors include fleeing, hiding, using more secluded habitats or being more active when people are less active, all of which can promote better acceptance and tolerance of grizzly bears. However, the restrictive allowable mortality limits would allow for only a very limited amount of hunting to occur within the GYA. Hunting should not be expected to have a considerable or immediately noticeable impact on grizzly bear behavior.

Livestock Conflicts

Preferred management approaches to manage livestock conflicts:

- APHIS's Wildlife Services (WS) will continue to be the lead agency dealing with livestock depredation through a Memorandum of Understanding (MOU) with FWP (Appendix A). However, depredations will be jointly investigated and grizzly bear captures and removals will be jointly conducted.
- Focus on preventive programs to minimize livestock conflicts with priority toward those areas with a history of conflict or those areas currently occupied by bears.
- Work with beekeepers to assist with electric fences for all apiaries accessible to bears. Re-evaluate and modify as necessary the guidelines for bear depredation to beehives (Appendix B).
- Cooperatively respond to conflicts within 48 hours with at least initial contact by telephone or in person if possible. Response is typically within 12 hours of reported conflict. FWP and WS cooperatively respond to conflicts.

Livestock depredations have historically accounted for a small percentage of the annual grizzly/human conflicts and grizzly bear mortalities. In Montana's portion of the GYA, 4.8% of all conflicts and 8% of all grizzly mortalities are related to livestock depredations (1992-2012). However, with continued increases in grizzly bear distribution, it should be expected that more livestock related conflicts will occur as bears range farther into private and public agriculture lands.

Livestock operators provide many benefits to the long-term conservation of grizzly bears, not the least of which is the maintenance of open space and habitats. At the same time, livestock operations can bring bears into close proximity to human activities and losses by bears can be significant. These losses tend to be directed at sheep and young cattle but also honey bees and chickens, all of which are classified as livestock in Montana. With the recent increasing trend of backyard chicken flocks in suburban and rural areas, the number of both black and grizzly bear conflicts with livestock is increasing. Being adequately responsive to livestock depredations is a critical aspect of the overall success of grizzly management efforts. At this time livestock depredation issues are primarily handled by WS (Appendix A). FWP anticipates this will continue while FWP programs will focus on the prevention of conflicts where possible. FWP anticipates continued partnership with outside groups offering technical assistance and materials to private landowners in order to prevent livestock loss.

The current FWP program encourages landowners to contact grizzly bear management specialists for assessments of bear conflict risk and for ideas on preventative approaches to minimize those risks. FWP advises livestock owners on conflict reduction techniques in attempts to reduce losses, thereby reducing conflicts and resultant grizzly bear mortalities. FWP may provide devices to protect apiaries, corralled livestock, chicken and turkey coops, and stored feeds. Protective supplies include electric fencing, audible and visual deterrent devices, and aversive conditioning devices. FWP also promotes livestock management techniques that reduce bear depredations. In some situations, FWP can simply assist by enclosing bee yards with electric fencing. Electric fencing is very effective at deterring both black and grizzly bears, and use of this technique can significantly reduce problems and the need to remove bears. In other situations, livestock that have died due to the consumption of poisonous plants, lightning, or other causes may be used to provide food for bears in areas away from potential conflict sites. By simply removing carcasses from areas around buildings or calving/lambing areas, potential conflicts with bears can be minimized. FWP has a program to redistribute livestock carcasses on the Rocky Mountain Front for this purpose. In some situations the transfer of grazing leases from areas of high conflict to other areas is a way to reduce conflicts when landowners/operators are willing. Conflict management will always emphasize long-term, non-lethal solutions, but relocating or removing offending animals will be necessary to resolve some problems. FWP will continue to explore new techniques and approaches that can be used to protect agricultural products from bear damage.

Providing unfettered flexibility to livestock operators and property owners to deal with conflict situations will fail to provide the necessary assurances for long-term conservation and/or the legal requirements for delisting. No other FWP program for managed species allows for flexibility without constraints yet expecting livestock operators to absorb losses that occurred on public lands no matter what the cost fails to recognize the significant contribution of private lands and landowners in grizzly bear conservation. Fortunately, Defenders of Wildlife has been providing financial reimbursements to owners for grizzly bear depredation losses through their Grizzly Compensation Trust. This has been beneficial during the recovery process. In addition, the 2013 Montana Legislature passed House Bill 323 which amended MCA 81-1-110 making Montana Livestock Loss Board compensation available for grizzly caused depredation losses. The compensation program will be administered by the Livestock Loss Board and became effective on 1 October, 2013 (http://liv.mt.gov/llb).

Property Damage

Preferred management approaches to manage property damage by grizzlies:

- Focus on preventive measures, including securing attractants, and improving overall sanitation; the agency's bear management specialist works on these issues on public and private lands.
- Seek secure, long-term funding to continue the grizzly bear management specialist position currently stationed in Region 3 and seek additional funding to add a management specialist position in R5
- Respond to conflicts as soon as feasible by phone or in person if possible.

Bears can and do damage personal property as bears are highly attracted to almost any food source. Processed human food, gardens, garbage, livestock and pet feeds, and birdseed are particularly attractive to bears near camps and residential areas. These attractants are often the cause of human-bear conflicts. FWP works to identify potential sources of attractants and works with private property owners, recreationists, and government agencies to reduce and secure the source of these attractants. When the attractant cannot be eliminated, FWP provides technical assistance to protect the property and to reduce the potential for human-bear conflicts. Techniques to prevent damage may include aversive conditioning, electric fencing, deterrent devices, and relocating or removing offending animals. FWP continually explores and uses effective non-lethal damage management techniques and equipment. FWP cooperates with city, county, state, and federal governments to develop systems of managing attractants and pursues penalties for non-compliance with food storage or intentional feeding of wildlife regulations (MCA 87-6-216).

FWP knows that prevention is more effective than response and continually works to keep bears from obtaining unnatural foods or becoming habituated to humans. Keeping bears and people apart is an unreasonable approach as bear distribution and densities would have to be so low that it would preclude the objective of maintaining a healthy bear population and violate recovery and conservation strategy requirements.

Nuisance Grizzly Bear Management

Preferred management approaches to manage nuisance grizzly bears:

- Promote cost-sharing programs that focus on preventative work. Encourage interest groups to work together with FWP to minimize problems and increase tolerance for bears.
- Quickly respond to and resolve grizzly/human conflict situations when possible.
- Minimize the number of bears removed from the population.

- Consider the potential impacts of any nuisance bear response action to the overall health of the GYA grizzly population.
- Respond to nuisance grizzlies in similar fashion to the protocols described within the CS nuisance bear guidelines.

Considering how many people live, work, and recreate in southwestern Montana, it is important to note that conflicts have been minimal, yet conflicts are increasing as the bear population continues to increase in number and distribution (Figures 10 and 11). Annual variation in natural food supplies results in notable variation in nuisance complaints. The primary goal of nuisance bear management is to maximize human safety and minimize all types of conflicts while maintaining viable populations of grizzly bears. Not managing nuisance or 'problem' bears threatens public safety, the satisfaction with grizzly management programs and overall tolerance of the grizzly bear population.

Figure 10. Total grizzly/human conflicts to include all types by year, from 1992-2012.

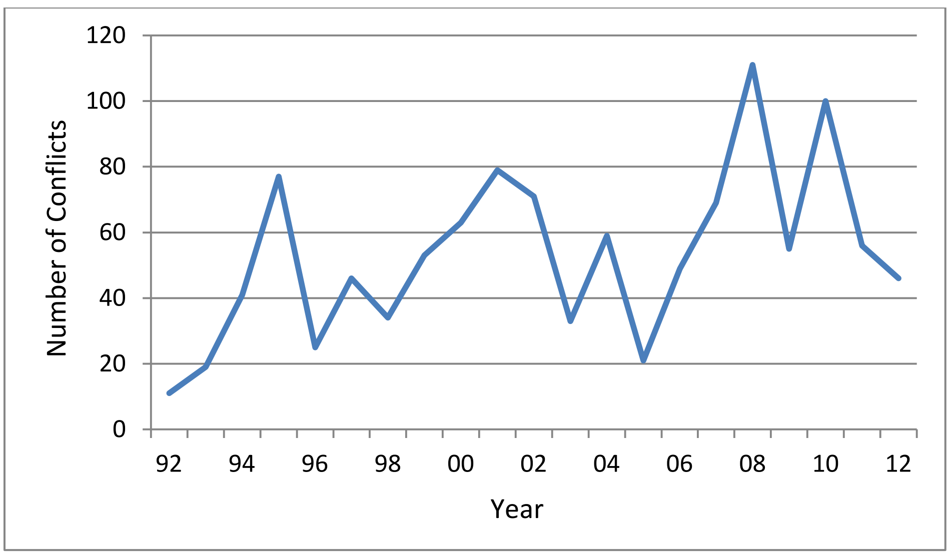
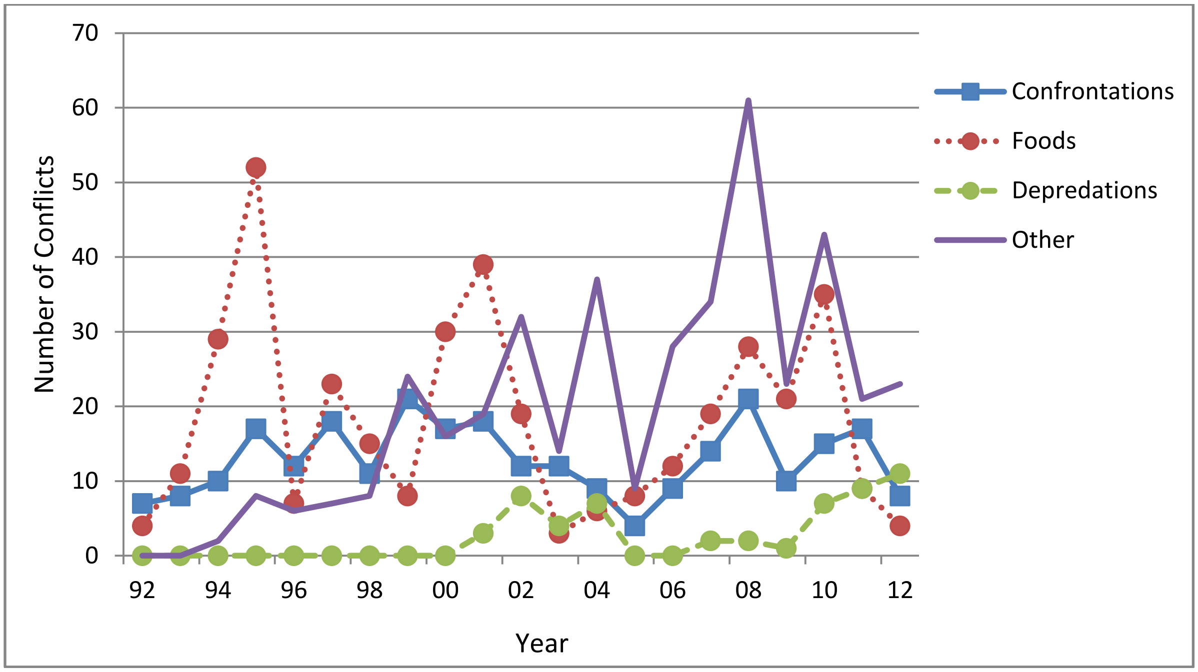


Figure 11. Annual grizzly/human conflicts by type and year (1992-2012). 'Confrontations' include grizzlies injuring, approaching or threatening people or otherwise coming into close proximity to people. 'Food' conflicts include grizzly consumption of garbage, bird seed, livestock feed, orchard fruit, garden produce, etc. 'Depredations' include confirmed losses of livestock such as sheep, cattle or chickens and 'other' conflicts include bears near residences, damaging structures or other property.



From 1993-2002, there was an average of 48 conflicts per year. During 2003-2012, the average number of conflicts was 60 for an increase of 24% since the previous 10 year period. In reality, conflicts have been occurring at a relatively constant rate when considering the increase in human population (25%) over the last 10 years, the increase in the GYA grizzly population (32%), and the 36% increase in grizzly distribution. FWP believes that conflict reduction efforts have been successful in keeping the level of conflicts stable.

Most notable since 2001 are the changes that have occurred in the number and types of conflicts (Table 9). Unnatural food related conflicts have decreased due to government and public efforts to improve sanitation and public awareness. The percentage of confrontation conflicts (close proximity encounters, DLPs, human injuries) that often result in human injuries / bear mortalities decreased slightly, but the geographic area of the occurrences increased. Livestock depredations and "other" types of conflicts, mostly bears near residences or developed sites, have increased as the bear population and bear distribution has increased.

Since completion of the 2002 plan there have been 22 human injuries and one human death from grizzly-human interactions in the Montana portion of the GYA. Three additional incidents involved a bear making physical contact with a person, but no injuries were received. This is an average of two human injuries per year in MT's portion of the GYA, from 2002 thru 2012.

During the previous 11 year period (1991–2001), an average of one person per year was injured. During 1993, 1998, 1999, 2005 and 2006 no human injuries were reported or investigated. Of the people actually injured during a grizzly bear(s) encounter from 2002 thru 2012, 5 were recreationally hiking, 3 were recreationally camping/sleeping during evening hours, 1 was mountain biking, 6 were archery hunting, 6 were rifle hunting and 1 was severely injured from being shot by his hunting partner. Nearly all human injury incidents (19) involved surprise encounters with female bears and cubs. A wide array of situations precipitated these events and this is why it is so difficult to predict or eliminate these chance encounters. Some individuals had been unwisely tracking the bear(s), some encountered bears at a food source, some were either rapidly or quietly moving and some were scent/visually camouflaged while hunting. To FWP's knowledge all grizzly bear caused human injuries have been reported and investigated. This information is annually reported through the IGBST yearly reports and covered by local and sometimes national media.

Table 9: Conflict types by percent of total and by 10 year periods, 1993-2012.

	Conflict Type			
Years	Confrontations	Depredations	Foods	Other
1993-2002	28%	2%	46%	24%
2003-2012	20%	7%	42%	49%
Average	24%	5%	44%	37%

Confrontation conflicts (encounters, DLPs, human injuries) are nearly impossible to alleviate due to the randomness of the location and timing of the occurrences. Confrontation conflicts generally occur during fall big game hunting seasons, but they also occur with people engaged in summer recreational activities. In the GYA, all grizzly bear caused human fatalities have occurred with people involved in non-hunting related activities. As bear populations increase in number and distribution, the geographic area and the number of potential public involved increases.

In recent years, most of the livestock depredations are occurring on private land beyond the monitoring area or the USFWS suitable habitat line in areas of little or no recent history of grizzly bear activity. Many of these areas are marginal for bear habitat leaving immigrant bears with few high quality, natural food sources. There is little that can be done to minimize depredation conflicts on open range land and therefore, management actions most often involve capture, relocation or lethal removal of the depredating bears. Developed sites and the associated attractants of natural or unnatural grizzly foods are the cause of many of the other conflicts, e.g., property damage, human habituation, food conditioned, and vehicle collisions. These types of conflicts are usually resolved through aversive conditioning techniques and/or securing attractants.

Upon initial delisting and implementation of the CS in 2007, federal funds were allocated to management agencies for grizzly management. FWP had initiated an improved sanitation program in 2006 that was boosted with these federal funds in 2007 to place 214 bear-resistant garbage containers on the landscape in the Gardiner, Cooke City/Silver Gate, West Yellowstone and upper Boulder areas. Several conservation groups joined this effort after it was established and have collectively provided an additional 81 bear-resistant garbage containers for the

Gardiner and Cooke City/Silver Gate areas. This sanitation effort has helped reduce the grizzly/human conflicts that result in food conditioned grizzlies, property damage and unsafe conditions, ultimately reducing management actions on grizzly and black bears.

The cause, severity, and appropriate response to human-bear conflicts often varies considerably from one incident to another, making a broad range of management applications desirable to wildlife managers. Outside of the PCA, greater consideration will be given to humans when bears and people come into conflict, provided problems are not the result of intentional human actions. Active management aimed at individual nuisance bears regardless of location is often required as part of nuisance bear management. Nuisance grizzly bears will be controlled in a practical, timely, and effective manner. Location, cause of incident, severity of incident, history of bear, health/age/sex of bear, and demographic characteristics of animals involved will all be considered in any management decision.

Definitions employed in nuisance grizzly management (*taken from the GYA Conservation Strategy):

Grizzly/Human Conflicts*: incidents in which bears injure people, damage property, kill or injure livestock, damage beehives, obtain anthropogenic foods, damage or obtain garden and orchard fruits and vegetables.

Nuisance bear: Any grizzly bear involved in a grizzly/human conflict that results in agency management activity.

Unnatural Aggression*: Behavior that includes active predation on humans, approaching humans or human use areas, such as camps, in an aggressive way, *or* aggressive behavior when the bear is unprovoked by self-defense, defense of cubs, defense of foods, or in a surprise encounter.

Natural Aggression*: Behavior that includes defense of young or food, during a surprise encounter, or self-defense.

Food-Conditioned Bear*: A bear that has received significant food reward of human foods such as garbage, camp food, pet food, or processed livestock food, and persistently seeks these foods.

Habituated Bear*: A bear that does not display avoidance behavior around humans or in human use areas such as camps or town sites or within 100 meters of open roads.

Relocation*: The capture and movement by management authorities of a bear involved in a conflict with humans or human-related foods, to remote areas away from the conflict site, usually after fitting the bear with a radio collar.

Repeat Offense*: The involvement of a bear that has been previously relocated in a nuisance situation, or if not relocated, continues to repeat a behavior that constitutes a grizzly/human conflict.

Removal*: The capture and placement of a bear in an authorized public zoological or research facility or destruction (euthanization) of that bear. Removal can also involve killing the bear through active measures in the wild when it is not otherwise possible to capture the bear.

Depredation: An action generally associated with the killing of domestic livestock animals.

Range of techniques to be used in dealing with nuisance grizzly bears:

No Action: FWP may take no action when the circumstances of the conflict do not warrant control or the opportunity for control is low.

Aversive Conditioning, Deterrence, or Protection: FWP may employ various options that deter or preclude the bear from additional depredation or nuisance activities (i.e., electric fencing, bear proofing buildings or containers, etc.).

Translocation: FWP will initiate capture operations when deemed appropriate and necessary or when human safety is a concern. Capture efforts will be initiated when they are practical, and when they can be conducted in a timely and safe manner. Management agencies may rely on translocation of some problem bears as this approach provides time to deal with the cause of conflict and provides the bear an opportunity to remain in the population. However, relocation is often a short-term solution to an immediate crisis because many bears return to the general area of conflict or may simply repeat the problem behavior in the new area. Survival of translocated bears is largely affected by whether the bear returns to the capture site. Return rates are most affected by distance transported, and age and sex of the bear. Return rates decrease with translocation distances of $\geq$75 km. Subadult female bears return the least. Translocation of female bears who later contribute back to the population through reproduction is considered particularly successful. In general however, translocation is often the final action for conflict bears as low survival and high rates of return to the conflict site ultimately end in natural or human-caused death of the bear.

Removal: FWP will employ live or lethal control techniques when other options are not practical and a reasonable opportunity for removal exists. Captured grizzly bears identified for removal may be permanently loaned to public research institutions or accredited public zoological parks for educational or scientific purposes as per state laws and regulations. Grizzly bears not suitable for these purposes will be euthanized.

On the Ground Approaches to Nuisance Grizzly Bear Conflict Prevention and Management:

1. Provide conflict-avoidance information and education to people living, working, and recreating in grizzly bear habitat. Technical assistance, including information on preventative and aversive techniques is available to property owners, outfitters, and land managers. Specific information and education recommendations are addressed in the Education/Outreach Section.
2. Provide timely information to the public and land management agencies about current bear distribution, including relocations, natural food conditions, known bear activity, potential and current conflicts (news releases, etc.).

3. Encourage land management agencies to inform permittees about practices to avoid and minimize conflicts.
4. Monitor situations where the activities or behaviors of bears inhabiting the area increases the likelihood of conflicts.
5. Work with livestock operators and land managers to implement strategies that minimize the potential for bear damage.
6. Work with property owners, recreationists, and land managers to identify and resolve potential conflicts. Provide property owners deterrent or aversive conditioning supplies when appropriate for management of specific conflicts.
7. Investigate all grizzly/human bear conflicts as soon as practical. Property owners will be advised of the process to secure compensation if warranted. Information regarding ongoing conflicts is shared with potentially affected neighbors, livestock producers, permittees, or others when possible in order to reduce risk of further conflict.
8. Attempt to remove any grizzly bear displaying unnatural aggression or considered a threat to human safety, as quickly as possible.
9. Attempt to remove any grizzly bear displaying natural defensive behavior when, in the judgment of FWP, circumstances warrant removal and non-lethal methods are not feasible or practical.
10. Aversively condition, relocate, or remove any grizzly bear displaying food-conditioned, or habituated behaviors, or damaging property based on the individual bear and specific details of the incident. Management authorities will make these decisions after considering the cause, location, and severity of the incident or incidents.
11. Preemptively move a grizzly bear when it is in an area where it is likely to come into conflict with humans or their property. Conversely, temporarily exclude people from an area if the situation has a high risk to the public, e.g. a carcass on a trail being fed on by grizzlies.
12. Grizzly bears may be relocated several times if FWP determines it is appropriate.
13. Grizzly bears involved in chronic or significant depredations or bears with a high probability to cause significant or chronic depredations, will be removed when practical.
14. Grizzly bears relocated due to conflict situations will be released in a location where the probability of future conflicts is lowest. Land managing authorities will continue to provide adequate and available sites for relocations.
15. Any grizzly bear to be relocated is uniquely marked (ear-tags, tattoo, microchips, etc.) and radio collared (if appropriate) to follow movements as necessary.
16. Grizzly bears not suitable for relocation will be removed.
17. Train and equip appropriate state and federal agency personnel to manage conflicts.
18. Respond to all grizzly/human conflicts within 48 hours of reporting and base management actions on the circumstances of each individual situation.

Hunting of Grizzly Bears

Preferred management approaches relative to sport harvest of grizzly bears:

- Incorporate regulated harvest after delisting as part of Montana's long-term conservation program.
- Design a hunting program that is justified and open to public review, similar to the processes used for all other managed species in Montana, and coordinated with surrounding states to ensure mortalities from all causes are within the sustainable population mortality limits.

- Give additional consideration to the female segment of the population in any proposed hunting program. For example, the killing of females accompanied by young will be prohibited.
- Utilize any hunt as part of overall species management and as a way to garner additional public support and ownership for long-term persistence of the grizzly population in Montana.
- Encourage all hunters and recreationists to carry bear spray in bear habitat.

Managing grizzly bears as a game animal (MCA 87-2-101) confers additional recognition to them as a valuable wildlife species: A species that is protected from illegal harvest and prioritized for population monitoring and research. Regulated harvest of game animals is one of the major tools that assures the maintenance of predator and prey populations in Montana and elsewhere. The Interagency Grizzly Bear Committee (IGBC) supports the use of regulated hunting in recovered and delisted populations as one approach to help manage numbers and distribution of bears to promote coexistence and help minimize conflict. Although specifics regarding the hunting of a recovered grizzly bear population will be unique to the ecosystem and legal jurisdictions involved, IGBC supports hunting regulations that reflect the best available science, are adaptable to changing factors, are established in a public process, and are consistent with standards in the ecosystem specific Conservation Strategies. It is therefore intended that the eventual regulated harvest of grizzly bears will be a part of Montana's program and commitment to grizzlies, when and where appropriate.

Regulated hunting as a management tool for grizzly bears has a long successful history in Montana and was conducted until 1991. Regulated hunting can result in the removal of unwary bears or bears that associate with and habituate to people. Two of the three bears taken in the last legal Montana hunt were known problem bears. Regulated hunting can also reinforce human avoidance behaviors different than those exhibited by unhunted populations. Ultimately, these avoidance behaviors and the removal of unwary bears promotes the long-term survival and social tolerance of the grizzly population.

Wildlife populations sometimes produce surplus animals that can be removed without dampening growth of the population. Population estimates and trend data for the GYA indicate this has been the case, however, much of the ‘removal’ has been from unregulated mortalities. Any regulated public hunt must be evaluated in the context of these unregulated mortalities, overall population goal, and the overall bear management program and its efforts to promote management and ongoing recovery of this species. Regulated hunting programs or recommendations will be conservatively applied and while hunting may alter the timing and nature of grizzly use of some habitats, any negative impacts to the population should be negligible based on the anticipated low level of harvest opportunity.

From the 2012 IGBST population demographic review, the adult male portion of the population has been increasing throughout the ecosystem. The removal of adult males in relatively remote areas through hunting will not negatively impact the overall population. Removal of adult males may in fact enhance adult female, cub and sub-adult survival in areas with less human presence, thereby allowing survival in areas where fewer conflicts occur.

Regulations that direct harvest toward males and away from adult females may allow for higher hunter quotas. Hunters would primarily remove males during early spring seasons due to their earlier emergence from dens. Similarly, hunters would primarily remove males during late fall seasons as they are last to enter dens. Females accompanied by newborn cubs are the last to emerge and move away from den sites and the first to enter dens in the fall. Using season timing and protective regulations for females with young, FWP was successful in focusing harvest on males during previous regulated grizzly hunting. Similar season setting techniques would be used to focus harvest on males in future hunts.

FWP would likely not institute hunting seasons in areas where bear density is low and harvest mortality is not sustainable. In addition, FWP would likely not institute hunting seasons in areas where bear density is low and removal of bears would negatively impact the potential for movement of grizzlies between ecosystems when desired and acceptable.

In summary, FWP recommends a regulated hunting season be a part of the overall grizzly bear management program for the following reasons:

1. Legal harvest can be managed so as to have minimal impact on the population as a whole.
2. Hunters have legally harvested problem bears in the past and would be expected to do so in the future, potentially reducing grizzly/human conflicts in some areas.
3. Hunter harvest may be partially compensatory in that it may remove some nuisance animals.
4. Hunters may remove unwary or bold bears and hunter activity may cause other bears to be wary of humans, thereby decreasing the need for FWP control of problem bears.
5. Hunting promotes acceptance and tolerance of this large and potentially life threatening animal by some of the local public who are asked to live with grizzlies. This acceptance and tolerance is key to long-term survival of the bear.
6. Removal of adult males can increase cub survival and recruitment, which in turn, can promote a more stable population.
7. Hunters have been and continue to be one of the strongest supporters of long-term conservation efforts. Hunter dollars have purchased more habitat than any other group in the GYA ultimately providing for a variety of species including grizzlies. This strong connection between hunters and habitat is critical to continued successes in restoring wildlife including grizzly bears. Hunting gives direct ownership for the welfare of this species by some of the most ardent supporters of wildlife in Montana.
8. Hunting activity provides revenue from license sales and excise taxes on equipment to support wildlife management and the enforcement of wildlife management regulations.
9. The presence of licensed hunters can reduce illegal activities. Every year ethical hunters in Montana report people who have violated laws protecting wildlife.

Regulated hunting has been used as only one tool among many to provide for the long-term recovery and survival of grizzly bears. A regulated public hunt must therefore be evaluated in the context of an overall bear management program. There are also many statutes, regulations, and considerations that will affect any proposed hunt to include:

1. Upon delisting, hunting will be proposed only after all components of the grizzly bear management program and CS are being adequately implemented.

2. The justification for any proposed hunt will be available for public scrutiny and comment prior to any decision or possible implementation.
3. MCA 87-5-302 regulates the hunting of grizzly bears, including the establishment of tagging requirements for carcasses, skulls, and hides; and establishing requirements for the transportation, exportation, and importation of grizzly bears. The Commission shall establish hunting season quotas for grizzly bears that will prevent the population of grizzly bears from decreasing below sustainable levels and with the intent to meet population objectives for elk, deer, and antelope.
4. Commission rules make it illegal to harvest/take black bear cubs or females with young and it is expected the Commission would enact a similar rule for a grizzly hunt.
5. MCA 87-2-702 states a person may take only one grizzly bear in Montana with a license authorized by 87-1-701.
6. The Commission has the authority to close seasons at any time if mortalities from any cause have been excessive, i.e. if the yearly total ecosystem-wide mortality limits are near to or have been exceeded.
7. Damage hunts, targeting individual problem bears, have proven to be of limited value.
8. MCA 87-6-401 makes it illegal to hunt any game animal with the use of bait.
9. MCA 87-6-404 makes it unlawful to chase any game animal with a dog.
10. Bear hides and carcasses must be presented for inspection. Hunters are prohibited from wasting bear meat unless the meat is determined to contain trichinella. Evidence of species and sex of animal must remain attached to carcass or parts to be legally possessed or transported.
11. MCA 87-6-202 makes it unlawful to possess, ship or transport grizzly bear parts that have been unlawfully obtained.
12. MCA 87-6-206 makes it illegal to buy or sell grizzly bear parts unless they have been registered with FWP.

Montana's hunting season setting process is an open and dynamic process, with ample opportunity for public comment. Season structure for most big game species is adopted on a biannual basis, while quotas are set annually.

FWP considered eliminating hunting as a part of its grizzly bear management program. However, in FWP's judgment, this approach would eliminate a key local and national constituent group with demonstrated commitment to the species and its habitat.

FWP targets all types of recreationists and workers in grizzly country for education on the benefits of carrying and knowing how to use bear spray. FWP has considered requiring all hunters to carry bear spray while in the field, yet believes that there are significant liability and enforcement issues around a "mandatory" approach. In addition, carrying spray can give people a false sense of security and replace common sense and thoughtful backcountry practices. Bear spray can be ineffective in windy areas and in certain weather conditions, and individual bears can respond differently to the spray. Also, there are only a few manufacturers who produce bear spray that meets EPA ingredient requirements and the required propellant duration. Approved bear spray is a valuable tool, but it cannot replace knowledge of bear behavior and appropriate human behavior in bear encounter situations. FWP makes bear spray available to field personnel operating in bear country and encourages employees to carry and know how to use it.

Enforcement

Preferred approaches for grizzly conservation through enforcement authority:

- Enforce statute that criminalizes intentional feeding of both black and grizzly bears (MCA 87-6-216).
- Investigate and prosecute violations of Montana law relative to the protection of grizzly bears (MCA 87-5-301, 87-5-302).
- Assist federal agencies as requested to enforce federal regulations (i.e., CFRs).

FWP enforcement efforts concerning grizzly bears are focused in three areas: patrols of both wilderness and non-wilderness areas, grizzly/human conflict control to include instances of property damage and human injury or death, and illegal take investigations.

Wilderness and non-wilderness areas are patrolled during the general hunting season and at other times throughout the year. Hunter camps are checked for harvested animals, food storage compliance, and compliance with outfitter regulations. Although FWP enforcement has no authority to enforce federal food storage orders they do communicate rules and regulations to those they contact and they do record information for use by federal enforcement personnel.

Response to nuisance bear complaints can involve many FWP personnel, although Enforcement Division personnel are frequently the first on the scene. Response to grizzly/human conflicts that result in human injury or death is managed by the Enforcement Division and handled under a formal response/investigation protocol (Wildlife/Human Attack Response Team). This system integrates other state, local and federal personnel in the response and provides a structured approach to dealing with these types of major incidents.

FWP enforcement personnel investigate and prosecute all violations involving illegal grizzly bear mortality. Cases are processed through the county attorney's office or turned over to the USFWS when they appear to involve interstate movement of grizzly bear parts. FWP also coordinates with federal officials in undercover operations. Current state law sets restitution for illegal take of grizzlies at an amount of $8,000 in addition to the fines and imprisonment tied to the misdemeanor or felony charge. Anyone found guilty of illegal grizzly take will also forfeit any current hunting, fishing, recreational use, or trapping license issued by this state and the privilege to hunt, fish, or trap in this state for 30 months from the date of conviction or forfeiture unless the court imposes a longer period. Fines for the interstate movement of illegally killed or possessed animals can also be imposed.

The USFS manages food storage restrictions on their own lands. The county sheriff's office enforces county ordinances on food storage. FWP personnel enforce food storage rules on all WMAs that fall under an annual rule adopted by the FWP Commission in 2013.

A statute (MCA 87-6-216) first passed in 2001 makes it illegal to provide food attractants to bears or improperly store food attractants, including garbage. Individuals who intentionally feed or attract bears to their residence create problems that impact their neighbors, jeopardize human safety, and result in problem situations. FWP personnel have no enforcement authority to enforce food storage regulations on Forest Service lands, yet FWP personnel spend a great deal of time in backcountry areas checking people on national forest lands. When violations are encountered, they attempt to ensure compliance and refer the infraction to USFS or BLM law enforcement. Added presence and patrol by federal resource officers will become even more critical in reducing grizzly/human conflicts. This will be increasingly important as the grizzly bear population expands and, food storage regulations are required on additional national forest lands.

The 2002 EIS stated that FWP would seek authority to enforce food storage regulations on federal lands. However, in the 10 years since publication of that document the cooperative efforts between FWP and Federal land managers have been successful in enforcing food storage without a formal MOU. FWP officers work closely with Federal law enforcement in monitoring food storage compliance and talking to recreationists about the importance and legal requirements of food storage as stated. The cooperative efforts of all agencies have no doubt contributed to the ability of bears to persist in close contact to humans. Anecdotally, the number of non-compliance cases have decreased as recreationists recognize the importance of clean camps for both the good of the bear and their own personal safety. Education and outreach efforts by all agencies have no doubt contributed to compliance. These efforts to work cooperatively and educate the public will continue.

By Commission rule, FWP personnel enforce federal travel restrictions during Commission-designated hunting seasons. At other times, personnel refer violations to USFS or BLM law enforcement. They also regularly work with USFS and BLM law enforcement in saturation patrols, both aerial and ground-based, to ensure compliance with travel management plans.

The 2002 EIS stated that FWP would seek authority to enforce travel management plans. FWP is no longer pursuing this authority as FWP believes its current ability to enforce travel management plans during hunting seasons has been adequate to protect grizzlies. In non-hunting seasons FWP works closely with the Federal land management agencies to monitor and report violations of plans as stated above.

There is currently a Memorandum of Agreement between the USFWS and FWP that outlines joint responsibilities for violations of federal and state law (Appendix C). The agreement also addresses responsibilities and guidelines for joint investigations by Montana game wardens and USFWS special agents. The MOU between FWP and WS outlines responsibilities and guidelines for joint investigations by WS and FWP in grizzly bear depredation situations (Appendix B).

A visible enforcement presence is critical to program success and additional resources would help implement new responsibilities. These would include sufficient funds for equipment and necessary overtime required to operate in remote areas and, ultimately, additional staffing. FWP will work cooperatively with the USFS and BLM to identify additional opportunities to support FWP in these efforts.

Education and Outreach

Preferred Approaches for Continuing Education and Public Outreach:

- Include hunter education class lessons that cover safety while hunting in bear county.
- Continue to expand efforts to assist hunters with identification of black versus grizzly bears through publications and mandatory training and testing for individuals interested in hunting black bears.
- Implement ways to target education efforts towards "new" and current Montana residents regarding grizzly/human conflicts and human safety while in bear country.
- Continue to work with the Board of Outfitters to ensure outfitters have adequate knowledge of appropriate practices for operating in bear country and encourage outfitters to provide training to clients, and to provide clients with bear spray and the knowledge of how to use it.
- Work with private organizations, wildlife advocacy groups and other interested parties to promote 'living in bear country' messages including safety tips for recreating in bear habitat and the utility and proper use of bear spray.
- Integrate education and public outreach with enforcement of food and garbage storage rules.
- Use education and outreach to minimize human activities that can lead to grizzly/human conflicts.
- Work with local planning entities to address the needs of grizzly bears in new developments and new residential areas, and provide continued support to existing communities to prevent and reduce bear conflicts.

Management strategies are unlikely to succeed without useable, state-of-the-art public information and education outreach programs. A partnership based information and education approach involving FWP, other agencies, local communities, and private interests, can result in minimal grizzly/human conflicts and a strong sense of agreement among Montana residents about the state's bear goals and management programs. Expanded and continued education and outreach efforts are essential to the objective to allow for expanded bear distribution and long-term survival of the species.

Human safety is of utmost concern when hunting in grizzly bear country. In order to teach young, old, and first-time hunters the proper techniques for hunting in grizzly country, FWP incorporates safety lessons for hunting in bear habitat in each hunter education class including general hunter education, archery hunter education, and the online hunter education courses. Topics covered include bear identification, bear awareness, the proper use of bear spray, and meat retrieval. There is a special focus on the proper use of bear spray during the field day portion of the courses in order to allow hunters to gain confidence in using bear spray as a deterrent. In Montana, no individual born after January 1, 1985 may apply for and receive any hunting license unless the person possesses a hunter safety certificate. Current records show that approximately 7,000 students are certified each year through FWP's hunter education program.

In 2001, the Commission approved mandatory bear identification testing for black bear hunters in Montana prior to their purchase of a black bear license. This requirement aims to reduce misidentification by black bear hunters as grizzly bear encounters are on the rise. Black bear hunters must be aware that they may encounter grizzly bears where they have not in previous years. Black bear hunters must sharpen their ability to tell the difference between black bears and grizzly bears to prevent and avoid mistaken identity killings of grizzly bears. The bear identification training program is available to all citizens and can help non-hunters also learn to distinguish between the two species. The test is available on line at www.fwp.mt.gov, by mail, or at FWP offices or license providers. A hunter must pass the test with a minimum score of 80% before they can purchase a bear hunting license. A hunter can retake the test until a passing grade is obtained. Annual recertification is not required. FWP believes the test for black bear hunters, as currently delivered, is effective in reducing mistaken identity mortalities. Due to hunter awareness there have been relatively few hunter caused mistaken identification mortalities (4 mortalities in the last 11 years).

The Commission is concerned about the impact that mistaken identity killings of grizzlies could have on maintaining a recovered grizzly bear population or on recovery in areas that remain below objective. While the Commission believes mistaken identity killings can be reduced through education, some consider a better solution to be elimination of the black bear hunting season in Montana. That action would minimize FWP's ability to manage black bears and create a myriad of other problems essentially lessening the support for management and expanded distribution of grizzlies.

In order to provide education resources to 'new' and long-term residents, FWP maintains a website dedicated to 'living with bears' type education (fwp.mt.gov/FishAndWildlife/ LivingWithWildlife/). This online site includes information on living and recreating in bear country, hunting in bear country, bear safety, and bear education. The website is an online tool that citizens and educators can use to learn more about bear safety and reduce bear conflicts. The site has a special section with tools for teachers to use in their classroom. It also provides contact information for the individuals involved in bear management in each region.

FWP encourages federal land management and wildlife agencies to continue playing a role in public education in order to protect bears and people while assuring wilderness values. FWP coordinates with these agencies to provide bear safety literature at their respective trailheads and at offices in occupied grizzly habitat. FWP will continue to work with the USFS to maintain an appropriate number and location of bear resistant food storage containers, meat poles, and bear resistant garbage containers (at all campsites) in occupied or potentially occupied areas.

FWP promotes the grizzly bear as a valuable state resource through school and community presentations, community-based workshops, news releases, magazine articles, social media outlets, and radio and television spots. FWP emphasizes the value of educating children about bear safety and identification. FWP has a 'head and hides' check out program that is available to educators and non-profit organization. FWP and partners have developed a "Getting Along with Bears" coloring and activity book.

The 2002 EIS stated that FWP would encourage the Board of Outfitters to require all outfitters and guides operating in bear country to be certified in grizzly/human safety. However, in the 10 years since publication of that EIS the documented number of conflicts between outfitters and grizzlies have been minimal and the number of outfitter caused bear deaths has decreased (K. Frey, pers. comm.). FWP has worked diligently through outreach efforts and trainings to ensure outfitters have adequate knowledge of appropriate practices for operating in bear country. FWP encourages outfitters to provide trainings to clients and to provide clients with bear spray and the knowledge of how to use it. It is obviously in the best interest of the outfitters to keep their clients safe. This, combined with their current record of limited conflicts has minimized the need for any formal outfitter and guide certification. Outfitters in Montana are under the jurisdiction of the Montana Board of Outfitters and the Montana Department of Labor and Industry, which is responsible for issuing outfitting licenses and the enforcement of laws regulating the outfitting industry. Outfitters using federal lands are also overseen by the respective federal land management agencies. Education and outreach efforts by all agencies have no doubt contributed to outfitter and guide success of operating in bear country and efforts to educate outfitters, guides and other hunters will continue.

FWP has developed a set of fish and wildlife recommendations for subdivision development in Montana. The goal of this document is to help Montana communities and counties mesh subdivisions for people with healthy habitats for fish and wildlife. The document may be viewed online on the Living with Wildlife page at www.fwp.mt.gov. The document contains a section about the recommended subdivision design standards for addressing grizzly/human conflicts. FWP and cooperating partners strive to work with homeowner groups in areas with bear activity to improve sanitation, increase the use of bear-resistant containers, and increase property owner knowledge of living in bear country. FWP recognizes that there are a large number of citizens moving into bear country for the first time. FWP continues to work to educate new residents of steps that can be taken to reduce bear conflicts.

Examples of current FWP education and outreach programs on living with grizzlies;

- Presentations to schools, colleges, private businesses, civic groups, sportsmen’s groups, and local watershed groups.
- Presentation of public and private land bear conflict reduction & safety programs.
- Presentations to rifle and archery hunter education classes.
- Presentations to outfitters and guides in areas of high bear use and/or past grizzly/human conflict.
- Bear safety presentations to field crews and educational classes.
- Timely interviews with newspaper, radio, and TV reporters following conflicts or during times of grizzly activity.
- Production of media clips regarding use of bear spray, safety during spring antler hunting, safety during big game hunting seasons.
- Use of social media to reach younger audiences with the ‘Living in Bear Country’ messages.
- Maintenance of an FWP website devoted to bear identification and bear awareness (www.fwp.mt.gov/fishand wildlife/livingwithwildlife/bebearaware/).
- Maintenance of a public information plan designed by the FWP Conservation and Education Division.
- Support for publication and distribution of education and outreach material including:
  - “Bears of Yellowstone” brochure
  - “Hiking in Bear Country” brochure
  - “Visiting Bear Country: How to Avoid Bears” brochure
  - “Living with Grizzlies” brochure
  - “Living in Bear Country” brochure
  - “Bear Spray” brochure

  - “Who’s Who? Know your Bear” brochure
  - “Be Bear Aware” children’s handout.
  - “Attention Hunters”: bear safety license holders
  - “Attention Hunters”: bear safety postcards
- Production and distribution of the “Staying Safe and Working in Bear Country” video.
- Maintenance of trail head signs with safety in bear country recommendations and food storage regulations.
- Posting trail heads with information regarding recent, potentially dangerous grizzly activity in the area.
- Cooperate with USFS on food storage regulations & bear safety issues.
- Dissemination of information regarding FWP and land management agency food storage regulations.
- Dissemination of information regarding the state law that makes it illegal to intentionally feed bears.
- Provide cities and counties information for improving refuse collection sites.
- Assist community groups such as the Gardiner Bear Aware Group in their efforts to promote ‘bear awareness’ and responsible behavior in bear country.
- Assist communities in addressing sanitation issues through education and outreach, e.g., South Gallatin County Ordinance to address sanitation in upper Gallatin Canyon and Big Sky.
- Frequent contact with the public regarding ‘bear awareness’, appropriate ‘living in bear country’ practices, and current conflict situation information.
- Mailing of ‘bear awareness’ and safety information to all FWP special permit holders, e.g., moose, goat, sheep tag holders.
- Assist bee-keepers and poultry producers in reducing conflicts through education and outreach.
- Work with others such as Defenders of Wildlife, to increase education and outreach to target audiences.
- Use outreach efforts to encourage the use of electric fence where appropriate to reduce bear conflicts and subsequent management actions.
- Provide internal (FWP) education and training.

Future Research

FWP has and will continue to conduct research into population monitoring methods in collaboration with the IGBST. Adult females and females with COY are considered the most important segment of the grizzly population and consequently are a major focus of the IGBST monitoring program. Efforts to document the distribution and abundance of females with cubs within the GYA began in 1973 and have continued to date. During the past 10 years (2003-2012), IGBST has estimated an average of 50 unique females with cubs of the year in the GYA annually. When combined with other data, these counts serve as the basis for estimating total population size and determining whether annual mortality is sustainable. Sustainable mortality establishes the upper limit on the number of grizzly deaths that can occur within a healthy population. Previous research has shown that population size is underestimated (Schwartz et al. 2008), likely resulting in conservative mortality limits. Recent research efforts of IGBST have focused on addressing this bias using mark-resight techniques (Higgs et al. 2013). Further investigation of this technique is underway to improve its application in the GYA. Assessment of this technique is needed to determine the feasibility of estimating grizzly density at a large GYA scale based on findings from smaller focal study areas.

FWP will continue to conduct research captures of grizzly bears in Montana to monitor survivorship, habitat use, change in distribution and ensure that enough female and male bears are telemetry marked for demographic analysis. Assessment of other techniques such as camera and hair traps, and DNA population monitoring is needed to determine the most cost efficient and effective method of tracking the expanding population and to ensure adequate information is available for management and the public.

As the delisting process proceeds, FWP will assess the potential impacts of hunting on the GYA grizzly population size and distribution. Any future hunting losses would be considered within annual population estimates and annual mortality limit calculations. Continuous evaluation of the impacts of sport harvest are part of FWP's management for all harvested species.

FWP will continue to collaborate with the IGBST on ongoing research to determine if the slowed growth of the overall GYA grizzly bear population is a factor of density dependence and/or food abundance. Initial indications are that both factors may be playing a role. In any healthy population, one should expect that the population will slow or stabilize at some point in time, due to density and carrying capacity of the habitat. FWP is assessing the natural biological carrying capacity of actual or potential grizzly bear habitats through cooperative efforts with other agencies. Such assessments are important to ensure that management efforts for grizzly bears are appropriate throughout their range in Montana.

Finally, FWP will continue to conduct and collaborate on research into the importance of anthropogenic impacts on bear populations and habitats. As documented elsewhere, roads, commercial activities (e.g., mining, logging), livestock grazing, urban sprawl, and recreation (e.g., snowmobiling, off road travel) may impact the ability of bear populations to persist in an area. More research is needed to determine threshold levels at which these impacts become significant and to determine mitigation actions to limit negative impacts to grizzlies when possible. Similarly, it is important to recognize threshold levels of social tolerance of grizzly bears and to continue assessing the most effective ways to minimize conflict between humans and grizzlies.

Other priority grizzly research needs will be considered and prioritized by FWP during the life of this plan, using the standard research prioritization process used to identify all priority wildlife research needs. Under this plan, proposals are developed and submitted for review by wildlife program managers and division staff, and resources are directed to priority projects through consensus. Before FWP dedicates resources (staff time, money, data, etc.) to a research effort, for grizzlies and other wildlife or habitat, the project will be prioritized through this process. Today's grizzly research techniques can be expensive and labor intensive, requiring agreement on the need to dedicate resources prior to initiatation of a research project.

Costs and Funding

The grizzly bear is a species of national interest. The USFWS, through congressional appropriations, has funded FWP and other managing agencies for the initial implementation of the GYA Conservation Strategy (CS) with funding to bridge the time period between federal funding under listed status and state funding after delisting. This FWS bridge funding was to allow the state time to get internal state funding (or some other funding source) in place to fund Montana's responsibilities to implement the CS. As this FWS bridge funding was not intended to cover the state responsibilities under the CS in the long-term, a funding mechanism to support Montana's responsibilities for Yellowstone grizzly bear management is necessary. Such stable funding ensures all state and federal agencies have the ability to effectively manage this species under the direction of the CS once it is recovered and delisted.

The minimum estimated costs to implement this plan are presented below (Table 10). This is not intended to be a detailed description of program costs, but it does provide a yearly average of current and anticipated expenses tied directly to personnel that work exclusively on grizzly bear management and their operations costs. Another 1500 or so hours of personnel time for 27 FWP staff persons ranging from local conservation wardens time to administrators time can be assumed necessary for grizzly bear management throughout the year. This amounts to an additional $50,000 in personnel time spent on this work. Operations dollars to include vehicle mileage are not tracked separately from other work making it difficult to estimate additional operations for these 27 employees. Employees with duties such as a conservation warden are tasked to work on whatever high priorities need attention. This ranges from responding to game damage to responding to grizzly/human conflicts or assisting with grizzly capture. The coverage of this work out of FWP license and Pittman Robertson dollars is allowable and appropriate.

FWP does acknowledge the need for a bear management specialist to be based in the Billings office. Approximate cost of this new position would be $60,000. Securing the funding for this position as well as the FTE has proven difficult but as grizzlies expand their range further east of Yellowstone National Park the press for this type of assistance may be prioritized over funding for other new positions. Cooperative funds could be sought from outside partners.

Independent efforts, not reported in Table 10, by staff at the FWP Montana Wild Center to implement a bear aware program for school and civic groups costs could be as high as $15,000 but staff time and operation dollars are difficult to track as staff work on a variety of projects. In addition these programs are targeted towards awareness for hunters, recreationists and those who live in bear country throughout Montana, not just within the area covered by this plan.

Montana's cost to implement a grizzly bear management plan as shown in the 2007 Conservation Strategy was estimated to be over $400,000. A budget this large would allow FWP to do additional work such as hiring a bear specialists in Region 5 and assigning more staff to grizzly specific work. In the absence of such a budget, implementation of the grizzly bear management program is divided among many personnel as indicated. We have a history of success in doing this with other species management programs and believe we can continue to operate in this manner. Annual budgets are greatly impacted by both federal and state processes. Annual funding fluctuations impact program priorities.

Table 10. FWP Southwest Montana Grizzly Bear Management Plan minimum expenses.

Expenses	Current State Expenditures	Current Federal Expenditures
Bear Management (includes investigations of human injuries, bear mortalities, site conflicts, sanitation, conflict reduction materials, staff time and operations)	$91,500	$65,000
Monitoring (observations of females with cubs, radio tracking, DNA work, population expansion tracking and FWP Laboratory expenses)	$5,000	$22,000
Outreach (Conservation Education information releases, hunter education, etc.)	$2,500	$1,500
Grand Total	$100,000	$88,500

Irreversible/Irretrievable Resource Commitment

This section describes irreversible and irretrievable commitments of resources associated with implementation of the proposed grizzly bear management program outlined in this EIS. A resource commitment is considered irreversible when impacts from its use limit future use options. Irreversible commitment applies primarily to nonrenewable resources, such as fossil fuels or minerals, and to those resources that are renewable only over long time spans, such as soil productivity. A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for use by future generations. In essence, irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the proposed action or preferred alternative. Such commitments include expenditure of funds, loss of production, or restrictions on resource use.

The grizzly bear management approaches recommended in this document should not result in any irreversible/irretrievable commitment of resources with few exceptions. If expansion of bears proves untenable in some areas because of issues related to public safety, FWP has demonstrated the ability to remove unwanted or nuisance bears. The level of recommended allowable mortality will not result in any irreversible commitment of the grizzly bear resource and should allow the species to flourish when its population is considered on a statewide scale. Some causes of grizzly mortality can be regulated or eliminated if necessary and the overall management program is designed to track the population and mortalities in a sustainable cost effective way. Likewise, habitat programs and access management actions can also be reversed or revised as needed.

The grizzly bear and other species are major components of our quality of life in Montana. This quality of life attracts new residents resulting in an expanding human population. Subdivisions, energy development, and other land development programs are slowly but steadily altering grizzly habitat. FWP is seeing some irretrievable commitment of resources to manage wildlife in the face of these changes as the department invests in habitat conservation efforts such as fee title purchase of quality habitats, attainment of conservation easements, and staff and equipment to manage nuisance bears.

Secondary and Cumulative Impacts

Successful implementation of this management plan does have some secondary impacts on other wildlife or habitat management programs, other wildlife species, and the public. Continued focus on habitat management, food storage, and conflict prevention actions as described in this plan can provide a positive secondary impact to black bear populations as black bear conservation and management issues are similar to grizzly bear issues. The careful management of road densities, off road vehicle use and seasonal area closures is beneficial to bears in addition to other sensitive species such as elk. In fact, road density standards as recommended have been in place for years and have allowed for expansion of the bear population while maintaining secure elk habitat. Reasonable limitations on subdivision or energy development are also beneficial to many of the wide ranging or migratory species. Increasingly smart development and recommendations as seen in the FWP subdivision recommendations (MFWP 2012) will maintain habitat for a diversity of species. Additionally, there is the potential that population levels of black bears could be somewhat reduced due to grizzly bear expansion into currently unoccupied habitats. Yet based on the current status of black bears in and adjacent to areas currently occupied by grizzlies in Montana, impacts are not anticipated to be significant.

In addition to secondary positive impacts to black bears, grizzly bear management can have positive secondary impacts to terrestrial and aquatic life and habitats because habitat management for grizzlies limits human uses and disturbance of habitats for all species. Management to limit open road densities and new developments ensure there is protected habitat for a diversity of wildlife. The enforcement of attractant storage orders and rules ensures other animals such as black bears and mountain lions do not gain access and become nuisance animals and generally results in greater public awareness of the risks of feeding wildlife.

There may also be secondary positive economic benefits to Montana from a recovered and sustainable bear population. Many people visit and relocate to Montana because of our diverse and abundant wildlife resources. FWP’s successful education and outreach programs have made it possible for people to live and recreate in grizzly country, in essence, adding to the value of many Montana properties. Yet while there are many benefits to expanded grizzly bear populations, there is no denying that there will be impacts to property owners and livestock producers due to conflicts with grizzly bears. Data from Defenders of Wildlife on livestock losses from 2002-2012 show $8,500 was paid to producers who lost sheep, cattle or poultry to grizzly bears within the Montana portion of the GYA. Not all losses are submitted for claims. Implementing the programs recommended in this document will minimize impacts through prevention, where possible, and adequate management when conflicts do occur.

Agencies that manage lands in southwestern Montana could see increased costs with expanding grizzly populations due to an increase in area requiring food storage, or other habitat management measures. Many of the areas that grizzlies could occupy in the near future however already have adequate habitat management.

A negative secondary impact of ongoing management of grizzly bears can be the cost of program implementation. These costs can limit the resources available to manage other species. There can also be negative secondary costs to individuals and communities. There can be financial burdens on the property owners and recreationists who live or recreate within grizzly country as they deal with livestock loss, property damage or increased costs of certain activities (e.g., purchase of food storage containers.) Anyone living or visiting grizzly country must accept the costs and risk of grizzlies on the landscape. Depending on a recreationists experience and comfort level their access to quality recreational and wilderness activities could be limited by their choice not to recreate in areas occupied by grizzlies. Grizzly bears are large and potentially dangerous animals. By their presence, they pose some risk to the human inhabitants of the state and to visitors. Current information shows that this risk is very real, but at surprisingly low levels. When one considers all of the people and activities that currently occur in grizzly habitat, and how few injuries or deaths happen, it demonstrates this low level of risk. In addition, the programs outlined in this plan should allow for management and further minimization of the risks of living with grizzlies knowing that no environment is totally risk free for people.

Impacts to local and state tax base and tax revenues are both positive and negative. Wildlife viewing and appreciation can bring visitors to Montana but wildlife can also decrease profitability and tolerance of local agricultural businesses, particularly livestock operations. While livestock losses have been minimal in southwest Montana, averaging 5 depredations per year from 2002-2012, the number of losses could increase as bears move farther outside of the Recovery Zone into private agricultural lands.

Since there are overlapping agency jurisdictions (USFWS, USFS, NPS, DNRC, and BLM) and associated agency plans for resource and wildlife management within Montana, there are some cumulative impacts to grizzlies and the humans that live, work, and recreate in southwest Montana. With the implementation of this proposed grizzly bear management plan, ongoing management of the species will continue to seek a balance between the habitat needs of grizzlies and humans in the area. An expansion of the grizzly bear population in the future may impact future land management, agency travel plans or agency projects. Furthermore, a great presence of grizzlies in an area may impact land use decisions by county officials. What these changes may be in the future is difficult to predict at this time, however past management changes have reflected the changing federal status of grizzlies. Any future changes to state or federal resource plans would be subjected to public review through either MEPA or NEPA processes.

The proposed southwestern management plan’s strategies are designed to work in harmony with the department’s grizzly bear management plan for western Montana as grizzlies continue to move across western Montana. This will ensure consistency of acceptable actions for the management of the species across its range.

FWP’s proposed management plan for grizzlies in southwestern Montana is just one of the many resource management plans that will assist in the protection of grizzly bear habitat and conservation of the species in the coming years.

FWP does not believe there are secondary or cumulative impacts of grizzly bear management to any of the following: water quality, quantity, and distribution; geology; soil quality, stability, and moisture; vegetation cover, quantity and quality; aesthetics; air quality; unique, endangered, fragile, or limited environmental resources; historical and archaeological sites; demands on environmental resources of land, water, air and energy; social structures and mores; cultural uniqueness and diversity; quantity and distribution of employment; distribution and density of population and housing; demands for government services; industrial and commercial activity; locally adopted environmental plans and goals; and other appropriate social and economic circumstances.

Preparers, Agencies, or Individuals Who were Consulted or Contributed Towards Preparation of the Final EIS and the Public Involvement Process

FWP's Lauri Hanauska-Brown and Kevin Frey were the primary authors of this document with oversight by Howard Burt, Rebecca Cooper, Quentin Kujala, Ken McDonald, Pat Flowers, and Ray Mule. Many additional FWP staff persons reviewed and edited drafts of this document including Shawn Stewart, Justin Gude, Jeremiah Smith, and Stephanie Adams. FWP's Adam Messer, Dan Tyers with the USFS, Mark Haroldson and Frank van Manen with the IGBST, Dan Bjornlie with Wyoming Game and Fish, and Chris Servheen and Rebecca Shoemaker with the USFWS all provided editing and technical assistance throughout document preparation.

FWP received an invitation by members of the Center for Biological Diversity, Defenders of Wildlife, Endangered Species Coalition, Greater Yellowstone Coalition, Natural Resources Defense Council, and Sierra Club to meet and discuss formulation of this plan in March 2013. FWP honored this invitation and listened to the groups suggestions.

GLOSSARY

APHIS – Animal Plant and Health Inspection Service
ARM - Administrative Rules of Montana
BLM - Bureau of Land Management
BMU - Bear Management Unit
CEM - Cumulative Effects Model
CMA - Conservation Management Area
COY - Cubs of the Year
CS - Conservation Strategy
DLP - Defense of Life or Property
DNA - Deoxyribonucleic acid -- the molecule that encodes genetic information
DNRC - Department of Natural Resources and Conservation
DOT - Department of Transportation
EIS - Environmental Impact Statement
ESA - Endangered Species Act
FCOY - Females with Cubs of the Year
FWP - Montana Fish, Wildlife & Parks
GYA - Greater Yellowstone Area
IGBC - Interagency Grizzly Bear Committee
IGBST - Interagency Grizzly Bear Study Team
MCA - Montana Codes Annotated
MEPA - Montana Environmental Policy Act
MOA - Memorandum of Agreement
MOU - Memorandum of Understanding
NEPA - National Environmental Policy Act
PCA - Primary conservation area or the designated Recovery Zone plus a 10 mile buffer
PEIS - Programmatic Environmental Impact Statement
USFS - United States Forest Service
USFWS - United States Fish & Wildlife Service
WMA - Wildlife Management Area
WS – Wildlife Services
YNP - Yellowstone National Park

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APPENDICES

APPENDIX A: Memorandum of Understanding between Montana Fish, Wildlife and Parks and US Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services regarding cooperative wildlife damage control program for grizzly bears, gray wolves, black bears, and mountain lions in the state of Montana

APPENDIX B: Bee Bear Policy Guidelines for Black Bears

APPENDIX C: Memorandum of Agreement for cooperative law enforcement between the US Fish and Wildlife Service and Montana Fish, Wildlife and Parks

APPENDIX D: Summary of Public Comments

See FWP webpage for Appendices:
http://fwp.mt.gov/fishAndWildlife/management/grizzlyBear/grizEis.html

Appendix I. Wyoming Grizzly Bear Management Plan

Wyoming Grizzly Bear Management Plan

Prepared by
Wyoming Game and Fish Department

Approved by
Wyoming Game and Fish Commission
May 11, 2016

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LIST OF ACRONYMS AND ABBREVIATIONS

APA	Wyoming Administrative Procedures Act
BMU	Grizzly Bear Management Unit
BOA	Grizzly Bear Observation Area
CFR	Code of Federal Regulations
Commission	Wyoming Game and Fish Commission
COY	Cubs of the Year
Department	Wyoming Game and Fish Department
DMA	Demographic Monitoring Area
DPS	District Population Segment
ESA	Endangered Species Act
FR	Federal Register
GTNP	Grand Teton National Park
GYA	Greater Yellowstone Area
GYE	Greater Yellowstone Ecosystem
ICST	Interagency Conservation Strategy Team
IGBC	Interagency Grizzly Bear Committee
IGBST	Interagency Grizzly Bear Study Team
LCS	Large Carnivore Section
MOA	Memorandum of Agreement
PCA	Primary Conservation Area
Study Team	Interagency Grizzly Bear Study Team
The ACT	Endangered Species Act of 1973
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
WGFC	Wyoming Game and Fish Commission
WGFD	Wyoming Game and Fish Department
WRR	Wind River Reservation
YES	Yellowstone Ecosystem Subcommittee
YGCC	Yellowstone Grizzly Coordinating Committee
YNP	Yellowstone National Park

FOREWORD

The Yellowstone Ecosystem Subcommittee (YES) of the Interagency Grizzly Bear Committee (IGBC) produced the original *Draft Conservation Strategy* for the grizzly bear (*Ursus arctos*) population in the Greater Yellowstone Area (IGBST 2000). That document outlined a cooperative management strategy state and federal agencies would implement for post-delisting management of the Greater Yellowstone Area (GYA) Distinct Population Segment (DPS) of grizzly bear. The U.S. Fish and Wildlife Service (USFWS) determined completion of such a plan, and a commitment to implement it, were necessary to delist the GYA DPS of grizzly bear.

During the spring of 2000, at the request of the state members of the IGBC, the governors of Idaho, Montana, and Wyoming appointed a 15-member citizen roundtable to review the *Draft Conservation Strategy* (IGBC 2000). The roundtable reached consensus on 26 recommendations provided for the governors' consideration in response to the *Draft Conservation Strategy*. The group also recommended the 3 states develop state plans addressing management in areas outside the Primary Conservation Area (PCA; Fig. 1) to:

a. Ensure the long-term viability of grizzly bears and preclude the need for re-listing;
b. Support expansion of grizzly bears beyond the PCA, in areas that are biologically suitable and socially acceptable for grizzly bear occupancy; and
c. Manage grizzly bears as a game animal – including allowing regulated hunting when and where appropriate.

Public comments on the *Draft Conservation Strategy* were reviewed and analyzed in 2000. YES ultimately developed a *Final Conservation Strategy* (ICST 2007), approved and released by the USFWS in 2007 (USFWS 2007a).

The Wyoming Game and Fish Department (WGFD or Department) developed and released a draft state management plan for public review during the summer of 2001. Over 8,000 written comments were received. In addition, the Department contracted an independent research firm to conduct a survey of Wyoming residents' attitudes related to grizzly bear management and conflict issues (WGFD 2001). Public input and survey results were considered in developing a final Wyoming Grizzly Bear Management Plan approved by the Wyoming Game and Fish Commission (WGFC or Commission) in 2002, and amended in 2005 (WGFD 2005). The Wyoming Grizzly Bear Management Plan is available online (https://wgfd.wyo.gov/WGFD/media/content/PDF/Wildlife/WYGRIZBEAR_MANAGEMENTPLAN.pdf) and the survey report can be requested from the Department's Office of the Director, 5400 Bishop Blvd., Cheyenne, WY 82009.

The 2016 update to the Wyoming Grizzly Bear Management Plan (this plan) is based on current U.S. Fish and Wildlife Service grizzly bear demographic monitoring and recovery criteria (Appendix I), and covers all areas under state management jurisdiction: the entire state of Wyoming excluding Yellowstone National Park (YNP), Grand Teton National Park (GTNP), and Tribal lands within the Wind River Reservation (WRR).

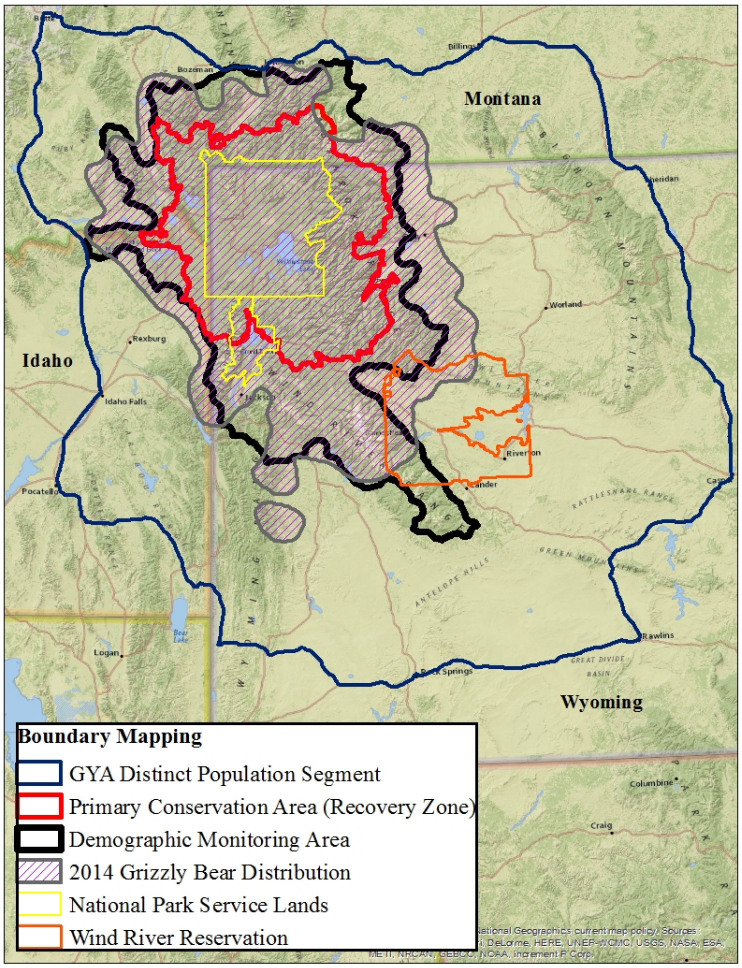

Fig. 1. Management and jurisdictional boundaries referenced throughout this plan.

The GYA DPS of grizzly bear was first delisted in 2007. Litigation immediately ensued and in 2009, threatened species status was restored under the Endangered Species Act (ESA). This reversal was due primarily to a Montana District Court's opinion that "the Service failed to articulate a rational connection between the scientific data and its conclusion that changes in whitebark pine production are not likely to impact the Yellowstone grizzly to the point where it is likely to become endangered within the foreseeable future . . ." [D.C. No. 9:07-cv-00134-DWM OPINION]. In light of this ruling, the Interagency Grizzly Bear Study Team (IGBST or Study Team) completed a comprehensive analysis demonstrating that reductions in whitebark pine have not negatively impacted grizzly bears on a population scale, and any reduction of the population growth rate is a response to density dependent factors indicative of a wildlife population approaching its environmental carrying capacity (Bjornlie et al. 2014a, van Manen et al. 2014, and van Manen et al. 2015). Updated demographic information from these studies has also been incorporated into a *Draft Revised Supplement to the Grizzly Bear Recovery Plan* (USFWS 2013) as well as the corresponding state management plans. The most current science and technical information pertaining to grizzly bear recovery and management are incorporated into this plan. The management plan is adaptive in nature and additional knowledge on GYA DPS grizzly bears gained through research, management experience, and/or public input (e.g. improved population estimation methodologies and conflict management techniques) may warrant future updates.

After the grizzly bear is removed from its listed status under the ESA, state wildlife agencies and tribes will assume management authority and lead roles for managing the species. This plan, in conjunction with applicable Wyoming statutes and Commission regulations, shall serve as the State's regulatory mechanisms (Appendix II) assuring a recovered population of grizzly bears is sustained into the foreseeable future.

It is the objective and policy of the Department and the Commission to maintain traditional land uses and public recreation throughout the Demographic Monitoring Area (DMA – Fig. 1) while assuring those uses are compatible with, and do not threaten the GYA DPS of grizzly bear. This approach enables traditional land uses to continue, which builds local public support for a State-managed grizzly bear population. Public support is key to the long-term welfare and sustainability of the grizzly bear population. This plan will accomplish the goal of maintaining a recovered population and public support by employing the best available science to implement the management strategies described herein, in an adaptive framework.

INTRODUCTION AND HISTORY

Many consider the grizzly bear an iconic symbol of wilderness and wild places. In the Wyoming portion of the Greater Yellowstone Ecosystem (GYE), balancing grizzly bear recovery and management with other uses of the land presents many unique challenges. The Department acknowledges grizzly bears have unique social and ecological values. The species is an important attribute of a landscape rich in wildlife viewing opportunities that contribute to a regional tourism-based economy; conversely, grizzly bears also come into conflict with humans and can impact their livelihood. The Department developed this plan in recognition that diverse opinions and viewpoints exist with respect to grizzly bear management. The plan will serve as the guiding document for sustaining a recovered grizzly bear population that fulfills a range of social and ecological values in the GYE.

The purpose of this plan is to outline the adaptive framework that will be used to manage and sustain a recovered population of grizzly bears in Wyoming. The plan, along with enabling state statutes and regulations, shall constitute Wyoming's core regulatory mechanism for post-delisting management of grizzly bears. The grizzly bear was originally listed as "threatened" under the Endangered Species Act in 1975 (Fed. Reg. 40:145,31734-31736). Since then, recovery goals, management criteria, and monitoring protocols have been largely defined by the USFWS through the original *Grizzly Bear Recovery Plan* (USFWS 1993), *Interagency Grizzly Bear Guidelines* (Mealey 1986), *Final Conservation Strategy* (ICST 2007, USFWS 2007a), and *Draft Revised Supplement to the Grizzly Bear Recovery Plan* (USFWS 2013).

Section 4.(f)(1)(B)(ii) of the Endangered Species Act of 1973 (the ACT) states:

"*The Secretary shall develop and implement plans (hereafter in this subsection referred to as recovery plans) for the conservation and survival of endangered species and threatened species listed pursuant to this section, unless he finds that such a plan will not promote the conservation of the species. The Secretary, in developing and implementing recovery plans, shall, to the maximum extent practicable …incorporate in each plan …objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list.*"

The 1993 *Recovery Plan* identified specific criteria which when met would result in delisting the GYA DPS of grizzly bears. As additional data and technical information warranted, recovery criteria were updated in the 2000 *Draft Conservation Strategy* (USFWS 2003); the 2007 *Final Conservation* Strategy (ICST 2007, USFWS 2007a); and again in the 2013 *Draft Revised Recovery Plan Supplement* (USFWS 2013). Updated recovery and post-delisting management criteria are now incorporated into the *Final Revised Recovery Plan Supplement* (USFWS 2016a) and *Revised Conservation Strategy* (USFWS 2016b) based on the accumulated knowledge and experience gained from more than 40 years of grizzly bear monitoring, research and management.

The original and current demographic and habitat-based recovery criteria have been met for multiple years. After recovery criteria are met, a prerequisite for delisting requires that the USFWS demonstrate the 5 factors listed in Section 4(a)(1) of the ACT no longer threaten the GYA DPS of grizzly bear. The 5 factors are: "(A) the present or threatened destruction, modification, or curtailment of [the species'] habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting [the species'] continued existence." In order to demonstrate existing regulatory mechanisms will not threaten GYA DPS grizzly bears (referred to as factor D in the ESA), the states must prepare post-delisting management plans. This plan provides the framework for post-delisting management of grizzly bears in Wyoming and a mechanism for public input to State management in accordance with the Wyoming Administrative Procedures Act (APA) [W.S. 16-3-107 through 112]. After the GYA DPS of grizzly bear is delisted, the Department will assume primary authority for grizzly bear management throughout Wyoming, except on National Park Service lands within YNP and GTNP, and on Tribal lands of the WRR.

The original Wyoming Grizzly Bear Management Plan (WGFD 2002) was based on criteria outlined in the first *Draft Conservation Strategy* released two years prior (USFWS 2000). That earlier management plan was developed in preparation for delisting as the grizzly bear population originally neared recovery goals set forth in the Service's *Draft Recovery Plan*. In 2005, the Department updated the management plan (WGFD 2005) prior to release of the *Final Conservation Strategy* in 2007 (USFWS 2007a). However, the 2005 plan did not incorporate some of the updated demographic criteria and monitoring protocols ultimately adopted in 2007. The 2016 plan incorporates the *Final Recovery Plan* (USFWS 2016a), *Conservation Strategy* (USFWS 2016b) criteria, and post-delisting adaptive management framework agreed upon by the USFWS and the states of Idaho, Montana, and Wyoming. In addition, the states have entered into a Memorandum of Agreement (MOA; Appendix I) committing to manage the GYA grizzly bear population in accordance with the adaptive framework outlined in Table 1 and Appendix I of this plan. The adaptive framework includes an annual process for reviewing and allocating allowable mortality. The states fully understand and accept that coordination must continue after delisting to assure pertinent information and data are shared and effectively utilized to sustainably manage the GYA DPS of grizzly bear.

Scientists and managers have delineated a Demographic Monitoring Area (DMA) based on suitable grizzly bear habitat to replace the outdated "Conservation Management Area" in the GYA (Fig. 1). In order to assure population trajectory and mortality data are reported consistently, YES and IGBC unanimously voted to incorporate the DMA concept. The PCA or "Recovery Zone" is encompassed within the exterior boundary of the DMA, but the larger DMA is the geographic area where state wildlife agencies will actively monitor the grizzly bear population and manage for its long term viability (for further information, see Population Monitoring and Management subsection, page 12). The DMA boundaries are based on biological criteria whereas the former "Conservation Management Area" was based predominantly on easily identifiable infrastructure and administrative boundaries such as roads/highways, county lines, etc. area (USFWS 2016b).

ADAPTIVE MANAGEMENT CRITERIA

The adaptive framework for post-delisting management (Appendix I) is designed to ensure the GYA DPS of grizzly bears is maintained at or above current demographic recovery criteria. Three basic grizzly bear life history parameters are monitored as recovery criteria: (1) sufficient reproduction to offset mortality to ensure population viability; (2) adequate distribution of breeding females throughout the area; and (3) an annual evaluation of total human-caused mortality that will ensure a recovered population (*Final Recovery Plan* 2016, *Draft Final Conservation Strategy* 2016). Specific management objectives for the Wyoming grizzly bear population will be established by the Commission. Management objectives will ensure the population is managed within the range stipulated in Demographic Recovery Criterion 3 and will ensure Demographic Recovery Criterion 1 and 2 continue to be met or exceeded. It is important to note that multiple layers of protection are afforded by the demographic criteria. While the Commission may set a specific population objective within the range specified by Crierion 3, the other criteria will also determine the objective that is ultimately adopted. Objectives will be adjusted as necessary to assure all three criteria are met. The combination of a conservative population estimate, highly regulated discretionary mortality, the intensive collection and analysis of grizzly bear demographic information and the conservative mortality limits outlined in the demographic recovery criteria ensure there are multiple and layered checks and balances that serve to ensure the maintenance of a recovered grizzly bear population.

In March of 2016, the USFWS proposed updated Demographic Recovery Criteria as listed below:

- Demographic Recovery Criterion 1: Maintain a population size of at least 500 bears and at least 48 females with cubs in the demographic monitoring area (DMA) as indicated by methods established in published, peer-reviewed scientific literature and calculated by the IGBST using the most updated protocol as posted on their website. The current method (2016) used to estimate population size is the model-averaged Chao2 method. If the estimate of total population size drops below 500 in any one year, or counts of females with cubs go below 48 unduplicated females with cubs in 3 consecutive years, this criterion will not be met. The population estimate and counts of unduplicated females with cubs will be calculated by the IGBST using data obtained within the DMA.
- Demographic Recovery Criterion 2: Sixteen of 18 grizzly bear management units (BMUs; Fig. 2) within the Recovery Zone must be occupied by females with young, with no 2 adjacent bear management units unoccupied, during a 6-year sum of observations. A 6-year sum of observations means a BMU is considered occupied if it has a female with young in at least 1 year of each 6-year period. The GYA DPS of grizzly bears will be managed to meet this criterion. Should this criterion not be met for 3 consecutive years, the IGBST will initiate a Biology and Monitoring Review to inform an appropriate management response. This criterion is important as it ensures that reproductive females occupy the majority of the Recovery Zone and are not concentrated in one portion of the ecosystem.

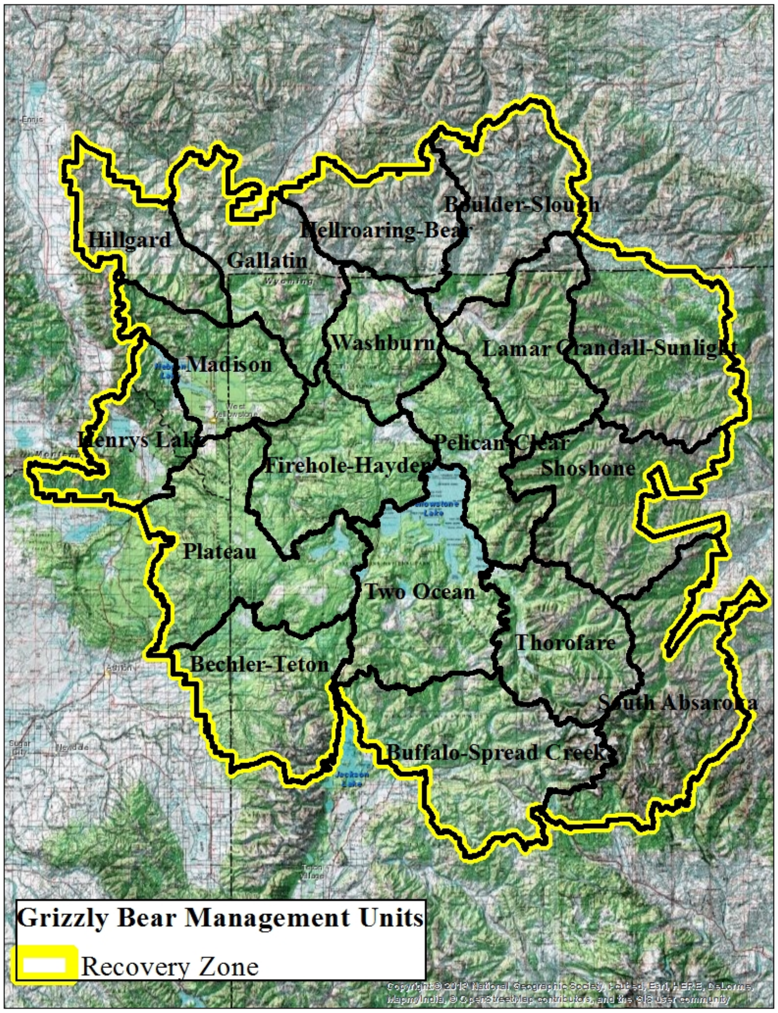

Fig. 2. Current grizzly bear management units (BMUs; *n* = 18) within the primary conservation area (PCA).

- <u>Demographic Recovery Criterion 3</u>: Maintain the population around the 2002-2014 Chao 2 modeled average ($\overline{X}$= 674; 95% CI = 600-747; 90% CI = 612-735) by maintaining annual mortality limits for independent females, independent males, and dependent young as shown in Table 1. If mortality limits are exceeded for any sex/age class for three consecutive years and any annual population estimate falls below 612 (the lower bound of the 90% confidence interval), the IGBST Study Team will produce a Biology and Monitoring Review to inform the appropriate management response. If any annual population estimate falls below 600 (the lower bound of the 95% confidence interval), this criterion will not be met and there will be no discretionary mortality, except as necessary for human safety.

Table 1. Total mortality rates used to establish annual mortality limits for independent females, independent males, and dependent young grizzly bears inside the DMA (from USFWS proposed 2016 Demographic Recovery Criteria).

	Annual Grizzly Bear Population Estimate		
	≤674	675-747	>747
Total mortality rate for independent FEMALES.	≤7.6%	9%	10%
Total mortality rate for independent MALES.	15%	20%	22%
Total mortality rate for dependent young.	≤7.6%	9%	10%

POPULATION STATUS

The GYA DPS of grizzly bears exceeded the demographic recovery criteria many years ago. Summaries of the GYA DPS recovery progress and its current status follow.

Demographic Recovery Criterion 1 is met with a minimum population of at least 500 grizzly bears within the DMA. Fig. 3 depicts annual population estimates with an overall increasing population since 2000. The GYA DPS of grizzly bear has exceeded this criterion since at least 2002. The Commission will establish management objectives that ensure this recovery criterion continues to be exceeded. The annual documentation of independent female grizzly bears with cubs is a primary driver of the current Chao2 population estimation technique. This criterion has been achieved since at least 2004; however it should be noted that using females with cubs as a specific recovery criterion is problematic in that is merely a portion of the data used to derive a population estimate and also does not account for the future potential of incorporating new methodologies to estimate population size. It should be noted that currently with the most updated best available science, 48 females with cubs equates to approximately 600 grizzly bears. In addition, achievement of Recovery Criterion #3 ensures the population remains above 500 grizzly bears within the DMA.

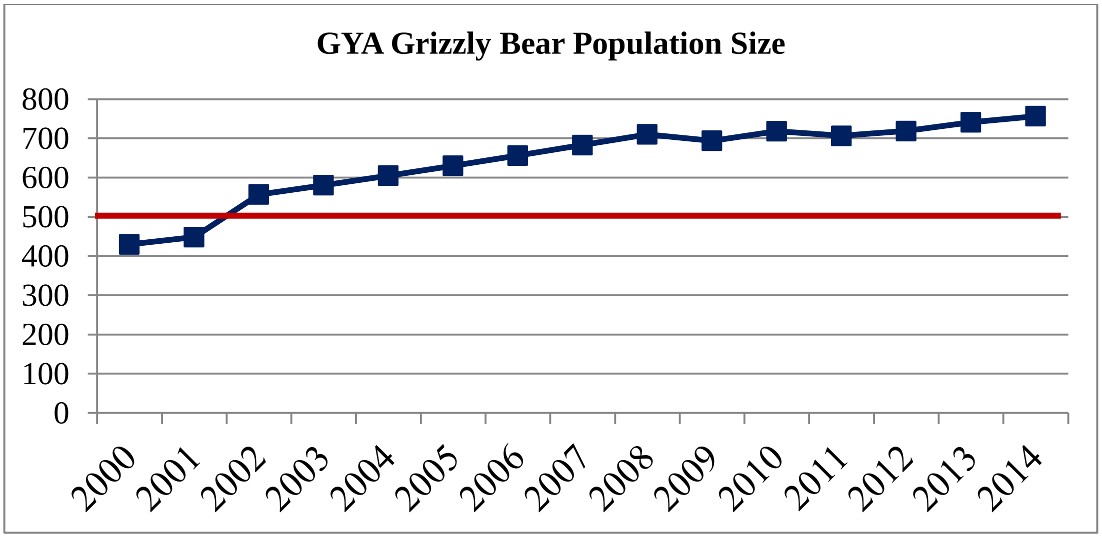

Fig. 3. Annual estimates of the GYA DPS based on the Chao2 estimator (with updated vital rates and ratios). Solid red line represents the minimum population size of 500 grizzly bears required to meet demographic Recovery Criterion 1.

Demographic Recovery Criterion 2 is a distributional criterion that requires 16 of 18 BMUs within the PCA must be occupied by females with young, with no 2 adjacent BMUs unoccupied, during a 6-year sum of observations. Fig. 4 illustrates BMU occupancy by females with young within the PCA since 1996. Fig. 5 demonstrates the increase in occupancy between two 5-year periods (2001-2006 and 2007-2012), and also depicts the expansion outside the PCA since 2006. This recovery criterion has been met or exceeded since 1999.

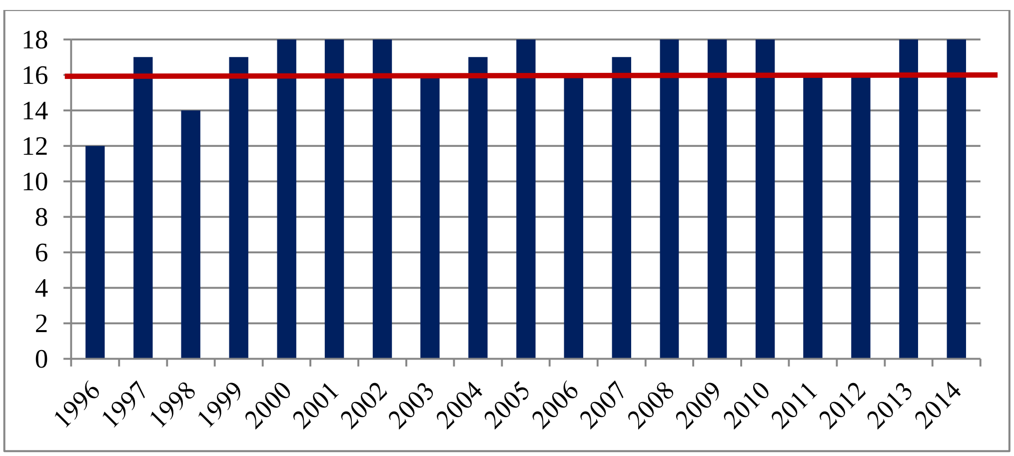

Fig. 4. Annual numbers of BMUs occupied by females with young in the PCA.

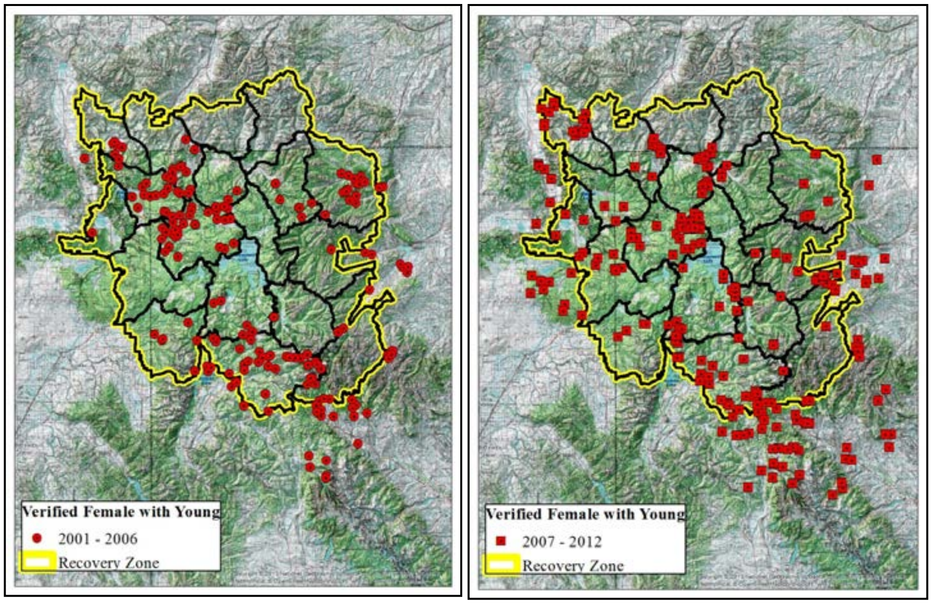

Fig. 5. Observations of radio-marked female grizzly bears with young during two 5-year intervals (18 BMUs are outlined in black).

Demographic Recovery Criterion 3 establishes that grizzly bear mortalities within the DMA should not exceed population-based thresholds established for identified age and sex cohorts of grizzly bears. The mortality limits in the adaptive framework (Table 1) are calibrated to maintain the GYA grizzly bear population at least within a range of 600-747. Figs. 6 and 7 depict annual mortality rates of independent-aged male and female grizzly bears in relation to annual mortality thresholds.

Conservative mortality limits allow for population growth if the population declines below 674 and even more conservative limits would be applied should the population decline below 600. The Commission will establish mortality limits based on their population management objectives to at least within the limits established in Appendix I and the Recovery Criteria. Mortalities will be counted and reported annually based on data obtained from within the DMA. Total mortality estimates of independent males and females will include unreported/undocumented mortalities based on the method described by Cherry et al. (2002). Natural mortalities are estimated based on survival data obtained from representative samples of radio-collared grizzly bears. If the grizzly bear population within the DMA is less than 674 and any one of the mortality limits specified at that level (7.6% for independent females or dependent young, 15% for independent males) is exceeded for 3 consecutive years and the population falls below 612, the IGBST will initiate a Biology and Monitoring Review to inform an appropriate management response.

Federal law allows the take of any grizzly bear that is an immediate threat to human safety. Authorized state or federal agencies continue to take grizzly bears chronically involved in livestock depredations, property damage, or threatening public safety. These are classified as management removals. From 1990-2000, management removals and illegal take averaged 1.0 grizzly bear per year. An annual average of 2.6 grizzly bears was taken by the public in self-defense situations during the same time period (Fig. 8). As the grizzly bear population has grown and expanded into areas outside the Recovery Zone, and in some instances outside the DMA, the Department has documented an increase in aggressive encounters, self defense mortalities, and management removals. From 2001-2014, the Department documented annual averages of 5.1 grizzly bears taken in self defense, and 7.1 grizzly bears removed for management reasons in Wyoming (Fig. 8).

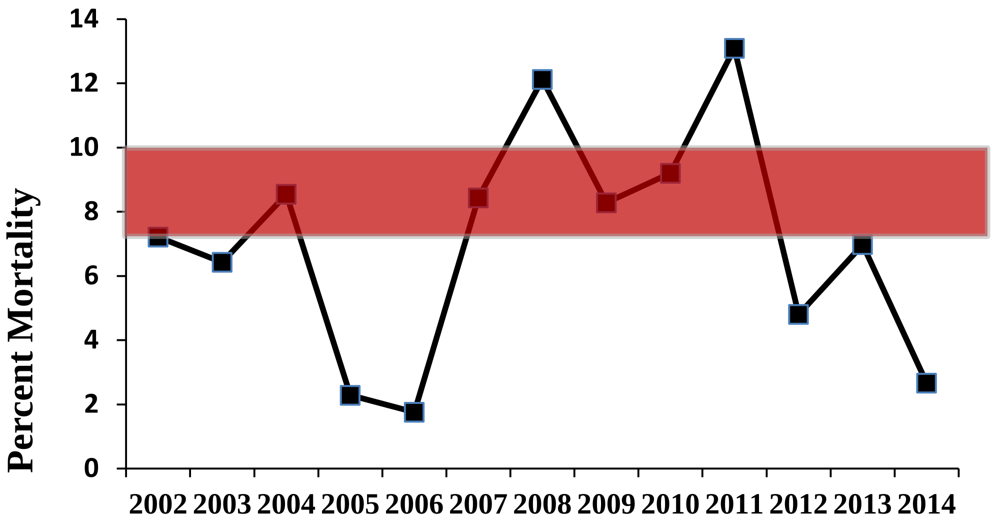

Fig. 6. Estimated annual mortalities of independent aged (≥ 2 years old) female grizzly bears in the GYA DPS. Shaded portion of chart depicts the allowable mortality range (Table 1). Refer to IGBST (2012) for description of methods used to estimate total mortality and numbers of independent females.

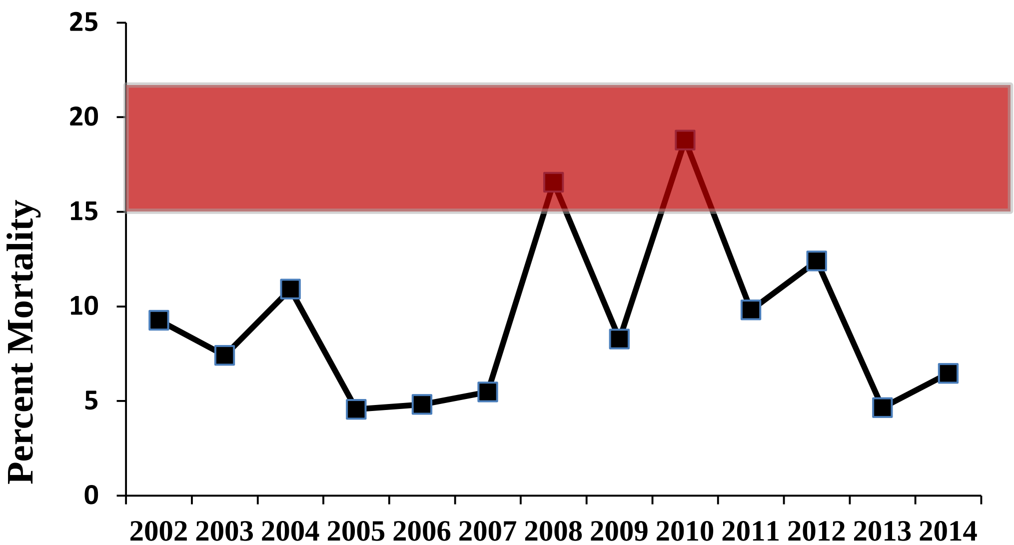

Fig. 7. Estimated annual mortalities of independent aged (≥ 2 years old) male grizzly bears in the GYA DPS. Shaded portion of chart depicts the allowable mortality range (Table 1). Refer to IGBC (2012) for description of methods used to estimate total mortality and numbers of independent males.

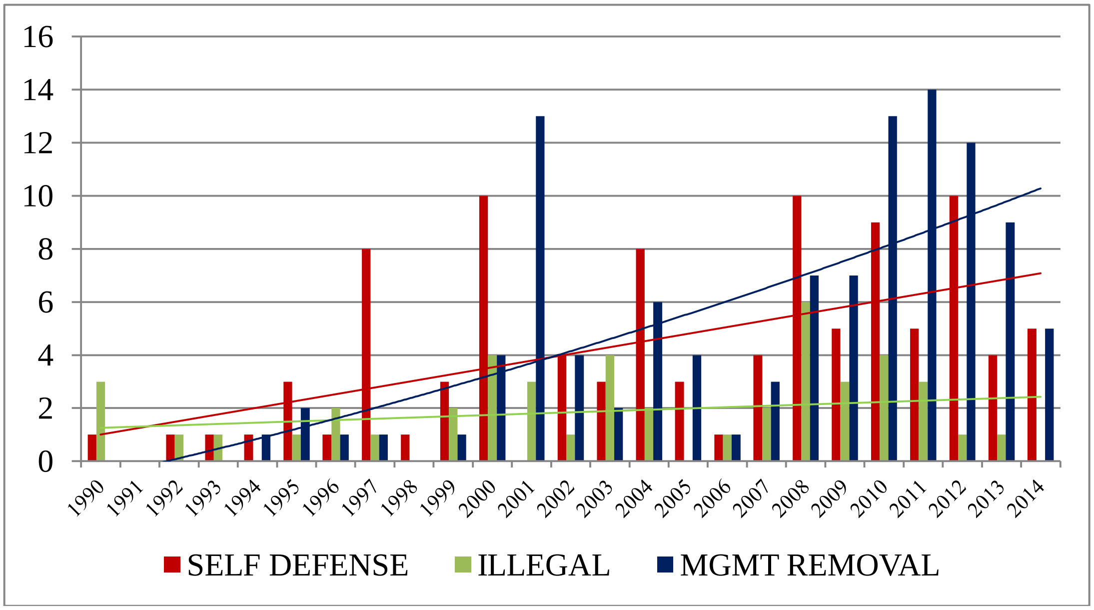

Fig. 8. Annual grizzly bear mortalities attributed to human causes in Wyoming. Linear trend lines illustrate changes in mortality sources through time.

REGULATIONS

History

The state did not devote much attention to grizzly bear management during the early part of the 20th century. The 1899 *Game and Fish Laws of Wyoming* made no mention of grizzly bears. The 1903 *State Game Warden Report* simply stated it was a misdemeanor to hunt, kill, or trap grizzly bears upon any of the National Forest Reserves in the state, except during the open game (ungulate) seasons. In 1937, black bears and grizzly bears were classified as game animals on most national forests and in the Black Hills; however they remained classified as predatory animals throughout the remainder of the state. Wildlife classified as “game animals” could not be trapped or hunted with dogs without approval of the Chief Game Warden or local game warden. Hunting seasons for black and grizzly bears generally corresponded with elk or deer hunting seasons. Any person holding an elk and/or deer license could kill one bear of either species.

Current Wyoming Statutes and Wyoming Game and Fish Commission Regulations

Wyoming Statute (W.S.) 23-1-101 (a) (xii) (A) classifies the grizzly bear as a "trophy game animal." This classification empowers the Commission to regulate take of grizzly bears. State regulatory mechanisms authorizing the Commission to manage grizzly bears are summarized in Appendix II.

MANAGEMENT STRATEGIES

Large Carnivore Section

The Department established the Large Carnivore Section (LCS) to effectively manage grizzly bears and other large carnivores in Wyoming. The LCS works with regional wildlife managers, information /education personnel and agency leadership to ensure the strategies and directives in this plan are executed. With respect to grizzly bears, LCS's primary responsibilities include monitoring and management of a recovered grizzly bear population, promptly addressing human-grizzly bear conflicts, participation in research that informs management, and conducting appropriate planning based on the best available science. Additionally, the LCS conducts public education and outreach through a variety of forums including the Bear Wise Wyoming Program. Outreach and education efforts are designed to proactively prevent conflicts, address public safety issues, and provide general education about grizzly bear ecology and management. The LCS works closely with all Department personnel to ensure agency efforts are coordinated and consistent with this plan.

The following sections address six key components of the Department's grizzly bear management program.

Occupancy

The distribution of grizzly bears in Wyoming currently encompasses all of YNP and GTNP, and extends east of the Absaroka and Owl Creek Mountains, and south into the Wind River Range and the Wyoming Range (Fig. 9).

Habitats that are biologically and socially suitable for grizzly bear occupancy are the portions of northwestern Wyoming within the DMA that contain large tracts of undisturbed habitat, minimal road densities, and minimal human presence (Fig. 9). Suitable habitat is the area capable of sustaining a viable grizzly bear population now and into the future, based on findings of the IGBST. The DMA is based on the United States Fish and Wildlife Service (USFWS) biological suitability model (USFWS 2007b) with additional consideration given to data on grizzly bear occupancy, mortality, and social tolerance (IGBST 2012). The USFWS provides a comprehensive discussion of how suitable habitat is delimited at: http://www.fws.gov/mountain-prairie/es/species/mammals/grizzly/BackgroundOnUSFWS_SuitableHabitatMarch2013.pdf.

The suitable habitat areas are within the geographic area commonly known as the Greater Yellowstone Area (GYA). For purposes of this plan, GYA and GYE are geographically synonymous. The Wyoming portion of the GYA includes parts of Park, Hot Springs, Fremont, Teton, Sublette and Lincoln counties. The GYA includes all lands within the Shoshone, Bridger-Teton, and Caribou-Targhee National Forests, YNP, GTNP, the National Elk Refuge, and the western portion of the WRR. It also incorporates private, state and BLM lands within and adjacent to the above mentioned national forests (Fig. 9).

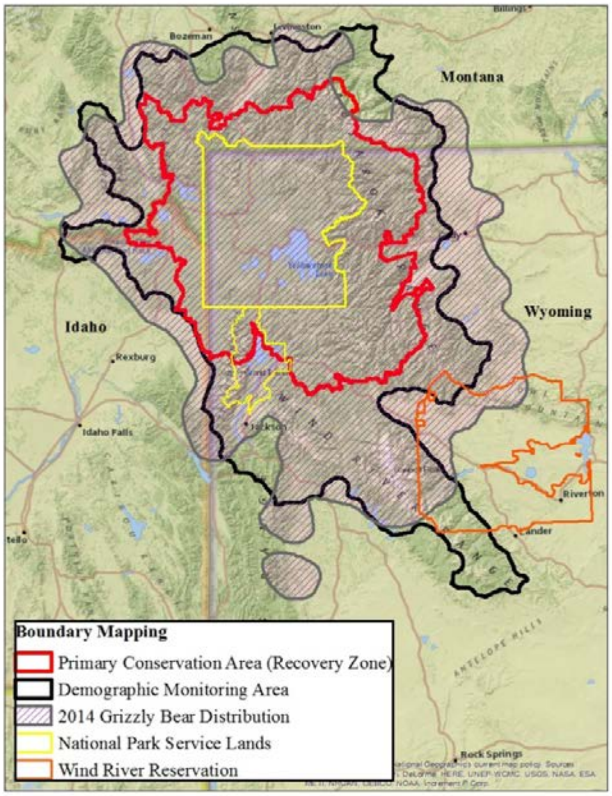

Fig. 9. Grizzly bear distribution in Wyoming as of 2014 (adapted from Bjornlie et al 2014b).

Areas outside the DMA, including isolated mountain ranges such as the Bighorns, Sierra Madres, Snowy Range, Laramie Range, and the Black Hills, do not contain sufficient amounts of suitable habitat (as defined by the IGBST) needed to meet essential requirements for occupancy by grizzly bears. The potential for conflicts is extraordinarily high and resulting mortality levels would be too great to sustain a grizzly bear population in those locations.

A recovered grizzly bear population will be maintained within the DMA. The State will apply more conservative management policies within portions of the PCA outside the national parks to assure the demographic distribution criterion (at least 16 of 18 BMUs occupied by females with young over a 6-year sum of observations) is met. Management flexibility will be greater outside the PCA boundary. However overall mortality within the DMA should not exceed the mortality limits prescribed in the adaptive management framework (Table 1, Appendix I) and the updated *Conservation Strategy* (USFWS 2016b).

Human activities and traditional land uses outside the DMA would contribute to a higher frequency of human-grizzly bear conflicts potentially resulting in a lower public tolerance for grizzly bears. Accordingly, those areas identified outside the DMA where the potential for conflict is high will generally be managed to proactively discourage these occurrences from happening (see Conflict Management page 20). Public hunting seasons may also be used to limit grizzly bear occupancy outside the DMA, but will be regulated to assure overall population and distribution goals continue to be met within the DMA.

Grizzly bears will inevitably continue to disperse outside the DMA due to success of the grizzly bear recovery program, and associated increase in abundance and distribution. However, this does not imply that the Department will manage for grizzly bear occupancy in these areas. The DMA identifies the areas containing biologically suitable and socially acceptable habitats where we are committed to maintain a recovered grizzly bear population. Grizzly bears occupying areas outside the DMA contribute little to population maintenance due to high frequency of conflicts and lower reproduction compared to grizzlies within the DMA. Although grizzly bears will not be actively discouraged from occupying all areas outside the DMA, management decisions will focus on minimizing conflicts and may proactively limit occupancy where potential for conflicts or public safety issues are very high. It should also be noted that the areas lying beyond the DPS boundary are within the area where grizzly bears will remain listed as a threatened species under the Endangered Species Act.

Population Monitoring and Management

Reliable status and trend data are essential to effectively manage the GYA DPS of grizzly bear. Investigations are continually underway to refine population estimators and improve monitoring efficacy. The current population estimator is the model averaged Chao2 (Keating et al. 2002, IGBST 2005, Cherry et al. 2007) with updated vital rates (IGBST 2012, USFWS 2013). Because it is conservative and sensitive to changes in trend, the model averaged Chao2 estimator will continue to be used until a more accurate estimator is available. Improved data collection protocols and population analysis techniques may be implemented if they are demonstrated to be reliable, approved by the IGBST and the Yellowstone Grizzly Coordinating Committee YGCC, and reasonably cost-effective. All monitoring data will be compiled, analyzed and reported annually in grizzly bear job completion reports.

Population Monitoring

The Department has invested enormous fiscal and personnel resources to monitor and manage the GYA DPS of grizzly bears over a period of decades. Those efforts have included capturing many individual bears and fitting them with radio collars, collecting and analyzing biological samples, monitoring physiological condition, conducting radio telemetry and observation flights, monitoring food sources, and other aspects of grizzly bear ecology and general management activities of the Department. In recent years, annual costs of the Department's grizzly bear program have approached and exceeded the $2 million mark. After the GYA DPS of grizzly bears is delisted, the Department will continue to annually assess population trends, mortality, reproduction, distribution, and other factors to be considered in management decisions. Every bear captured by the Department represents an opportunity to gain additional insight into the overall health of the grizzly bear population. The Department will continue to collect biological samples (i.e., hair, tissue, and blood as applicable) for monitoring purposes. Cataloging biological samples will enable the Department to monitor the genetic diversity of the population, as well as provide valuable information related to condition, diet, and potential for disease prevalence.

Recent research evaluating genetic viability of GYE grizzly bears (Kamath et al. 2015) has demonstrated the effective population size (N_e) of the GYE grizzly bear population increased from 102 in 1982 to 469 in 2010, which is greater than four times the minimum effective population size needed to maintain genetic health (Miller and Waits 2003). According to the authors, the observed heterozygosity and current effective population size are sufficient to avoid inbreeding depression, and to reduce concerns regarding genetic viability of GYE grizzly bears (Kamath et al 2015). The Department will continue to collect genetic samples from grizzly bears (i.e., captures, reported mortalities, hair collected from rub trees) on an annual basis in order to evaluate potential changes in heterozygosity and overall genetic diversity of the population. Should genetic issues become a concern in the future, translocation of genetic material into the GYE DPS will be considered.

Data from radio-collared grizzly bears will continue to provide crucial information about distribution, movements, reproduction, mortality, habitat use, and home range size of grizzly bears. Movements of marked grizzly bears have been analyzed to map seasonal, annual, and lifetime home ranges, and to identify important seasonal habitats and foods, potential travel or linkage corridors, activity patterns, and den sites. Information obtained from a representative subset of the population has enabled managers to estimate survival rates for various demographic classes, age at first reproduction, rate of reproduction, and life expectancy. Over time these metrics can change as a function of habitat quality and population density, and must be continually monitored and calibrated to accurately estimate rate of change in the population. Information on causes of grizzly bear mortalities also informs management and assists with efforts to identify potential areas where additional attention may be needed.

Regular observation flights have been conducted in the GYA since the 1980s. Originally, the Recovery Zone was divided into 18 BMUs that served as the geographic basis for monitoring. As the grizzly bear population expanded, it was necessary to increase the area and number of units flown to effectively monitor the entire population. Grizzly Bear Observation Areas (BOAs) (Fig. 10) were established for this purpose (IGBST 2015). BOAs will be the geographic reference areas used for observation flights and other population monitoring efforts as well as for recording mortalities. In order to report data consistently and provide a basis for long-term trend evaluation, BOA boundaries are intended to remain fixed. However, some limited modifications may be considered to improve monitoring efficacy and accuracy. Female distributional data will continue to be reported based on the original 18 BMUs to address requirements of the demographic recovery criteria (USFWS 2013, 2016a, 2016b).

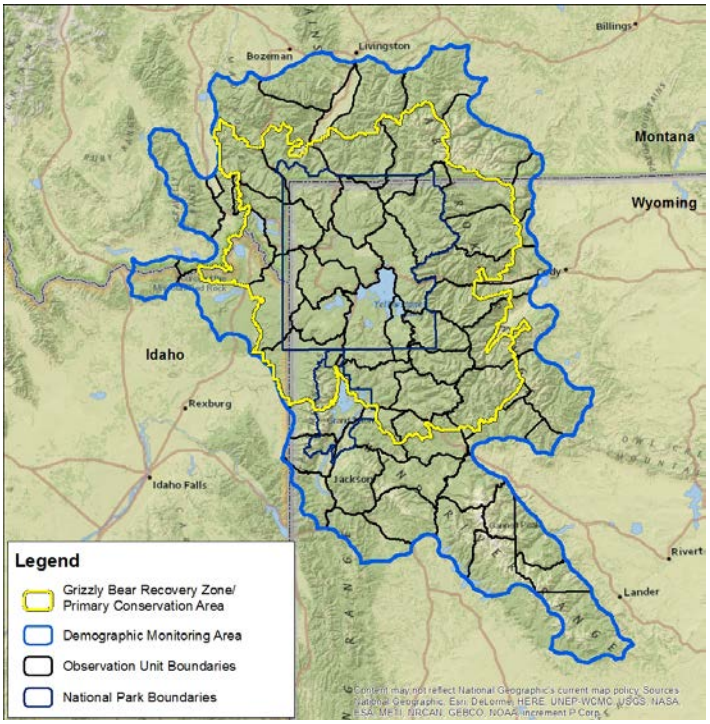

Fig. 10. Grizzly bear flight observation units (also called Bear Observation Areas – IGBST 2015) used to systematically monitor grizzly bears throughout the DMA.

All forms of mortality will be monitored for Wyoming grizzly bears. The Department will manage human-caused mortality to assure overall mortality limits for the DMA are not exceeded. Allowable discretionary mortality within the Wyoming segment of the GYA grizzly population will be determined annually based on demographic and monitoring information provided by the Department and the IGBST and the allocation process outlined in the tri-state MOA (Appendix I). The Commission will determine where to apply discretionary mortality within the state based on Commission established management objectives and recommendations from the Department and considering public comments. The Commission will ensure that distributional recovery criteria are met within the PCA. The Department will manage non-hunting sources of mortality through education, enforcement, and implementation of the conflict management guidelines (Appendix IV). Consultation with the appropriate state and federal agencies will continue to ensure management objectives for Montana, Idaho and the National Parks are not compromised.

Portions of the WRR are known to be occupied by grizzly bears. The WRR is located entirely outside the PCA and represents less than 5 percent of the DMA. The Department lacks management jurisdiction on Tribal lands, but will continue coordination with the Eastern Shoshone and Northern Arapaho Tribes to ensure our collective management actions sustain a recovered grizzly bear population. The Tribes are members of the YES (YGCC) and management of WRR grizzly bears is fully coordinated with the other agencies in the context of ecosystem-scale management. Upon delisting, Tribes will assume full authority to manage grizzly bears on Tribal lands.

Grizzly Bear Foods Monitoring

Grizzly bears are opportunistic omnivores capable of surviving in a variety of habitats (Craighead 1998) by utilizing a broad range of food items (Craighead and Mitchell 1982, IGBST 2013, Gunther et al. 2014). Changes in climate may affect regional vegetation, hydrology, fire regimes, and pathogen prevalence, which may in turn influence the abundance, range, and elevational distribution of foods consumed by GYA grizzly bears (Gunther et al. 2014). However changes in abundance of various food sources are not likely to negatively impact grizzly bears at the population scale due to their dietary plasticity (IGBST 2013, van Manen et al. 2014, van Manen et al. 2015). An in-depth dietary analysis revealed 266 different species from 200 genera and 4 kingdoms are consumed by grizzly bears in the ecosystem (Gunther et al. 2014), indicative of the grizzly bear's broad dietary flexibility (Gunther et al. 2014). Moreover, past changes in key food abundance resulting from the Yellowstone fires, cutthroat trout declines, and whitebark pine die-off were not associated with population-level responses by grizzly bears.

The Department will continue to participate in coordinated monitoring of grizzly bear food sources and will consult with land management agencies and private landowners regarding issues related to grizzly bear habitat protection, disturbance, enhancement and mitigation. The Department will continue to work closely with the USFS to assist in the monitoring of selected whitebark pine stands and army cutworm moth aggregation sites based on methodology implemented by the IGBST (IGBC 2000). Whitebark pine stands will be inventoried and monitored for seed production, tree health (i.e. tree mortality, evidence of blister rust, *Cornartium ribicola* and mountain pine beetle, *Dendroctonus ponderosae* infestation), and evidence of grizzly bear use. Grizzly bear use at existing and newly identified moth aggregation sites will also be monitored. The Department will continue to identify areas of interest related to grizzly bear diet in order to better understand and manage the population.

Hunting

Since the early 20th century, regulated hunting has played an instrumental role in the recovery and health of wildlife populations. Regulated hunting is not only a pragmatic and cost effective tool for managing populations at desired levels; it also generates public support, ownership of the resource, and funding for conservation as well as greater tolerance for some species such as large predators that may cause safety concerns and come in conflict with certain human uses.

Regulated hunting may be a component of the Department's grizzly bear management program. Hunting, along with other management tools, may be utilized to ensure the long-term conservation of grizzly bears in Wyoming by maintaining the population within a healthy, sustainable range and by potentially limiting occupancy of unsuitable habitats. Public take may also be directed, when appropriate, to areas with high frequencies of human-grizzly bear conflicts. If implemented, this strategy will evaluate the use of hunter harvest to replace some of the mortality that might otherwise result from agency take in conflict situations. Any proposed grizzly bear hunting seasons will be promulgated in a manner similar to that used for other trophy game species in Wyoming. Wildlife managers will consider population objectives, annual population data and trends, grizzly bear distribution information, species specific characteristics (i.e. reproductive rates and behavior) and habitat data to develop hunting season proposals.

Regulations governing grizzly bear management will be promulgated in conformance with the Wyoming Administrative Procedures Act (APA) and presented for Commission action each year. The APA mandates public review of all agency rulemaking. Initial proposals will be thoroughly reviewed and approved by the Department. The Commission will ultimately take formal action on the proposed seasons, either adopting as presented, or making modifications based on biological data and social concerns expressed by the public. Hunting regulations must also be promulgated in conformance with Wyoming Statutes governing legal methods of take. W.S. 23-3-109(a) prohibits use of dogs to take trophy game animals. (This statute directs the Commission to regulate the use of dogs to take mountain lions).

Female grizzly bears with dependent young as well as dependent young will be protected from hunter harvest. Hunting seasons may also be timed to reduce exposure of females to harvest. Early spring and late fall hunts tend to focus hunting pressure on males because females with young are more likely to be in dens at those times. Persons who draw a grizzly bear license will be required to participate in training on grizzly bear ecology, identification, and safety. In general, males are more exposed to harvest because they range more widely and are more likely to be encountered by hunters. At any given time, approximately 67 percent of independent females are accompanied by dependent young (WGFD 2014, IGBST Annual Report 2015). A regulation that prohibits take of females with young will functionally extend protection to approximately two-thirds of the adult females in the population. Protecting females will serve to focus regulated harvest on the male segment of the population.

If hunting seasons are promulgated, license allocation and mortality limits will be developed annually within geographically-defined hunt areas to attain an appropriate distribution of harvest, both within and outside the DMA. A great deal of interstate and interagency collaboration and communication will be incorporated into season planning processes. Hunting season structures will be evaluated and adaptively managed to achieve desired harvest results, thereby ensuring recovery criteria continue to be met.

Research and Monitoring

Applied research to develop more accurate and efficient population and/or density estimation techniques will continue to be a priority. The Department also has interest in research addressing how an intact large carnivore guild may directly and indirectly impact ungulate populations in northwest Wyoming. This research question has management, social and ecological implications. The Department will continue to evaluate interactions among grizzly bears, ungulates, and other large carnivores. There are also multiple questions related to efficacy of management strategies for population stabilization and conflict resolution. The GYA grizzly bear population affords unique research opportunities to address these types of questions from the perspective of a long-term dataset.

Increased abundance and expansion of grizzly bears within areas with differing land use patterns will afford unique opportunities to look at potential changes to survivorship and birth rate as well as habitat selection patterns outside the core recovery zone. In addition, managers will have the opportunity to evaluate how changes in the population may relate to anthropogenic influences on the landscape (e.g., human-grizzly bear conflicts, habituation) as well as how the population responds to management and changing habitat conditions (Bjornlie et al. 2014a, van Manen et al. 2015). It will be particularly important to evaluate how harvest management influences population demographics should hunting occur. Questions may arise regarding survivorship, recruitment, movements, genetic diversity, and behavioral adaptations in response to hunting and other anthropogenic influences.

Much of the PCA is designated wilderness and national parks, whereas lands outside of the PCA, while still containing wilderness and roadless areas, are predominantly multiple-use. Given the diverse land use patterns, differences in grizzly bear demographic characteristics and habitat utilization may emerge. Understanding these differences may have implications for management of grizzly bears outside the PCA.

The Department will continue to identify questions that have specific management implications, and will develop hypotheses to test through relevant research projects. The Department will continue to serve on the IGBST and will play a key role in furthering the body of information available for managers to adaptively manage this and other grizzly bear populations.

Habitat and Land Management

Effective grizzly bear habitat consists of areas where biological needs of grizzly bears are met and mortality risk is low – in other words, large contiguous areas that are remote from human activities [USFWS 2007, Schwartz et al. 2010]. The majority of secure habitat inside the PCA is within national parks and designated wilderness. Outside the PCA, most habitat occupied by grizzly bears is on USFS lands. The Department is responsible for managing grizzly bears on all lands in Wyoming, excluding national parks and Tribal lands; however the Department has no direct authority to manage habitat except on Commission-owned lands.

The six national forests within the GYA, in their capacity as members of YES, have committed to maintain secure grizzly bear habitat at 1998 levels (ICST 2007, FR 72:14925, USFWS 2016b). All six forest plan revisions include standards ensuring habitat will be conserved at levels needed to sustain the recovered GYA DPS grizzly bear population [FR 72:14923]. Once the grizzly bear is delisted, the YES will continue as the YGCC. The Department will provide data and input to all appropriate land management decisions in our capacity as a member of YGCC, and when providing agency comments on proposed planning and permitting actions on federal lands. Coordination among state and federal agencies and private landowners will be essential to assure adequate grizzly bear habitat is maintained.

The central reason why grizzly bear populations declined in North America was the settlement of vast tracts of land and conversion of those lands to more intensive anthropogenic uses, leading to increasing frequencies of encounters and conflicts with grizzly bears, and consequently increased grizzly bear mortality. The result of these combined factors was fewer tracts of suitable habitat where grizzlies could survive. The following factors contribute to loss of suitable habitat: conversions of native vegetation, depletion of food resources, disturbance, displacement from human activities and developments such as roads and subdivisions, and fragmentation of habitat into increasingly smaller blocks that are inadequate to maintain viable grizzly bear populations.

Roads contribute significantly to degradation of suitable grizzly bear habitat. Grizzly bears living near roads also have a higher probability of mortality (Schwartz et al. 2010). Road development has displaced adult females from approximately 16 percent of the total available habitat in YNP (Mattson et al. 1987). Female displacement is higher in areas having higher road densities. The distances at which grizzly bears appear to be displaced from roads vary in different habitats and seasons. The impact of roads is greatest in spring. During the fall, grizzly bears tend to move to higher elevations where they forage in locations that are typically more isolated from existing roads. Consequently, roads are a less important source of disturbance during the fall season. The amount of traffic also appears to influence the degree of road avoidance.

The Department supports maintaining roadless areas where they currently exist within occupied grizzly bear habitat (primarily within the PCA). This is consistent with forest management plan commitments to maintain secure grizzly bear habitat at 1998 levels. Grizzly bears rely on security cover to insulate themselves from threats and disturbances. Overall habitat suitability can be impacted by loss of security cover as a direct or indirect consequence of various human activities. Such activities may include: land management practices, recreational developments and primary roads (Mattson et al. 1987), restricted roads and motorized trails (Mace et al. 1996); human use (Knight et al. 1988, Mattson 1989, McLellan and Shackleton 1989); oil and gas development (Schallenberger 1977, Reynolds et al. 1983, McLellan and Mace 1985); logging practices (Zager et al. 1983, Archibald et al. 1987, Bratkovich 1986, Hillis 1986, Skinner 1986); and forest fires (Zager et al. 1983, Blanchard and Knight 1990). The Department will continue to provide technical advice, including data and expertise regarding grizzly bear ecology, to inform decisions of land management agencies. We will encourage jurisdictional agencies to address the impact of human activities in their land management plans and permitting actions.

The majority of suitable habitat occupied by the GYA DPS of grizzly bears is a contiguous region of northwest Wyoming that, for the most part, remains intact. A comparatively limited number of two-lane highways bisect portions of the GYA. The Department will work with appropriate land management agencies and the Wyoming Department of Transportation to minimize impacts if additional highway projects should be proposed in the future.

Human activities, including recreation in occupied grizzly bear habitat, are also linked to disturbance, human-grizzly bear conflicts and grizzly bear mortalities. The Department promotes the use of bear pepper spray in areas occupied or likely to be occupied by grizzly bears. The Department also recommends that land management agencies require proper food/waste handling practices (i.e. food storage orders) that reduce the potential for conflicts.

Habitat Recommendations

The following general guidelines will be considered in formulating Department comments on land use plans and permitted actions in occupied grizzly bear habitat:

- Work with land management agencies to monitor habitat conditions and trends potentially affecting all sensitive and priority wildlife species.

- As mandated by Sections 1502.16, 1508.7, and 1508.8 of the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act [40 CFR Parts 1500-1508], identify and evaluate the cumulative effects of all past, present, and reasonably foreseeable actions potentially affecting sensitive and priority wildlife or their habitats. The potential significance of impacts created by the project being analyzed must be evaluated in the context of an overall cumulative effects analysis covering an appropriate unit of land or the ecosystem as a whole.

- Monitor human activities that may reduce habitat effectiveness on seasonally important wildlife habitats and recommend changes in management of human uses if warranted.

- Base road construction proposals on completed transportation plans that take into consideration important wildlife habitats and seasonal-use areas.

- Use minimum road design and construction specifications based on projected transportation needs. Schedule construction to avoid important seasonal use periods as identified in species-specific guidelines.

- Recommend site-specific design and mitigation standards to locate roads, drill sites, landing zones, etc. in a manner that avoids adversely impacting important wildlife habitat.

- Stabilize and reclaim disturbed areas with native plant species whenever possible to provide proper watershed protection. Species that provide wildlife forage and/or cover should be used in rehabilitation projects where deemed appropriate. However, to reduce potential for traffic collisions and mortalities, plant species that attract wildlife should not be planted within road rights-of-way.

- As general guidance, the Department recommends the average density of open roads should not exceed one mile of road per square mile. This is consistent with the Department's elk management guidelines.

- When necessary, recommend seasonal road closures and/or vehicle restrictions during important seasonal use periods. Road closures may also be recommended in specific situations where there is concern about potential conflicts due to increased bear activity.

- Encourage the USFS and Bureau of Land Management to enforce regulations banning motorized travel off established roads as well as food storage orders within USFS lands.

- Focus efforts to improve habitat quality in areas of recurring grizzly bear mortalities related to human causes. Such efforts may include improved sanitation, seasonal road closures, and enhanced educational efforts.

The Department recognizes large tracts of roadless areas are crucial for successful conservation of grizzly bears. The Department will work with local groups and land managers to develop compatible travel management plans. In general, the density of open roads has remained the same or decreased in most bear management subunits since 1998 (IGBST 2015).

Conflict Management

The guidelines outlined in the final *Conservation Strategy* (USFWS 2016) along with the guidelines below will be used to manage human conflict both inside and outside of the DMA. Human welfare will receive priority consideration when grizzly bears and people come into conflict. Management actions will be based on a risk assessment that considers the impact to humans as well as the grizzly bear population and mortality status. Department responses to conflict include no action, aversive conditioning, deterrence, exclusion, relocation, and/or removal. Situations involving grizzly bears occupying locations where the potential for conflicts is high (e.g. subdivisions) will be managed proactively to prevent damage and address human safety concerns. All management actions will be documented in the annual grizzly bear job completion report. As the grizzly bear population has increased in abundance and distribution, the Department has documented a corresponding increase in abundance and distribution of conflicts (Fig. 11). The Department will continue to stress the importance of conflict resolution and maintain vigilance in response to grizzly bear/human conflicts.

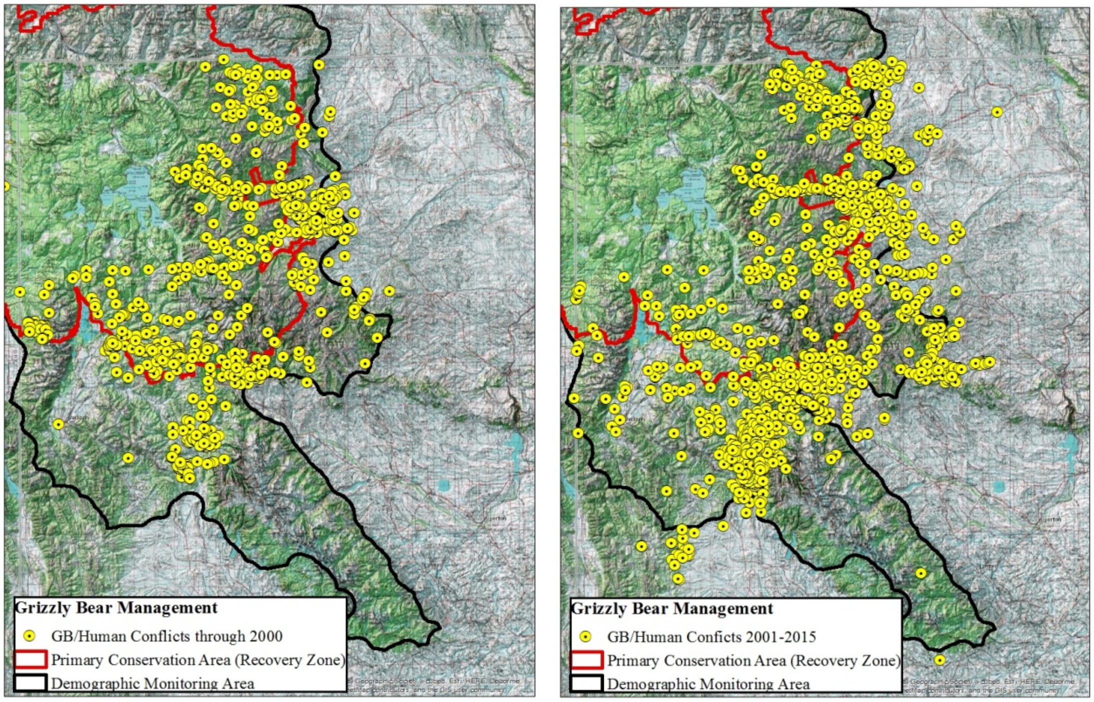

Fig. 11. Verified grizzly bear-human conflicts illustrating the increased distribution of conflicts beyond the Primary Conservation Area and Demographic Monitoring Area in Wyoming.

The Department's conflict management program will focus on education and preemptive management strategies. Public safety will remain the paramount consideration in all Department management decisions related to grizzly bear conflicts. To the extent possible given logistical and manpower constraints, situations involving grizzly bear conflicts will be handled in a timely and effective manner. Non-lethal control measures will be exercised whenever appropriate and practical. Location, cause of incident, severity of incident, history of the offending grizzly bear(s), and bear's health, age, and sex will be considered in any decisions to identify appropriate management actions. Additionally, the Department will include the prevention of future conflict as a consideration when developing strategies to deal with individual situations. Appropriate circumstances in which response actions may be taken are described below:

No Action

The Department may elect to take no action after the initial investigation if the circumstances do not warrant control or if the opportunity for effective control of the situation is low.

Many human-grizzly bear conflicts are one-time events. The activities and circumstances leading to the conflict may not be repeated, thus a management response becomes unnecessary. In other situations, the location of the grizzly bear involved is unknown, or the location where the next conflict may occur cannot be reliably anticipated.

Aversive Conditioning, Deterrence, and Exclusion

The Department may employ various options to prevent or reduce the potential for conflicts and/or depredations (e.g. electric fencing, bear proof structures or containers, scare devices). As circumstances warrant, the Department will employ nonlethal methods such as removing the source of the conflict or altering the behavior of the bear(s) that may be contributing to a conflict.

Often the most effective action is to manage the root cause(s) of the conflict. Implementing property protection (bear exclusion) measures or eliminating attractants will often result in grizzly bears abandoning the area and discontinuing undesirable behaviors. Aversive conditioning by actively deterring grizzly bears from a specific site or area will sometimes have the same effect depending on the situation.

Relocation

The Department may capture grizzly bears and relocate them away from conflict situations when other options are likely to be ineffective, or where human safety is a concern. Capture and relocation efforts will be initiated in a timely manner when practical. The Department will attempt to relocate conflict grizzly bears to locations where the probability of causing additional problems is low. Grizzly bears captured to manage conflicts will not be relocated into unoccupied habitat. Grizzly bears not suitable for release will be removed from the population. All sub-adult and adult grizzly bears to be relocated or released on site will be permanently marked and may be radio-collared when applicable.

Removal

Lethal control may be employed when other options are not practical or feasible, in particular when bears become food-conditioned, human-habituated, or aggressive toward humans. Grizzly bears displaying these behaviors are a public safety threat and often continue to be involved in property damage incidents. In other circumstances, some grizzly bears may not be suitable for release due to injuries, illness or their physical condition. When the option to lethally remove a bear is exercised, the source of the conflict should also be managed as appropriate. As with other known human-caused mortalities, Department removals will be reported annually.

Conflict Management Procedures

General

The following conflict management procedures shall be implemented in accordance with the guidelines above:

- The Department will ensure that appropriate LCS and regional personnel are trained to manage conflicts involving grizzly bears. Conflict management is a high priority for the Department.

- Conflict reporting procedures will be made available to the public.

- Appropriate personnel within other state and federal agencies may be trained, authorized, and equipped to manage conflicts in appropriate circumstances as determined and approved by the Department.

- Livestock depredation information and training may be made available to livestock producers and their employees. It shall remain essential, however, for Department personnel to respond to and verify instances of livestock depredation in a timely manner.

- The Department will provide a timely response to reports of human-grizzly bear conflicts. Appropriate actions to address human-grizzly bear conflicts will be identified and implemented in accordance with Department guidelines and protocols.

- The Department will evaluate reports of human-grizzly bear interactions and will promptly conduct an investigation when warranted. The Department will inform the affected parties or their representatives of the findings as soon as feasible.

- The Department will provide information and technical assistance to prevent, manage, and mitigate human-grizzly bear interactions.

- The Department may provide deterrent or aversive conditioning devices or supplies for use in preventing or managing interactions and conflicts.

- The Department may preemptively capture and relocate grizzly bears to prevent interactions and conflicts with humans in cases where this is deemed necessary.

- Grizzly bears involved in conflicts may be captured and relocated to prevent additional conflicts.

- When action is necessary to prevent additional conflicts or to address public safety, grizzly bears may be removed from the population in cases where relocation is not possible or practicable, or where prior relocation attempts have proven ineffective.

- Grizzly bears displaying aggression or considered to present a continued threat to human safety will be removed from the population as the situation warrants.

- Grizzly bears displaying food-conditioned or habituated behaviors may be relocated, aversively conditioned, or removed from the population dependent on the specific details of the incident.

Property Damage Management

Grizzly bears are attracted to processed human foods, gardens, garbage, bird feeders, livestock and pet feed, livestock carcasses, improperly stored big game carcasses, and septic treatment systems near camps and residential areas. These types of attractants often lead to property damage by grizzly bears.

The Department has developed a statewide proactive outreach program called "Bear Wise Wyoming Program" to improve public awareness of conditions or circumstances that may lead to conflicts, how to avoid conflicts, and how to respond appropriately in a bear encounter. The Department will continue to identify potential sources of attractants and work with private property owners and land management/local government agencies to reduce sources of attractants throughout areas potentially occupied by grizzly bears. When an attractant cannot be eliminated, the Department will provide technical advice to protect property and reduce the potential for human-grizzly bear conflicts. Techniques to prevent damage may include aversive conditioning, physical exclusions such as electric fencing, relocation or removal of offending animals, and use of deterrent devices. The Department will encourage further development of effective, non-lethal damage management techniques and equipment. The Department will implement the following actions as warranted to manage property damage caused by grizzly bears:

- The Department will evaluate reports of property damage and will promptly investigate when warranted. The Department will inform the affected parties or their representatives of the findings as soon as feasible.

- The Department will provide information and technical assistance to prevent, manage, and mitigate property damage caused by grizzly bears.

- The Department may provide deterrent or aversive conditioning devices or supplies for use in preventing damage.

- The Department may preemptively capture and relocate grizzly bears to prevent damage in cases where this is deemed necessary.

- Grizzly bears causing property damage may be captured and relocated to prevent additional damage.

- When relocation is not possible or practical, or when it is unlikely to resolve the problem because of food conditioning, habituation, or other behavioral traits, grizzly bears may be removed from the population.

Agriculture Damage Management

Grizzly bears can cause extensive damage to unprotected agricultural commodities including livestock, livestock feeds, and apiaries. The Department will cooperate with livestock producers and land management agencies to promote livestock management techniques that reduce depredations. Grizzly bear management actions will emphasize long-term, non-lethal solutions, however, it will be necessary to relocate or remove offending animals to resolve specific conflicts. The Department will continue to promote development and improvement of techniques and devices to protect agricultural products from damage. Responsible Department personnel maintain awareness and knowledge of current literature on depredation management techniques. The Department will implement the following actions as warranted to manage and mitigate agricultural damage caused by grizzly bears:

- The Department will evaluate reports of damage to livestock or agricultural products caused by grizzly bears and will promptly investigate when warranted. The Department will inform the affected parties or their representatives of the findings as soon as feasible.
- The Department will provide information and technical assistance to prevent, manage, and mitigate agricultural damage caused by grizzly bears.
- The Department may provide protective, deterrent, or aversive conditioning devices or supplies to prevent damage.
- The Department may preemptively capture and relocate grizzly bears to prevent agricultural damage in cases where this is deemed necessary.
- Grizzly bears causing agricultural damage may be captured and relocated to prevent additional damage.
- Grizzly bears that are involved in livestock depredations may be removed from the population.
- Grizzly bears involved in livestock depredation often times create human safety risks and may be handled as such if the circumstances warrant.
- The Department will reimburse landowners for compensable damage to agricultural products as directed by Wyoming Statutes and Commission regulation (Appendix II).
- The Department will develop and update outreach materials that explain the damage claim process. Some related papers, agreements, and brochures include: Demaree (1985), Iverson (1989), WADMB et al. (2002), Bruscino and Cleveland (2004), and WGFD and WADMB (undated).

Outdoor Recreation-Grizzly Bear Conflict Management

Encounters between grizzly bears and humans that live, work, and recreate in grizzly bear occupied habitats may increase the potential for grizzly bear mortalities to occur due to self-defense actions, and may also result in injuries or death of humans engaged in activities such as hunting, fishing, hiking, camping, recreating or working in grizzly bear country. The Department will implement the following actions to manage human grizzly bear conflicts.

- The Department will encourage the reporting all instances of conflicts with grizzly bears.
- The Department will encourage the carrying of bear pepper spray when recreating and working in locations potentially occupied by grizzly bears.

- The Department will encourage the development of additional products and techniques outdoor resource users can utilize to avoid or manage interactions with grizzly bears in a non-lethal manner.

- The Department will annually publicize news releases with safety tips for recreating and working in grizzly bear occupied habitat [e.g., https://wgfd.wyo.gov/News/Hunters-urged-to-use-caution-when-hunting-in-grizz]

- The Department will utilize a multi-faceted information and education program to assist in managing outdoor resource user-grizzly bear conflicts [e.g., the "Bear Wise Wyoming Program" https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Large-Carnivore/Grizzly-Bear-Management/Bear-Wise-Wyoming]. Also see next section.

- The Department will investigate all reported human-grizzly bear conflicts that result in death or injury to a person or grizzly bear.

Grizzly bears identified for removal may be captured and donated alive to public research institutions or public zoological parks for appropriate educational or scientific purposes in accordance with Wyoming statutes and Wyoming Game and Fish Commission regulations. Grizzly bears not suitable for release, research, or educational purposes will be lethally removed. The Department will direct the disposition of all grizzly bears that are lethally removed by other than a licensed hunter. Grizzly bears lethally removed in authorized management actions shall be retained by the Department or donated to scientific or educational institutions in accordance with Wyoming Statutes and Wyoming Game and Fish Commission regulations.

Information and Education

In 1991, the Department launched an education outreach effort that emphasizes learning to co-exist with grizzly bears by reducing human-grizzly bear conflicts. Its focus was to increase public understanding and awareness of grizzly bears, their behavior and physical characteristics, and how to avoid conflicts.

Three target audiences were originally identified and continue to be highest priorities. They include:

- Persons hunting in occupied grizzly bear habitat.

- Schools, teachers and youth organizations with particular emphasis on grades 3-12 in the GYA.

- Persons residing in and visiting the GYA.

In 2004, a subcommittee of the IGBST analyzed causes and spatial distribution of grizzly bear mortalities and conflicts occurring from 1994-2003 throughout the GYA DPS. The majority of known, human-caused grizzly bear mortalities resulted from agency management actions in response to conflicts (34%), self-defense killings, primarily by big game hunters (20%), and illegal (vandal) killings (11%). The report contained 33 recommendations to reduce human-grizzly bear conflicts and identified the following 3 sources of grizzly bear mortality that Department programs could effectively influence: 1) conflicts at developed sites; 2) self-defense killings; and 3) illegal killings (IGBST 2006).

To address the first mortality source, the committee recommended implementing enhanced management strategies in a "demonstration area" where developed site conflicts and Department management actions had been historically high. The North Fork of the Shoshone River, comprised primarily of private lands west of Cody, was selected to implement a multi-agency/public approach to reduce bear conflicts at developed sites.

In 2005, the Department also began implementation of the Wyoming Bear Wise Community Program [https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Large-Carnivore/Grizzly-Bear-Management/Bear-Wise-Wyoming]. Although efforts were focused primarily in the initial demonstration area, the Department also initiated a smaller scale project in the Jackson, Wyoming area to address the increased frequency of black and grizzly bear conflicts. For the past 10 years, the Wyoming Bear Wise Community programs in Cody and Jackson areas have been effective at educating the public, minimizing human-grizzly bear conflicts and promoting proper attractant management. Although challenges remain and vary among communities, progress is expected to continue as the Wyoming Bear Wise Community Program effort reaches more people. In an effort to broaden the program, the Department branded this work as the "Bear Wise Wyoming Program" beginning in 2013. This rebranding was in response to increasing distribution of grizzly bears and the realization that interest in Wyoming's grizzly bears has broadened to statewide, national, and even international scales. Efforts to proactively reduce human-grizzly bear conflicts have been accomplished through the Bear Wise Wyoming Program and are summarized in grizzly bear annual job completion reports (Bjornlie et al. 2012, 2013; Atkinson et al. 2014):

The Department will continue to implement and expand its information and education efforts. Resources will continue to be allocated to the Bear Wise Wyoming Program to maintain current levels of service and for future expansion as recommended by the Department and approved by the Commission. This statewide program focuses on the proactive measures designed to reduce conflicts, and on educational efforts to inform the public about grizzly bear ecology, management and conflict resolution. Presentations will continue throughout the state, as well as on a national and international scale.

Law Enforcement

The Commission will ensure the fair, consistent and effective enforcement of laws and regulations related to grizzly bears. As is the case with all Wyoming wildlife, the Department's law enforcement charge and mission is a high priority. The Department will invest in the protection of the grizzly bear population, the thorough investigation of reported and discovered violations and will work with local prosecutors to adjudicate violations appropriately and in accordance with state law. Additionally, the Department will focus many of its' grizzly related education efforts towards ensuring understanding and compliance with Commission regulations and Wyoming statutes.

Grizzly Bear Management Costs and Funding

As the grizzly bear population size and distribution increase, management costs have continued to rise (Fig. 12) primarily due to the increasing costs of conflict management. From 1990-2015, the Department expended over $40 million to manage grizzly bears. Total future costs are difficult to predict, however costs associated with data collection and conflict management will vastly exceed any revenue generated by the grizzly bear program. The Department will continually seek ways to use new technology, new science and new methodologies to improve efficiency of the grizzly bear management program. The Department has the infrastructure and personnel in place to continue the current management program. Costs associated with managing a delisted grizzly bear population will not increase. The Department is legally bound and committed to maintaining the viability of all Wyoming wildlife.

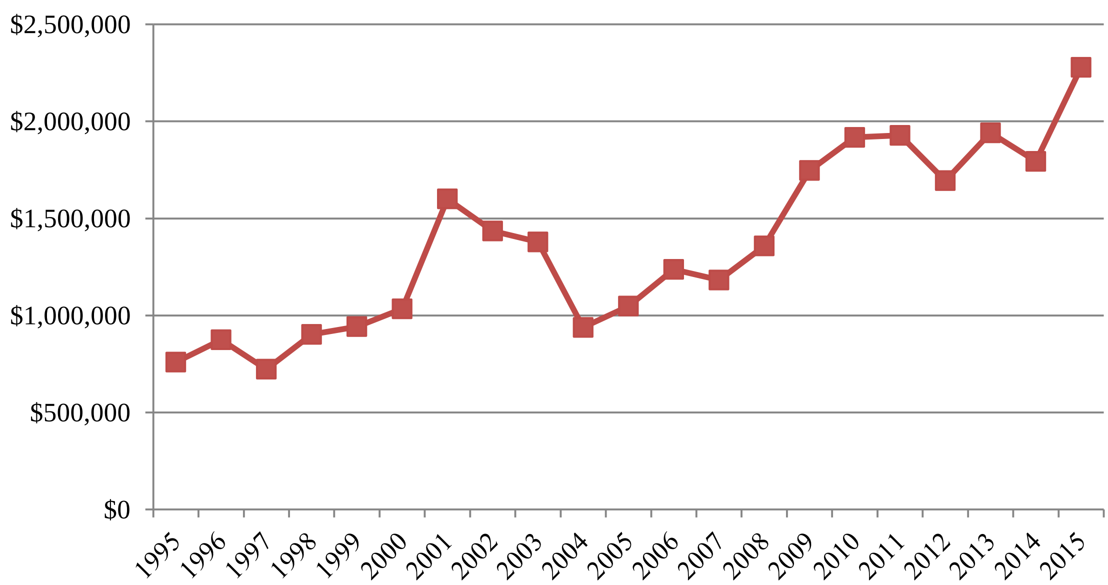

Fig. 12. Annual expenditures by the Department related to grizzly bear recovery and management.

— W G F D —

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APPENDIX I: MEMORANDUM OF AGREEMENT REGARDING THE MANAGEMENT AND ALLOCATION OF DISCRETIONARY MORTALITY OF GRIZZLY BEARS IN THE GREATER YELLOWSTONE ECOSYSTEM

Among

Wyoming Game and Fish Commission, Wyoming Game and Fish Department, Montana Fish and Wildlife Commission, Montana Fish, Wildlife and Parks, Idaho Fish and Game Commission, and Idaho Department of Fish and Game

This Memorandum of Agreement (MOA) is made and entered into by and among the Wyoming Game and Fish Commission and the Wyoming Game and Fish Department (collectively WGFD), the Montana Fish and Wildlife Commission and Montana Fish, Wildlife and Parks (collectively MFWP), and the Idaho Fish and Game Commission and the Idaho Department of Fish and Game (collectively IDFG), collectively referred to as the Parties.

I. Purpose

The purpose of this MOA is to define the process by which the Parties will coordinate the management and allocation of discretionary mortality of grizzly bears in the Greater Yellowstone Ecosystem (GYE). The Parties enter into this MOA in support of the re-designation of the Distinct Population Segment (DPS) of GYE grizzly bears and delisting of this DPS under the federal Endangered Species Act. The Parties intend this MOA to be consistent with the 2007 interagency *Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area* (Strategy) and individual state management plans, and with revisions to these documents made in conjunction with the delisting process.

II. Background

The Interagency Conservation Strategy Team, with the participation of the Parties and various federal agencies, developed the Strategy to implement regulatory mechanisms, interagency cooperation, and population and habitat management and monitoring, and other actions to ensure continued recovery of the GYE grizzly bear. The Strategy was subject to public comment and scientific peer review. The Strategy's key mechanisms for maintaining a recovered GYE grizzly population are its population and habitat standards, which are based on the recovery criteria originally set forth in the USFWS Recovery Plan. The Strategy incorporated the Parties' individual state management plans that have different, but compatible, management objectives. USFWS has published for public comment draft revisions to the Strategy. The signatories to the Strategy, including representatives of the Parties and federal agencies, will finalize revisions to the Strategy in conjunction with the delisting process.

On February 19, 2016, USFWS approved a draft Supplement to Demographic Recovery Criteria for obtaining public comment. For purposes of this MOA, the Parties assume adoption of the Demographic Monitoring Area (DMA) identified in the 2016 draft Supplement as the geographic area used to monitor continued achievement of GYE population and distribution objectives. The Interagency Grizzly Bear Study Team (IGBST) and the Yellowstone Ecosystem Subcommittee (YES) of the Interagency Grizzly Bear Committee (IGBC) have recommended the use of the DMA for population monitoring, including mortality monitoring.

USFWS' draft 2016 Supplement would use a recovery criterion for a conservative total population size of at least 500 GYE bears. This minimum population size includes a conservative buffer in addition to the recommendation of Miller and Waits (2003) for a minimum population size of at least 400 bears to adequately mitigate the potential effects of genetic drift and inbreeding depression in light of the relative isolation of the GYE population. This draft 2016 recovery criterion would also reflect a goal of at least 48 females with cubs in the DMA. For purposes of this MOA, the Parties assume the conservative criterion for minimum population size and number of females with young will apply.

USFWS' draft 2016 Supplement would keep in place the conservative recovery criterion for female occupancy standards in the Primary Conservation Area (PCA). For purposes of this MOA, the Parties assume this conservative criterion will remain in place.

The demographics and vital rates of the GYE population have changed over time. USFWS' draft 2016 Supplement proposes a revision to mortality standards to reflect changes in these rates to ensure a total GYE population of at least 500 bears and to meet the occupancy standard for female bears. For purposes of this MOA, the Parties identified adjustable mortality rates (see Paragraph IV. 2) to manage human-caused mortality within the DMA to levels that will sustain a population range based on the 2002-2014 model-averaged Chao2 population estimate of 674 grizzly bears within the DMA (95% Confidence Interval = 600 to 747).

Adjustable mortality levels allow for higher or lower mortality rates and correspond to the upper and lower 95% confidence intervals of the 2002-2014 model-averaged Chao2 estimate. Adjustable mortality rates enable the Parties to address higher human-bear conflict levels that may occur when the bear population is well above the population recovery criterion. They also ensure the population stays above the recovery criterion of a minimum population size of 500 animals in the GYE. The Parties will review the population vital rates and demographics (compiled by IGBST) a minimum of every 5 years to recommend appropriate adjustments to mortality rates.

From 2002 to the present, the IGBST has used the Chao2 estimator and model averaging process to calculate population size on an annual basis. As the bear population has grown, the model-averaged Chao2 estimates have become increasingly conservative (i.e., prone to underestimation). The IGBST has also made population estimates more recently using a mark-resight based technique (IGBST Report, 2012). The mark-resight approach has no known density-associated bias, and should better reflect actual bear abundance; however, current implementation of the approach is less precise than Chao2 at tracking population trend. For purposes of this MOA, the Parties assume that USFWS will, as a matter of best available science and appropriate conservatism, rely on the model-averaged Chao2 estimate for assessing the population size for at least the 5-year post-delisting monitoring period. The Parties recognize that methods for population estimation may change in the future as circumstances warrant and new methods are scientifically vetted and accepted.

III. Definitions

1. "Discretionary mortality" is the amount of human-caused grizzly bear mortality over which agencies have discretionary authority, such as management removals and regulated harvest.

2. "Non-Discretionary mortality" is documented loss over which agencies do not have discretionary authority, such as naturally occurring mortality or human-caused mortality such as illegal shootings, defense-of-human-life shootings, and vehicle collisions.

3. "Greater Yellowstone Ecoystem" (GYE) is defined as that portion of Idaho that is east of Interstate Highway 15 and north of U.S. Highway 30; that portion of Montana that is east of Interstate Highway 15 and south of Interstate Highway 90; that portion of Wyoming south of Interstate Highway 90, west of Interstate Highway 25, Wyoming State Highway 220, and U.S. Highway 287 south of Three Forks (at the 220 and 287 intersection), and north of Interstate Highway 80 and U.S. Highway 30. This definition of GYE was used in the 2007 USFWS rule to designate a distinct population segment (DPS) of grizzly bears under the Endangered Species Act, and to delist that DPS; in 2010 USFWS vacated this rule in response to a court decision. The Parties assume USFWS will re-designate a grizzly bear DPS for the GYE geographic area as defined herein.

4. "The Recovery Zone," also known as the "Primary Conservation Area" (PCA), is the area whose boundaries are approximately depicted on the map attached hereto as Attachment A; the Recovery Zone is divided into 18 Bear Management Units.

5. "Demographic Monitoring Area" (DMA) is the area that includes the Recovery Zone and an additional area surrounding the Recovery Zone, approximately 19,279 mi^2 in area and whose boundaries are depicted on the map attached hereto as Attachment A. The DMA is based on suitable habitat. The DMA is the area within which the GYE population is annually surveyed and estimated and within which the total mortality limits will apply.

6. "Chao2" is the population estimation technique currently used for the GYE population of Grizzly Bears.

IV. Responsibilities

1. The Parties will employ best science and adaptive management approaches to collectively manage grizzly bears within the GYE.

2. To achieve population criteria to support a recovered GYE grizzly bear population, the Parties will:

   a. Maintain a minimum population size of 500 bears in the GYE.

      i. The Parties agree to manage the GYE grizzly bear population within the DMA, to at least within the 95% confidence intervals associated with the 2002-2014 long-term average grizzly bear population estimate calculated using the model-averaged Chao2 estimator (i.e, 600-747).

   b. Ensure that 16 of the 18 Bear Management Units within the PCA are occupied by at least one female with offspring over a six-year period, with no two adjacent Bear Management Units unoccupied over a six-year period.

   c. Ensure annual total mortality rates are not exceeded within the DMA for independent males, independent females and dependent young, as set forth in the following table, based on the 2002-2014 model-averaged Chao2 estimate for the total population with 95% confidence intervals (600-747). These adjustable mortality rates were calculated as those necessary to manage the population around the 2002-2014 Chao 2 modeled average ($\overline{X}$= 674; 95% CI = 600-747 which occurred during the time period when the population reached a biological carrying capacity.

	Total Grizzly Bear Population Estimate		
	≤674	675-747	>747
Total mortality rate for independent FEMALES.	≤7.6%	9%	10%
Total mortality rate for independent MALES.	≤15%	20%	22%
Total mortality rate for dependent young.	≤7.6%	9%	10%

i. The Parties agree to achieve this criterion using an adaptive management framework that will include, but not be limited to, the following:

- If the population is less than 600, the Parties will not allow discretionary mortality unless necessary to address human safety issues.
- At any population level greater than 600, if total allowable independent male or female mortality is exceeded, the number exceeding the total allowable mortality will be subtracted from the next year's discretionary mortality available for harvest for that gender.
- If a state meets any of its allocated regulated harvest limits at any time of the year, the respective state will cease hunting within the DMA.
- If the total mortality limit for independent males, independent females, or dependent young is exceeded for three consecutive years and any population estimate falls below 612 (the lower bounds of the 90% confidence interval), the Parties will evaluate alternatives to reduce discretionary mortality and request IGBST biology and monitoring review. The Parties will consider the results of the IGBST review in determining appropriate changes to the management framework.
- If the distribution of reproductive females does not meet the criterion for Bear Management Unit occupancy, the Parties will request IGBST biology and monitoring review. The parties will consider the results of the IGBST review in determining appropriate changes to the management framework.

3. The Parties will support the IGBST in the annual monitoring of the GYE grizzly bear population.

4. a. The Parties will meet annually in the month of January to review population monitoring data supplied by IGBST and collectively establish discretionary mortality limits for regulated harvest for each jurisdiction (MT, ID, WY) in the DMA, so DMA thresholds are not exceeded, based upon the following allocation protocol.

- Begin with DMA Chao2 total population estimate and estimates for independent males, independent females, and dependent young (demographic classes) for the previous calendar year, as reported by the IGBST.
- Determine the maximum allowable mortality limit for each demographic class based on the mortality rates identified in the table above.
- Determine total mortality during the previous calendar year for each demographic class.
- Subtract the previous year's total mortality from the maximum allowable mortality limit for each demographic class. If the difference is negative (*i.e.,* a DMA annual mortality limit is

exceeded for any of the three classes), the number of mortalities above the limit will be subtracted from the corresponding DMA discretionary mortality limit for that class for the current year.

- Allocate discretionary mortality available for regulated harvest for independent males and females to each management jurisdiction as provided in the following table. The Parties may agree to adjust the allocation of discretionary mortality based on management objectives and spatial and temporal circumstances.

Management Jurisdiction*	% of DMA outside NPS lands
WY inside DMA	58%*
MT inside DMA	34%
ID inside DMA	8%

*Four percent (4%) of the DMA outside of National Park System lands in Wyoming is under the jurisdiction of the Joint Business Council of the Eastern Shoshone and Northern Arapaho Tribes of the Wind River Reservation.

b. The Parties will prohibit hunting of females accompanied by young, and young accompanied by females, and discretionary mortality of such animals will only occur for management removals.

c. Each party has discretion as to how it applies its allocation of discretionary mortality pursuant to its respective regulatory processes and management plan.

d. The Parties will coordinate with IGBST to review and make any appropriate adjustments to mortality rates at least every five years.

5. The Parties will confer with the National Park Service (NPS) and United States Forest Service (USFS) annually. The Parties will invite representatives of both GYE National Parks, the NPS regional office and GYE USFS Forest Supervisors to attend the annual meeting.

6. The Parties will monitor mortality throughout the year, and will communicate and coordinate with each other and with federal land management agencies as appropriate to minimize the likelihood of exceeding mortality limits.

7. Each party has discretion to manage grizzly bears within its jurisdiction of the GYE that are outside the DMA pursuant to its respective regulatory processes and state management plan.

8. Each party will designate one representative as a respective Point of Contact for purposes of achieving the objectives of this MOA.

V. Authorities and Regulatory Mechanisms

The Parties enter this MOA pursuant to their respective state authorities as set forth in Title 87 Montana Code Annotated, Title 23 Wyoming Statutes Annotated, and Title 36 Idaho Code.

The Parties have the authority, capability and biological data to implement appropriate hunting restrictions, management relocations and removals, and population management. The Parties will use their respective individual authorities to regulate discretionary mortality as allocated to their jurisdictions under this MOA. The Parties' respective regulatory mechanisms to manage, monitor, restrict, and adjust mortality include, but are not limited to, those identified in Attachment B.

This MOA in no way restricts the Parties from participating in similar activities with other states, agencies, tribes, local governments, or private entities.

VI. No Obligation of Funds

This MOA is neither a fiscal nor a funds obligation document. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds among the Parties will be handled in accordance with applicable laws, regulations, and procedures and such endeavors will be outlined in separate agreements or contracts that shall be made in writing by representatives of the Parties. This MOA does not provide such authority.

VII. Term, Termination and Effective Date

This MOA shall become effective upon the date of signature of all Parties. It shall remain in effect until it is terminated by the Parties. Any party may terminate its participation in the MOA by providing one hundred-eighty (180) days written notice to the other Parties, which notice shall be transmitted by hand or other means of delivery confirmation.

VIII. Amendment

The Parties will meet annually to review implementation of the MOA and to recommend any appropriate modifications to the MOA based on changes to the Strategy, state management plans or other pertinent regulatory documents. Any modification to the MOA will only become effective upon the written consent of all Parties.

IX. No Third Party Beneficiary

Nothing contained herein shall be construed as granting, vesting, creating or conferring any right of action or any other right or benefit upon any third party.

X. Severability

Should any portion of this MOA be judicially determined to be illegal or unenforceable, the remainder of the MOA shall continue in full force and effect.

XI. Sovereign Immunity

The states of Wyoming, Montana, and Idaho do not waive their sovereign immunity by entering into this MOA, and each fully retains all immunities and defenses provided by law with respect to any action based on or occurring as a result of this MOA.

In Witness Thereof, the Parties hereto have executed this MOA as of the last written date below.

____ _____________________

President, Wyoming Game and Fish Commission **Date**

____ ____________________
Director, Wyoming Game and Fish Department **Date**

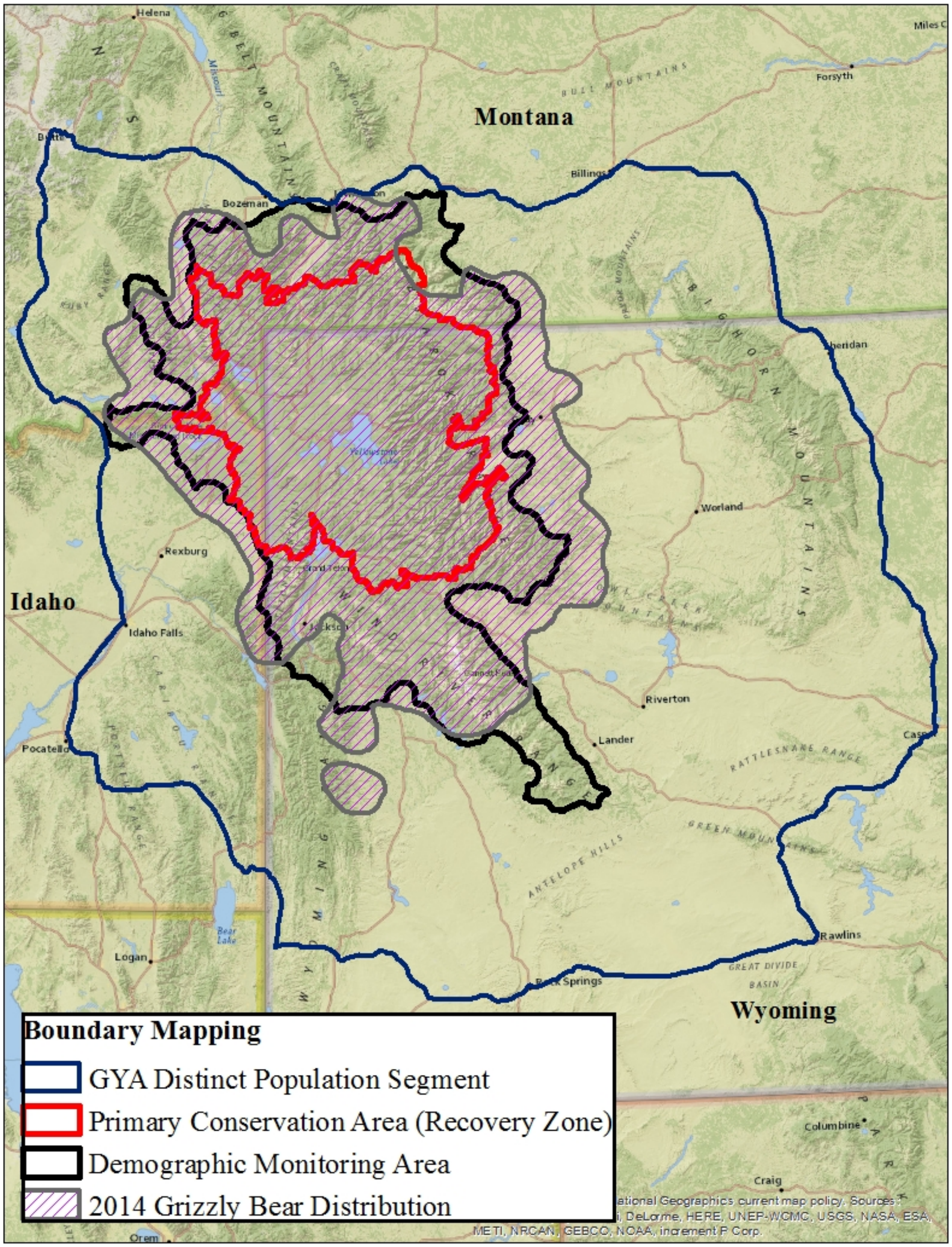
____ ____________________
Chairman, Montana Fish and Wildlife Commission **Date**

____ ___________________
Director, Montana Fish, Wildlife and Parks **Date**

____ ____________________
Chairman, Idaho Fish and Game Commission **Date**

____ ____________________
Director, Idaho Department of Fish and Game **Date**

ATTACHMENT A



ATTACHMENT B

	Wyoming WS=Wyoming Statute WGBMP=Wyoming Grizzly Bear Management Plan	**Montana** MCA= Montana Code Annotated ARM=Admin. Rules of Montana MTFWC – Montana Fish and Wildlife Commission Regulation	**Idaho** IC=Idaho Code IDAPA=Idaho Admin. Code ISP=Idaho Season Proclamation
Protected Classification	W.S. 23-1-101 (a)(xii)(A) (classified as trophy game animal)	MCA 87-2-101 (4) (classified as a game animal)	IC 36-201 IDAPA 13.01.06.100.01(e) (classified as big game animal)
No Take without Statutory/Commission/Director Authorization	W.S.23-3-102(a)	MCA 87-1-301; MCA 87-1-304; MCA 87-5-302	IC 36-1101(a)
Commission restriction of season, location boundaries, limits, gender, age	W.S. 23-1-302(a)(ii), WGBMP	MCA 87-1-304 (1); MCA 87-5-302	IC 36-104(b)(2) seasons, locations, sex, limits, methods of take; ISP
Commission limit of harvest to automatically close season, including gender-based limits	W.S. 23-1-302(a), WGBMP	MCA 87-1-304; MCA 87-5-302	IC 36-104(b)(2); ISP
Commission authority to restrict hunter effort (e.g., controlled hunts, tag limits)	W.S. 23-1-302(a)(i), WGBMP	MCA 87-1-201(8); MCA 87-1-304 (1); MCA 87-2-702; MCA 87-5-302;	IC 36-104(b)(2) IC 36-104(b)(5) authority to designate controlled hunt IC 36-408(1),(2); ISP
Prohibition against take of females with young present	W.S. 23-1-302(a)	MCA 87-1-304; MCA 87-5-302; MCA 87-5-302	IC 36-104(b)(2) (Commission authority to prohibit in conjunction with season setting); ISP Commission authority to enact through rule (*see* IDAPA 13.01.08.300)
Requirement for license and tag	W.S. 23-3-102(a)	MCA 87-1-201(8); MCA 87-2-701; MCA 87-2-702; MCA 87 2-814; MCA 87-5-302	IC 36-401 IC 36-409(c)
Mandatory Check/Report to	W.S. 23-1-302(a)	MCA 87-1-301; MCA 87-5-302	IC 36-104(b)(3)

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Monitor Harvest			Commission authority for rules for mandatory check and report requirements (see IDAPA 13.01.08.420-422 for rules for all big game species open to harvest)
Authority for Emergency Season Closure based on Change in Conditions affecting mortality/habitat	W.S. 16-3-103(b)	MCA 87-1-304 (5); MCA 87-5-302	IC 36-104(b)(3) Commission emergency closure authority IC 36-106(e)(6) Director authority, closure in emergency effective upon written order
Permit required for response to depredation unless self-defense/defense of others/defense of property under threat to human life or domestic animals	W.S. 23-1-302(a)(viii)	MCA 87-1-201(8); MCA 87-1-304(1)(e); ARM 12.9.103(1)(d)	IC 36-1107 (carcass remains property of state)
Mandatory Education	W.S. 23-1-302(a)(xxii)	MCA 87-1-301; MCA 87-1-304 MFWC Black Bear Regulations	IC 36-412(a) Hunter education mandatory for those born after 1/1/1975 IDAPA 13.01.02.100 Recommended additional materials and exam regarding bear identification available on-line.
Penalties	W.S. 23-3-102(d), W.S. 23-6-202, W.S. 23-6-206, W.S. 23-6-208	MCA 87-6-413. (Hunting or killing over limit)	IC 36-1404(c)Misdemeanor IC 36-1404(d) Felony IC 36-1404(e) Revocation of hunting license for certain violations, including for take during

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			closed season, exceeding bag/possession limit IC 36-1404(g): license revocation in Idaho revokes hunting privileges in all 44 states participating in the Interstate Wildlife Violator compact
Civil Penalty	W.S 23-6-204(e)		IC 36-1404(a)(3)
Procedural Aspects of State Regulatory Mechanisms	W.S. 16-3-101, Wyoming Administrative Procedures Act	MCA 2-4-101, et seq, Montana Administrative Procedures Act	IC 74- Open Meeting Requirements, including notice for all meetings of Idaho Fish and Game Commission IC Title 67, Chapter 52 (Idaho Administrative Procedure Act), requirements for public notice and comment, legislative review IC 36-105(3) Public Notice & Publication requirements for season setting

APPENDIX II: REGULATORY MECHANISMS RELATED TO GRIZZLY BEAR MANAGEMENT IN WYOMING

The regulatory mechanisms listed below are codified in current Wyoming Statutes, currently or pending in Wyoming Game and Fish Commission (WGFC) Regulations, pending in the final approved WGFC Grizzly Bear Management Plan or pending a completed and executed Memorandum of Agreement (MOA) between the Idaho Fish and Game Commission (IFGC) and the Montana Fish Wildlife and Parks Commission (MFWPC)

- Wyoming Statutes define "Trophy game animal" as: Black bear, grizzly bear or mountain lion" (W.S. 23-1-101 (a)(xii)(A))
- "For the purpose of this act, all wildlife in Wyoming is the property of the state. It is the purpose of this act and the policy of the state to provide an adequate and flexible system for control, propagation, management, protection and regulation of all Wyoming wildlife. There shall be no private ownership of live animals classified in this act as big or trophy game animals or of any wolf or wolf hybrid. (W.S. 23-1-103)
- "The commission is directed and empowered: To fix season and bag limits, open, shorten or close seasons including providing for season extensions for hunters with disabilities as established by commission rules and regulation, on any species or sex of wildlife for any type of legal weapon, except predatory animals, predacious birds, protected animals, and protected birds, in any specified locality of Wyoming, and to give notice thereof;" (W.S. 23-1302(a)(i))
- "The commission is directed and empowered: To establish zones and areas in which trophy game animals may be taken as game animals with a license or, with the exception of gray wolves, in the same manner as predatory animals without a license, giving proper regard to the livestock and game industries in those particular areas; (W.S. 231302(a)(ii))
- The WGFC will enter into a Memorandum of Agreement (MOA) with the IFGC and the MFWPC detailing the allocation of discretionary mortality in the GYA DPS of grizzly bears on an annual basis (Three State MOA)
- The WGFC shall establish standards and requirements for mortality in accordance with demographic recovery criteria mortality thresholds as outlined in the three state MOA and the *Conservation Strategy* (Three State MOA, Conservation Strategy)
- No person shall take any grizzly bear in Wyoming without a proper license (W.S.23-3-102(a))
- No person shall take any grizzly bear outside of WGFC established hunting seasons or hunt areas (WGFC Regulation Chapter 16, pending)

- Hunting seasons, mortality limits and grizzly bear hunting regulations will be approved by the WGFC through a public process (WGFC Grizzly Bear Management Plan, pending)
- No person shall take any grizzly bear with dependent young at side, nor shall they take dependent young (WGFC Regulation Chapter 16 pending)
- Any person taking a grizzly bear will report the harvest to the Wyoming Game Fish Department (WGFD) office, game warden or biologist within 24 hours (WGFC Regulation Chapter 16, pending)
- Any person taking a grizzly bear will be required to present the hide and skull to a WGFD regional office within 5 days (WGFC Regulation Chapter 16, pending)
- Hunting license allocations will be based on a limited draw/mortality limit system within the DMA (WGFC Regulation Chapter 44, pending)
- Hunting seasons will close if female mortality limits are reached or exceeded (WGFC Grizzly Bear Management Plan, WGFC Regulation Chapter 16, pending)
- If adult female, adult male or dependent young mortality limits are exceeded, the following year's discretionary mortality allocation will be adjusted accordingly (WGFC Grizzly Bear Management Plan, pending)
- All hunters licensed to take grizzly bears must complete an informational grizzly bear ecology and management course focused on harvest regulations, safety, proper identification, and ethics related to hunting grizzly bears (WGFC Regulation Chapter 16, pending).
- All grizzly bear hunters must carry bear spray while engaged in the act of grizzly bear hunting (WGFC Regulation Chapter 16, pending)
- In order to annually evaluate the grizzly bear population, the Department will look at multiple recovery factors (population size, distribution, annual mortality) to evaluate the overall status of the population (WGFC Grizzly Bear Management Plan)
- Grizzly bears shall only be taken from ½ hour before sunrise to ½ hour after sunset (WGFC Regulation, Chapter 2)
- Grizzly bears shall only be taken with a legal firearm or archery equipment. WGFC regulations specify legal firearms including caliber and cartridge size as well as legal archery equipment including bow draw weight and arrow specifications to ensure adequate lethality (WGFC Regulation, Chapter 32).

WYOMING STATE STATUTES AND WYOMING GAME AND FISH COMMISSION REGULATIONS THAT ADDRESS DAMAGE CAUSED BY TROPHY GAME.

WYOMING STATUTE §23-2-101. FEES; RESTRICTIONS; NONRESIDENT APPLICATION FEE; NONRESIDENT LICENSES; VERIFICATION OF RESIDENCY REQUIRED.

(e) Resident and nonresident license applicants shall pay an application fee in an amount specified by this subsection upon submission of an application for purchase of any limited quota drawing for big or trophy game license or wild bison license. The resident application fee shall be five dollars ($5.00) and the nonresident application fee shall be fourteen dollars ($14.00). The application fee is in addition to the fees prescribed by subsections (f) and (j) of this section and by W.S. 23-2-107 and shall be payable to the department either directly or through an authorized selling agent of the department. At the beginning of each month, the commission shall set aside all of the fees collected during calendar year 1980 and not to exceed twenty-five percent (25%) of the fees collected thereafter pursuant to this subsection to establish and maintain a working balance of five hundred thousand dollars ($500,000), to compensate owners or lessees of the property damaged by game animals and game birds.

WYOMING GAME AND FISH LAWS TITLE 23 CHAPTER 1 ARTICLE 9: DAMAGE CAUSED BY GAME ANIMALS OR GAME BIRDS

W.S. §23-1-901. Owner of damaged property to report damage; claims for damages; time for filing; determination; appeal; arbitration.

(a) Any landowner, lessee or agent whose property is being damaged by any of the big or trophy game animals or game birds of this state shall, not later than fifteen (15) days after the damage is discovered by the owner of the property or the representative of the owner, report the damage to the nearest game warden, damage control warden, supervisor or commission member.

(b) Any landowner, lessee or agent claiming damages from the state for injury or destruction of property by big or trophy game animals or game birds of this state shall present a verified claim for the damages to the Wyoming game and fish department not later than sixty (60) days after the damage or last item of damage is discovered. The claim shall specify the damage and amount claimed. As used in this subsection, "verified claim" means a claim, which the claimant has signed and sworn to be accurate before a person authorized to administer oaths.

(c) The department shall consider the claims based upon a description of the livestock or bees damaged or killed by a trophy game animal, the damaged land, growing cultivated crops, stored crops including honey and hives, seed crops, improvements and extraordinary damage to grass. The commission is authorized to establish by rule, methods, factors and formulas to be used for determining the amount to compensate any landowner, lessee or agent for livestock damaged as a result of, missing as a result of, or killed by trophy game animals. Claims shall be investigated by the department and rejected or allowed within ninety (90) days after submission, and paid in the amount determined to be due. In the event the department fails to act within ninety (90) days, the claim, including interest based on local bank preferred rates, shall be deemed to have been allowed. No award shall be allowed to any landowner who has not permitted hunting on his property during authorized hunting seasons. Any person failing to comply with any provision of this section is barred from making any claim against the department for damages. Any claimant aggrieved by the decision of the department may appeal to the commission within thirty (30) days after receipt of the decision of the department as provided by rules of practice and procedure promulgated by the commission. The commission shall review the department decision at its next meeting following receipt of notice of request for review. The commission shall review the investigative report of the department, and it may approve, modify or reverse the decision of the department.

(d) Within ninety (90) days after receiving notice of the decision of the commission, the claimant may in writing to the department call for arbitration. Within fifteen (15) days after the department receives the call for arbitration, the claimant and the department shall each appoint a disinterested arbitrator who is an elector residing in the county where the damage occurred and notify each other of the appointment. Within twenty (20) days after their appointment, the two (2) arbitrators shall appoint a third arbitrator possessing the same qualifications. If the third arbitrator is not appointed within the time prescribed, the judge of the district court of the county or the court commissioner in the absence of the judge shall appoint the third arbitrator upon the application of either arbitrator.

(e) At least twenty (20) days before the hearing, the board of arbitrators shall provide the claimant and department notice of the time and place in the county when and where the parties will be heard and the claim investigated and decided by the board. A written copy of the decision shall be promptly served upon each party. Within ten (10) days after receipt of the decision, either party may apply to the board for modification of the decision under W.S. 1-36-111. Either party may apply to the district court for vacation of a decision under W.S. 1-36-114(a) or correction or modification of a decision under W.S. 1-36-115 within thirty (30) days after receipt of the decision or within twenty (20) days after action by the board on an application for modification under W.S. 1-36-111.

(f) If no applications under subsection (e) of this section are made after receipt of the decision, the commission shall promptly pay the amount, if any, including interest based on local bank preferred rates, awarded by the board. Within thirty (30) days after the award is final, the board's reasonable service and expense charges shall be paid by:

(i) The claimant if the award is no greater than the amount originally authorized by the commission;

(ii) Otherwise, the commission.

(g) For purposes of this section, “trophy game animals” shall include gray wolves located in the area described in W.S. 23-1-101(a)(xii)(B)(II) regardless of the date on which the damage occurs.

WYOMING GAME AND FISH COMMISSION CHAPTER 28: REGULATION GOVERNING BIG OR TROPHY GAME ANIMAL OR GAME BIRD DAMAGE CLAIMS

Section 1. Authority. This regulation is promulgated by authority of W.S. §23-1-101, §23-1-102, §23-1-302, §23-1-304 and §23-1-901.

Section 2. Definitions. Definitions shall be as set forth in Title 23, Wyoming Statutes, Commission regulations, and the Commission also adopts the following definitions:

(a) "Authorized hunting seasons" means any hunting season during the twelve (12) month period immediately preceding the date when the claimant filed the verified claim with the Office of the Department that is established by Commission regulation, including Depredation Prevention Hunting Seasons and kill permits, for the harvest of the species of big game animals, trophy game animals, or game birds for which the verified claim was filed.

(b) "Award" means compensation for damage offered to a claimant by the Department.

(c) "Board" means a board of arbitrators.

(d) "Claimant" means any landowner, lessee or agent whose livestock, bees, hives or honey have been damaged or killed by a trophy game animal; or, whose land, growing cultivated crops, stored crops, seed crops, or improvements have been damaged by big game animals or game birds; or, whose grass has been extraordinarily damaged by big game animals or game birds.

(e) "Commercial garden" means a business that grows fruits or vegetables for commercial sale.

(f) "Commercial nursery" means a business that grows or stores trees, shrubs or plants solely for commercial sale and that is required under W.S. § 39-15-106 to be licensed with the Wyoming Department of Revenue to collect and remit sales and use tax.

(g) "Commercial orchard" means a business that grows trees for fruit or nut production for commercial sale.

(h) "Confirmed by the Department or its representative" means the Department or its representative conducted an inspection or investigation of the damage and determined the damage was more likely than not caused by a big or trophy game animal or game bird.

(i) "Consequential damages" means damage, loss, or injury that does not flow directly and immediately from the act of the big game animal, trophy game animal or game bird, but only from some of the consequences or results of such act. Consequential damages include, but are not necessarily limited to, future or anticipated production (except as otherwise provided in this regulation for young of the year livestock), sentimental value, and labor or equipment costs to remove damaged property.

(j) “Damage” means actual damage to land, growing cultivated crops, stored crops, seed crops or improvements that is caused by big game animals or game birds, and sworn by the claimant on the verified claim to have occurred; or, extraordinary damage to grass that is caused by big game animals or game birds and sworn by the claimant on the verified claim to have occurred; and, actual damage to livestock or bees including honey and hives, that is caused by trophy game animals and sworn by the claimant on the verified claim to have occurred. Damage shall not include damage to other real or personal property including, but not necessarily limited to: other vegetation or animals; motor vehicles; structures; damages caused by animals other than big game animals, trophy game animals or game birds; diseases; lost profits; consequential damages; or, any other damages whatsoever that are not specified in this regulation.

(k) “Disinterested arbitrator” means an elector residing in the county where the damage occurred, who is capable of making a reasoned and unbiased decision based on evidence presented to the Board by the claimant and the Department.

(l) “Extraordinary damage to grass” means the loss or harm as proven by the landowner, lessee, or agent that significantly exceeds the usual, customary or average use of non-cultivated grass plants of the Family Graminae.

(m) “Growing cultivated crops” means crops or other vegetation that are grown on privately owned or leased land and harvested or utilized annually for commercial sale or to feed livestock, or for human consumption. “Growing cultivated crops” can include grasses and legumes maturing for harvest, small grains, row crops and vegetables, plants grown in commercial nurseries, commercial orchards, commercial gardens, and native hay meadows that are managed for hay or livestock forage. If the crop is not harvested or utilized annually, it is not a growing cultivated crop unless it requires more than one (1) year to become established and ready for harvest. “Growing cultivated crops” do not include rangelands managed for livestock forage, or products of nurseries, orchards, and gardens that are not intended for commercial sale.

(n) “Hearing” means a procedurally correct arbitration hearing as described in Section 8 of this Regulation that shall be conducted in such manner as to afford the claimant and the Department the opportunity to present, examine, and cross-examine all witnesses and other forms of evidence presented to the Board.

(o) “Hives” means an artificial structure designed and constructed specifically for housing bees.

(p) “Improvements” means a valuable addition made to real estate to increase the productivity or value of land, including fences and man made structures erected or windbreaks or shelterbelts planted on privately owned or leased land to enhance or improve crop or livestock production or grazing management or as a protection for livestock.

Improvements shall not include windbreaks or shelterbelts, if they are not planted solely to enhance or improve crop production or grazing management or as a protection for livestock.

(q) "Investigated by the Department" means an inspection determined by the Department to be a reasonable assessment of the damage caused by big or trophy game animals or game birds.

(r) "Kill permit" means a permit authorized by a Game and Fish Commissioner and the Chief Game Warden granting authority to take big game animals, trophy game animals or game birds that are causing substantial damage to property.

(s) "Land" means soil on privately owned or leased land.

(t) "Lessee" means a person who leases fee title land or State land for agricultural purposes.

(u) "More likely than not" means evidence reasonably tending to support the conclusion. Evidence that is competent, relevant, and material, and which to a rational and impartial mind naturally leads, or involuntarily leads to conclusion for which there is valid, just and reasonable substantiation.

(v) "Office of the Department" means the Wyoming Game and Fish Department, 5400 Bishop Blvd., Cheyenne, Wyoming 82006-0001 or the Wyoming Game and Fish Department, 3030 Energy Lane, Casper, Wyoming 82604.

(w) "Permitted hunting during authorized hunting seasons" means permitted hunting as described in Section 4 of this regulation.

(x) "Promptly served upon each party" means within ten (10) days following the arbitration hearing, the Board shall serve a written copy of its decision to the Office of the Department and the claimant.

(y) "Property" means livestock or bees, land, growing cultivated crops, stored crops including honey and hives, seed crops, improvements or grass that has been extraordinarily damaged.

(z) "Reasonable expense charges" means compensation given to an arbitrator while performing duties as an arbitrator that is the same compensation rate afforded to State employees by State statute for per diem and vehicular mileage; and, actual expenses incurred by the arbitrator and documented by receipt including, but not necessarily limited to, telephone calls, paper supplies, and mail service.

(aa) "Reasonable service charges" means reimbursement in the amount of one hundred ($100) dollars per day for performing duties as an arbitrator.

(bb) “Seed crops” means any crop intentionally planted, managed, and grown in accordance with accepted agricultural practices on privately owned or leased land for the production of seed for future propagation and that is harvested annually by manual or mechanical means. If the crop is not harvested annually, it shall not be classified as a seed crop unless the crop normally requires an establishment period of longer than one (1) year to be harvested or unless the crop is alfalfa seed or crested wheat grass seed.

(cc) “Stored crops” means crops that have been harvested and saved or stored for future use in accordance with accepted agricultural practices.

(dd) “Supervisor” means Regional Wildlife Supervisor.

(ee) “Trophy game animals” means black bear, gray wolf, grizzly bear or mountain lion or gray wolf in accordance with W.S. §23-1-901(g).

(ff) “Value of livestock” means the monetary value of individual livestock on the date the verified claim was filed with the Office of the Department based upon the fair market value on that date for like livestock at a rate substantiated by a livestock sales barn or other credible written valuation of the livestock provided by the claimant. However, the monetary value of young of the year livestock on the date the verified claim was filed with the Office of the Department shall be based upon the fair market value on that date for like livestock at the weaning weight substantiated by a livestock sales barn or other credible written valuation of the livestock provided by the claimant.

(gg) “Verified claim” means a Trophy Game Animal Damage Claim Affidavit or a Big Game Animal or Game Bird Damage Claim Affidavit that has been signed by the claimant and sworn to be accurate before a person authorized to administer oaths, that has been filed with the Office of the Department and contains all information required in Section 9 of this regulation.

Section 3. Damage to Livestock by Trophy Game Animals. Except as specified in subsection (a) of this section, the Department shall only offer payment for damage to individual livestock confirmed by the Department or its representative as having been injured or killed by a trophy game animal.

(a) In geographic areas determined by the Department to have terrain, topography, and vegetative characteristics that influence the ability of the claimant and Department to find missing calves and sheep that are believed to have been damaged as a result of a trophy game animal, the Department shall utilize the methods, factors and formulas in this subsection to determine the amount to compensate any landowner, lessee or agent for calves and sheep missing as a result of damage caused by a trophy game animal.

(i) Any claimant whose verified claim is for missing sheep or calves believed to have been damaged as a result of a trophy game animal, shall include on his verified claim the total known death loss, including missing animals, for the sheep or calves for the grazing season together with the number of such losses known to be due to causes other than damage by a trophy game animal.

(ii) Notwithstanding the use of the formulas in this section, the Department shall not offer compensation for more than the total known death loss less the number of such losses known to be due to causes other than damage by a black bear, grizzly bear, mountain lion, or gray wolf in those areas where gray wolves are designated as trophy game animals in accordance with Commission regulation. In order to utilize any formula, the Department or its representative must have confirmed the claimant had at least one (1) calf or one (1) sheep injured or killed by a trophy game animal.

(A) Calves and sheep in areas occupied by grizzly bears. To determine the amount of compensation due to a claimant for calves and sheep believed to be missing as a result of being damaged by a black bear, grizzly bear, or mountain lion in areas occupied by grizzly bears, the Department shall utilize the following formula:

(I) Number of individual calves or sheep confirmed by the Department or its representative killed by a black bear, grizzly bear, or mountain lion multiplied by three and one-half (3.5) multiplied by the value of livestock equals the amount of compensation.

(II) Sheep in areas not occupied by grizzly bears. To determine the amount of compensation due to a claimant for sheep believed to be missing as a result of being damaged by a black bear or mountain lion in areas not occupied by grizzly bears, the Department shall utilize the following formula:

(III) Number of individual sheep confirmed by the Department or its representative killed by a black bear or mountain lion multiplied by three (3) multiplied by the value of livestock equals the amount of compensation.

(iii) Sheep in areas set forth by Commission regulation where gray wolves are designated as trophy game animals. To determine the amount of compensation due to a claimant for sheep believed to be missing as a result of being damaged by gray wolves, in areas occupied by wolves, the Department shall utilize the following formula:

(A) Number of individual sheep confirmed by the Department or its representative killed by a gray wolf multiplied by seven (7) multiplied by the value of livestock equals the amount of compensation.

(iv) Calves in areas set forth by Commission regulation where gray wolves are designated as trophy game animals. To determine the amount of compensation due to the claimant for calves believed to be missing as a result of being damaged by gray wolves, in area occupied by gray wolves, the Department shall utilize the following formula:

(A) Number of individual calves confirmed by the Department or its representative killed by gray wolves multiplied by seven (7) multiplied by the value of livestock equals the amount of compensation.

(b) Veterinary costs for the treatment of individual livestock that have been injured by a trophy game animal shall be considered up to a maximum amount that is not to exceed the value of the livestock injured, only in cases where a licensed veterinarian believes the individual livestock in question had a reasonable chance to survive and return to a productive state. If the individual livestock died as a result of an injury inflicted by a trophy game animal, even though the livestock received veterinary care, payment shall only be made up to a maximum of the value of the livestock.

Section 4. Permitted Hunting During Authorized Hunting Seasons.

(a) A landowner shall not be eligible to receive an award for damage caused by big game animals, trophy game animals, or game birds unless the landowner has permitted hunting during authorized hunting seasons for the species for which the verified claim has been filed on his privately owned or leased land and adjoining Federal or State land within the herd unit in which the damage occurred in accordance with this section. For an award to be allowed, the landowner shall permit hunting during authorized hunting seasons delineated in subsection (i)(A) if the species of big game animals, trophy game animals, or game birds for which the verified claim was filed were present on the landowner's privately owned or leased land and adjoining Federal or State land during authorized hunting seasons delineated in subsection (i)(A). If the species of big game animals, trophy game animals, or game birds for which the verified claim has been filed were not present on the landowner's privately owned or leased land and adjoining Federal or State land during the authorized hunting seasons as delineated in subsection (i)(A), for an award to be allowed the landowner shall permit hunting during authorized hunting seasons delineated in (i)(B) and (i)(C) if requested by the Department. The landowner shall permit hunting during authorized hunting seasons delineated in (i)(B) and (i)(C) without access fees to hunters or the Department.

(i) Authorized hunting seasons include:

(A) Hunting seasons as established by Wyoming Game and Fish Commission rule and regulation;

(B) Depredation prevention hunting seasons as approved by a District Wyoming Game and Fish Commissioner and the Chief Game Warden; or,

(C) Lethal taking of wildlife through a kill permit as approved by a District Wyoming Game and Fish Commissioner and the Chief Game Warden.

(b) The Department shall determine if the landowner permitted hunting during authorized hunting seasons for the species of big game animals, trophy game animals, or game birds for which the verified claim has been filed. For an award to be allowed, the Department shall have to determine the landowner allowed sufficient numbers of hunters to access his privately owned or leased land and adjoining Federal or State land to harvest more than the number of big game animals, trophy game animals or game birds recruited in the preceding twelve (12) months into the segment of the population responsible for doing damage. The landowner shall contact the game warden to whom he reported the damage to determine how many big game animals, trophy game animals, or game birds meets the requirement of more than the number of big game animals, trophy game animals or game birds recruited in the preceding twelve (12) months into the segment of the population responsible for doing damage. An award may be allowed if the Department determines a reduction in big game animals, trophy game animals or game birds affects the Department's ability to sustain the population at the objective the Commission has established for the herd unit.

Section 5. Notification of Damage and Filing of Damage Claims.

(a) Any claimant who has incurred damage as defined in Section 2 of this Regulation shall report the damage to the nearest game warden, supervisor, or Commission member within fifteen (15) consecutive days following the date damage was discovered. If the claimant intends to take actions that prevent the damage being investigated by the Department, such as harvest of damaged crops or removal of damaged livestock, the claimant shall notify the nearest game warden, supervisor, or Commission member as soon as reasonably possible after discovery of the damage so the damage can be investigated by the Department prior to removal, harvest, modification, or destruction of the damaged property; however, in no case shall the claimant take actions that preclude the damage being investigated by the Department. If the claimant denies or precludes the damage being investigated by the Department, the Department shall deny the verified claim.

(b) The claimant shall present a verified claim in accordance with Section 9 of this regulation to the Office of the Department within sixty (60) consecutive days following the date the last item of damage was discovered.

(i) For verified claims of damage to individual livestock by a trophy game animal, the sixty-day (60) period shall commence from the last date the livestock were present on the grazing allotment or geographic location where the damage occurred;

(ii) For verified claims of damage to bees, honey, and hives by a trophy game animal, the sixty (60) day period shall commence from the last date damage occurred or from the last date the bees, honey, or hives were present on the location where the damage occurred, whichever date occurs first; and,

(iii) For verified claims of damage to land, growing cultivated crops, seed crops, stored crops, improvements, or extraordinary damage to grass by big game animals or game birds, the sixty (60) day period shall commence from the last date the growing cultivated crop or seed crop was harvested or the land, stored crops, or improvements were damaged or the extraordinary damage to grass occurred.

(c) If a claimant chooses to appeal the Department's decision regarding a verified claim to the Commission, the claimant shall file a written appeal that is received by the Office of the Department within thirty (30) consecutive days from the date the claimant received the Department's notification of its decision on the verified claim.

(d) The claimant shall have no right of appeal to the Commission of the Department's denial of the claim if based upon the information provided by the claimant in the verified claim, the claimant failed to comply with subsection (a) or (b) of this section. The claimant shall have no right of appeal to the Commission of the Department's decision on a verified claim if the claimant failed to comply with subsection (c) of this section.

Section 6. Investigation and Payment of Verified Claims.

(a) When investigating damage claims, the Department shall utilize the standard of "more likely than not" in determining whether or not the damage was the result of big or trophy game animals or game birds.

(b) The Department shall consider damage that was discovered by the claimant and reported to the nearest game warden, supervisor or Commission member within fifteen (15) consecutive days after the date the damage was discovered. Any damage that was reported more than fifteen (15) consecutive days after the date it was discovered by the claimant shall not be considered by the Department as damage under this regulation.

(c) The Department shall investigate the verified claim and either reject the claim or provide for full or partial payment to the claimant within ninety (90) consecutive days following the date the Office of the Department received the verified claim.

Section 7. Reasons for Denial of a Verified Claim.

(a) The Department shall deny the verified claim for any of the reasons specified in this subsection.

(i) The claimant did not report the damage to the nearest game warden, supervisor or Commission member within fifteen (15) consecutive days after the date the damage was discovered. Any damage that was reported more than fifteen (15) consecutive days after the date it was discovered by the claimant shall not be considered by the Department as damage under this regulation.

(ii) The damage was caused by animals or wildlife other than big game animals, trophy game animals or game birds.

(iii) The big or trophy game animals or game birds causing damage were on the landowner's privately owned or leased land and adjoining Federal or State land during authorized hunting seasons as specified in Section 4(a)(i)(A), and the landowner did not permit hunting in accordance with Section 4(a) of this regulation.

(iv) The big or trophy game animals or game birds causing damage were not on the landowner's privately owned or leased land and adjoining Federal or State land during authorized hunting seasons as specified in Section 4(a)(i)(A), and the landowner would not agree to the Department's implementation of a depredation prevention hunting season as specified in Section 4(a)(i)(B) or insisted on charging an access fee to hunters to participate in a depredation prevention hunting season as specified in Section 4(a).

(v) The big or trophy game animals or game birds causing damage were not on the landowner's privately owned or leased land and adjoining Federal or State land during authorized hunting seasons as specified in Section 4(a)(i)(A), and the landowner would not agree to the Department's implementation of a kill permit as specified in Section 4(a)(i)(C) or insisted on charging an access fee to the Department to implement a kill permit as specified in Section 4(a).

(vi) The verified claim was for property not defined as property in Section 2 of this regulation.

(vii) The claimant was compensated by crop or livestock insurance or a Federal subsidy program for the property damaged to the extent the claimant received compensation under that insurance or program.

(viii) The claimant did not present a verified claim complete with all required information specified in Section 9 of this regulation to the Office of the Department within sixty (60) days after the damage or last item of damage was discovered by the claimant.

(ix) The verified claim was for consequential damages.

(x) Hunting was not permitted during authorized hunting seasons on land in a platted subdivision where the damage occurred due to the actions of a municipal or county ordinance, or homeowners' association covenant prohibiting the discharge of firearms.

(xi) Due to actions of the claimant, the damage was not investigated by the Department.

(xii) The landowner prevented the Department's attempts to mitigate or alleviate the damage through such actions as moving the big or trophy game animals or game birds responsible for the damage or the claimant refused to utilize fencing materials provided by the Department to protect stored crops, including honey and hives.

Section 8. Arbitration.

(a) If the claimant wishes to appeal the Commission's decision regarding a verified claim, the claimant shall file a written call for arbitration with the Office of the Department within ninety (90) consecutive days from the date the claimant received written notice from the Office of the Department of the Commission's decision.

(b) If the claimant calls for arbitration, the claimant and the Office of the Department shall each appoint a disinterested arbitrator within fifteen (15) consecutive days from the date the Office of the Department received the written call for arbitration.

(c) When the claimant and the Office of the Department appoint arbitrators, written notification of the name, mailing address, and telephone number of arbitrators they selected shall be made by each party to the other within fifteen (15) consecutive days from the date the Office of the Department received the written call for arbitration.

(d) Within twenty (20) consecutive days after their appointment, the two (2) arbitrators shall appoint a third arbitrator. The two (2) arbitrators selected shall notify both the claimant and the Office of the Department in writing of the name, mailing address, and telephone number of the third arbitrator selected. If the third arbitrator is not appointed within this time period, the judge of the district court of the county or the court commissioner in the absence of the judge shall appoint the third arbitrator upon the application of either arbitrator.

(e) The three (3) arbitrators shall appoint a chairman who shall chair the Board and serve as secretary to carry out the correspondence of the Board.

(f) At least twenty (20) consecutive days before the hearing, the Board shall provide the claimant and the Office of the Department written notice of the time and place in the county when and where the testimony of the claimant and the Department shall be heard and the claim investigated and decided by the Board.

(g) Following the arbitration hearing, the Board shall within ten (10) days provide a written copy of its decision to the Office of the Department and the claimant.

(h) Unless otherwise specified in this section, the Uniform Arbitration Act, W.S. § 1-36-101 et seq. shall apply to the hearing.

(i) The decision of the Board shall become part of the Office of the Department's file and shall be made part of the record in the event of an appeal of the Board's decision and any appeal to district court shall be conducted in conformity with the Uniform Arbitration Act, W.S. §1-36-114(a) or W.S. §1-36-115.

Section 9. Verified Claim Requirements. The verified claim required by W.S. 23-1-901(b) shall be submitted on the form prescribed by the Department. The verified claim shall contain the following information:

(a) A description of the land on which the damage occurred, including the legal description (section, range, township), the county in which the land is located, and whether the land is privately owned, leased, or federally owned;

(b) Whether the claimant is the landowner, lessee, or agent of the landowner or lessee;

(c) A description of individual livestock, including the number, age class and sex if known, or description of bees, including honey and hives, damaged or killed by a trophy game animal;

(d) A description of the land, growing cultivated crops, stored crops, seed crops, or improvements damaged by a big game animal or game bird; or a description of the grass extraordinarily damaged by a big game animal or game bird;

(e) Competent, relevant and material evidence provided by the claimant that a big game animal, trophy game animal, or game bird caused the damage;

(f) The dates during which damage took place, to include the specific date the damage was discovered by the claimant and the specific date the damage ended;

(g) The amount and value of livestock or property damaged, including all calculations and evidence supporting the value determination;

(h) The species and number, if known, of big or trophy game animals or game birds that caused the damage;

(i) The name of the game warden, supervisor or Commission member to whom the claimant reported the damage and the specific date it was reported;

(j) Information to allow the Department to determine whether or not the landowner permitted hunting during authorized hunting seasons for the species causing damage in accordance with Section 4 of this regulation;

(k) Information as to whether or not an access fee was charged by the claimant for permitting hunting during authorized hunting seasons for the species of big game animal, trophy game animal or game bird for which the verified claim was filed; the total amount of access fee charged per hunter; and, the total number of hunters permitted to hunt during authorized hunting seasons for the species causing damage;

(l) Information by which the Office of the Department can recognize the claimant signed and swore before a person authorized to administer oaths (notarized) the verified claim to be accurate;

(m) For verified claims for calves and sheep missing as a result of damage by a trophy game animal, the total known death loss, including missing animals, for the sheep or calves for the grazing season together with the number of such losses known to be due to causes other than damage by a trophy game animal;

(n) Information to indicate if all or what portion of the property damaged was compensated for by crop or livestock insurance or a Federal subsidy program to the extent the claimant received compensation under that insurance or program; and,

(o) The claimant may submit additional supporting information, which shall be considered as part of the verified claim.

WYOMING GAME AND FISH COMMISSION
Dated: January 22, 2014

Appendix J. Yellowstone Grizzly Bear Management Plan (State of Idaho)

State of Idaho

Yellowstone Grizzly Bear Management Plan

to accompany HCR 62

Prepared by:

Idaho's Yellowstone Grizzly Bear

Delisting Advisory Team

As Modified by:

House Resource and

Conservation Committee

on March 13, 2002

March 2002

Table of Contents

ACKNOWLEDGMENTS

Idaho's Yellowstone Grizzly Bear Delisting Advisory Team is composed of individuals from Idaho, representing a wide variety of interests. Their primary goal was to develop recommendations for management of grizzly bears in Eastern Idaho that consider all the varied landscapes, people, current land uses, culture, grizzly bear ecology, and legal requirements once the population was removed from protection under the Endangered Species Act. Without dedication of the members and willingness to work together, this project would likely not have succeeded. Members of the Delisting Advisory Team (DAT) include:

Mark Orme, Team Leader, Idaho Falls
Dan Christopherson, Fort Hall
Brent Ferguson, Ririe
Marv Hoyt, Idaho Falls
Gerald Jeppesen, Rexburg
Delane Kritsky, Pocatello
Bruce Mincher, Idaho Falls
Jim Peek, Viola
Cindy Siddoway, Terreton
Jim Gerber, Alternate, St. Anthony
Kent Marlor, Alternate, Rexburg
Brent Robson, Alternate, Tetonia

The Delisting Advisory Team was provided logistical and technical support by a number of agency personnel representing the Governor's Office of Species Conservation (OSC), Idaho Dept. of Fish and Game (IDFG), and the U.S. Fish and Wildlife Service (USFWS) including:

Jim Caswell, OSC, Boise
Steve Huffaker, IDFG, Boise
Roger Fuhrman, IDFG, Boise
Bob Saban, IDFG, Idaho Falls
Brad Compton, IDFG, Idaho Falls
Lauri Hanauska-Brown, IDFG, Idaho Falls
Gregg Losinski, IDFG, Idaho Falls
Tanya Richardson, IDFG, Idaho Falls
Larry Dickerson, USFWS, Chubbuck

Facilitator Pat Entwistle, Horseshoe Bend, provided the necessary guidance and encouragement for the Delisting Advisory Team to move forward and complete its assignment in a timely fashion.

Disclaimer:

This plan was modified by the 56th Idaho Legislature, Second Regular Session. As a result of these amendments, certain members of the DAT may no longer support the management direction contained in this plan.

INTRODUCTION

The recommendations included within this document are only applicable to the grizzly bear population associated with Yellowstone National Park and surrounding areas. No recommendations are presented for the Selkirk, Cabinet-Yaak, or Selway-Bitterroot recovery areas. Furthermore, it is the policy of this management plan that no grizzly bears from the Yellowstone population be translocated to unoccupied range within Idaho.

Background

In the lower 48 states, grizzly bears were eliminated from 98% of their historic range during a 100-year period (Mattson et al. 1995). The 1920s and 1930s drove grizzlies to extinction throughout much of their range. Of 37 bear populations present in 1922, 31 were eliminated by 1975 (Servheen 1999). Currently there are five recognized grizzly bear populations in portions of Wyoming, Montana, Idaho, and Washington. Three of these populations contain fewer than 35 individuals.

The Yellowstone population, residing in portions of Idaho, Montana, and Wyoming currently contains an estimated 400-600 individuals. The grizzly bear was listed as "Threatened" under the Endangered Species Act in 1975, with primary management under the direction of the US Fish and Wildlife Service (USFWS). After delisting, the states would assume the primary management role within their respective state boundaries.

Currently, Idaho classifies grizzly bears as a Threatened species, making it illegal to take or possess grizzly bears except under certain circumstances, including scientific research, propagation, to stop damage to property and water rights and other specific circumstances outlined in 36-106(e)5 and 36-1107, Idaho Code. (Appendix I). In addition, the following Idaho State Statutes apply to management of all fish and wildlife species, including threatened species:

36-103 (a). Wildlife property of State – Preservation – Wildlife Policy. All wildlife, including all wild animals, wild birds, and fish, within the State of Idaho, is hereby declared to be the property of the State of Idaho. It shall be preserved, protected, perpetuated, and managed. It shall only be captured or taken at such times or places, under such condition, or by such means, or in such manner, as will preserve, protect, and perpetuate such wildlife, and provide for the citizens for the State and, as by law permitted to others, continuous supplies of such wildlife for hunting, fishing and trapping.

(b). Commission to Administer Policy. Authority, power and duty of the Fish and Game Commission to administer and carry out the provisions of the Idaho Fish and Game Code. The commission is not authorized to change the state's wildlife policy but only to administer it.

36-201. Fish and Game Commission authorized to classify wildlife. With the exception of predatory animals, the Idaho Fish and Game Commission is hereby authorized to define by classification or reclassification all wildlife in the State of Idaho. Animals currently classified as 'predatory' include coyote, jackrabbit, skunk, weasel, and starling.

The Grizzly Bear Recovery Plan (USFWS 1993) identifies specific criteria that must be accomplished prior to a change in status for the grizzly bear. Along with specific population criteria that have been met; habitat based recovery criteria, only within the Primary Conservation Area (PCA), would be developed and a Conservation Strategy would be prepared. Amendments to the Recovery Plan and the Draft Conservation Strategy (USFWS 2000) were submitted to the public for review in the spring of 2000. The habitat based recovery criteria will be finalized and appended to the Recovery Plan. The Conservation Strategy will be a cooperative management plan that describes agency interactions, regulatory mechanisms, population management, population monitoring, habitat monitoring, and habitat management that will be in effect after delisting. The Draft Conservation Strategy currently applies to the existing Recovery Zone (named the Primary Conservation Area in the Draft Conservation Strategy) and a 10-mile buffer. The final Conservation Strategy will have two primary roles. First, it will describe and summarize the coordinated efforts to manage the grizzly bear population and its habitat, and the public education/involvement efforts that will be applied to ensure continued conservation of the grizzly bear in the greater Yellowstone area. Secondly, it will document the regulatory mechanisms that exist to maintain the Yellowstone population as recovered through the legal authorities, policy, guidelines, management programs, monitoring programs, and the commitment of participating agencies. While the Conservation Strategy is in effect, there will be goals for population size and habitat status. If these goals are not met, the grizzly bear could be relisted.

Upon delisting, the Idaho Fish & Game Commission will have ultimate authority and obligation for managing grizzly bears within Idaho. Management of the population outside the PCA will be directed by state management plans, as approved by the Idaho Legislature, under the guidance of Idaho Dept. of Fish and Game, while management of the grizzly bear population within the PCA will be guided by the Conservation Strategy.

The Yellowstone Ecosystem Subcommittee (YES) of the Interagency Grizzly Bear Committee (IGBC) produced the "Draft Conservation Strategy for the Grizzly Bear in the Yellowstone Area." The governors of Idaho, Wyoming, and Montana appointed a 15-member citizen roundtable to review the strategy. This Governors' Roundtable identified and reached consensus on a number of issues and provided a series of recommendations. The Governors ultimately endorsed the following recommendations:

1. A Primary Conservation Area (PCA) should be designated and managed conservatively to protect a core of secure habitat and grizzly bear numbers. They endorsed the current size and management guidelines for the PCA.
2. Agencies should establish a joint agency-citizen education committee to promote better understanding and awareness of grizzly bear conservation needs. Key messages should include realistic information on grizzly bear management, living with grizzly bears, and hunting in grizzly bear country without encountering problems.
3. The Yellowstone Grizzly Management Committee (currently YES) should be expanded to include three (3) non-voting members from each state, appointed by the governors, to add citizen perspectives to management.
4. In the short term, states should continue funding essential grizzly bear recovery efforts. In the long term, better funding mechanisms are needed to distribute the cost equitably among interests that support grizzly bear conservation. The governors and congressional delegations from Idaho, Montana, and Wyoming should pursue additional federal funding.
5. State management plans for areas outside the PCA should be developed concurrently with the revision of the Draft Conservation Strategy and should seek to:
    a. Ensure the long-term viability of grizzly bears and preclude relisting.

b. Support expansion of grizzly bears beyond the PCA, into areas that are biologically suitable and socially acceptable.
c. Manage grizzly bears as a game animal, including allowing regulated hunting when and where appropriate.

Recommendation #5 initiated the development of a state plan. The section of Idaho Code that created the Office of Species Conservation authorizes a procedure to be followed in development of state management plans for Threatened and Endangered species (Appendix II).

Based on the procedure, Delisting Advisory Team members were selected in July 2001. Eight management planning meetings were held and attended by Delisting Advisory Team members, representatives of IDFG, U.S. Fish and Wildlife Service, Office of Species Conservation, regional experts on grizzly bear biology, and members of the public. Public comment was accepted throughout the plan's development. Public opinions and ideas were considered by the team and included in the plan where appropriate.

Plan Development & Scope

This document provides the recommended components of grizzly bear management in Eastern Idaho, as developed by the Delisting Advisory Team. Upon review by the Director of the Idaho Dept. Fish and Game, Fish and Game Commission, and the Idaho legislature, these recommendations will be approved and adopted as the management plan for grizzly bears in Eastern Idaho. The primary reason for most management efforts is to ensure long-term annual benefits from the wildlife resource to the human population. Such management efforts also benefit wildlife populations. A variety of "products" are provided by healthy wildlife populations, including tangibles such as harvest, watchable wildlife, scientific values, and recreational economic benefits, and intangibles such as social and cultural values. Wildlife is held in public trust for the people of Idaho, who ultimately decide which mix of products is most desirable.

Throughout this document the team has attempted to consider the interests of all Idahoans, as well as the needs of the grizzly bear, within biological, economic, social, and staffing constraints. If problems exist which are impossible to correct, it is important for the Department, in consultation with affected stakeholders, to re-evaluate and adjust management direction.

Upon review, final approval, and implementation of the recommendations contained within this document, it is recommended that a termination date not be established. Future management must be adaptive and responsive over time. As new data and knowledge of various biological and sociological factors are attained, management programs and frameworks will be adjusted and monitored as to their effect. An integral component to adaptive management is input and involvement by all affected stakeholders. The Department will work diligently toward informing and involving all publics interested in management of the grizzly bear.
Overall, the goal of the recommendations is to allow for the compatible co-existence of grizzly bears and humans in Eastern Idaho grizzly bear habitat. Management programs and frameworks must be adaptive and responsive in order to serve Idaho's citizens as well as grizzly bears.

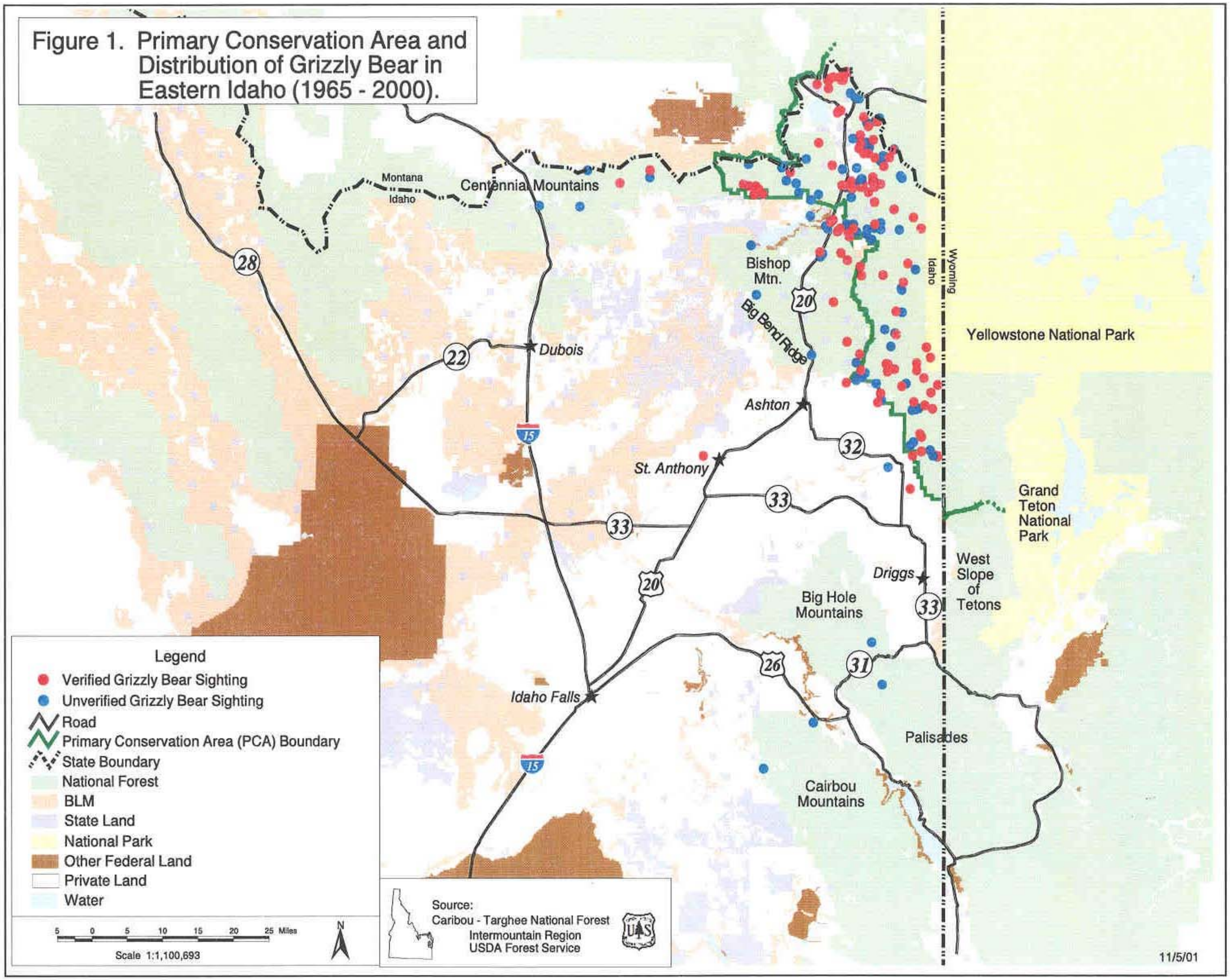

Figure 1. Primary Conservation Area and Distribution of Grizzly Bear in Eastern Idaho (1965 - 2000).
Montana
Idaho
Centennial Mountains
Bishop Mtn.
Big Bend Ridge
Dubois
Ashton
St. Anthony
Yellowstone National Park
Wyoming
Idaho
Grand Teton National Park
West Slope of Tetons
Driggs
Big Hole Mountains
Idaho Falls
Palisades
Cairbou Mountains
28
22
15
20
32
33
26
31
Legend
Verified Grizzly Bear Sighting
Unverified Grizzly Bear Sighting
Road
Primary Conservation Area (PCA) Boundary
State Boundary
National Forest
BLM
State Land
National Park
Other Federal Land
Private Land
Water
5 0 5 10 15 20 25 Miles
Scale 1:1,100,693
N
Source:
Caribou - Targhee National Forest
Intermountain Region
USDA Forest Service
11/5/01

Grizzly Bear Ecology

The grizzly bear is an opportunistic omnivore that readily adapts to a wide range of habitats. Historically, suitable bear habitat existed throughout North America, but current distribution is restricted to Alaska, Canada, and four (4) western states (Miller and Schoen 1999, McLellan and Banci 1999, Servheen 1999). In Idaho, grizzly bears currently occupy the Greater Yellowstone Ecosystem (GYE, Fig. 1), Selkirk Ecosystem, and Cabinet/Yaak Ecosystem. Grizzly bears historically occupied the Bitterroot Mountains of central Idaho, but no evidence supports current occupation of the area (Melquist 1985, Groves 1987, Servheen et al. 1990, Kunkel et al. 1991). Servheen (1999) completed a review of grizzly bear distribution in the lower 48 states.

Grizzly bear home ranges within the GYE are larger than those reported for other grizzly bear populations. Larger home ranges can indicate low environmental productivity and increased foraging requirements to meet bear nutritional needs. From 1975-1987, the Interagency Grizzly Bear Study Team reported mean home range sizes of 874 km^2 for adult males and 281 km^2 for adult females in the GYE. Females with new cubs used slightly less area, and those with yearlings used more. Subadult males disperse from their natal ranges to establish new home ranges, and these spatial requirements probably limit ultimate population density.

Within the GYE, a variety of foods are available to the grizzly bear; however, seasonal variation, weather, and human disturbance can influence the bear diet. To a large degree, abundance of high-quality foods dictates body size, reproductive rates, and population density. Animal matter is arguably one of the most valuable bear foods (Welch et al. 1997, Hilderbrand et al. 1999). Bears are most successful feeding on animals that are abundant and vulnerable to their predatory skills. For some interior populations, trout may provide a high-quality seasonal food. In the GYE, it is estimated that 30-50 grizzly bears forage annually on spawning cutthroat trout (*Oncorhynchus clarki*) in tributary streams of Yellowstone Lake (Reinhard and Mattson 1990). During the spring, grizzly bear use of ungulates, both scavenged and as neonate prey, is extensive (Gunther and Renkin 1990, French and French 1990, Green 1994). The annual percentage of energy obtained from ungulate meat is considerably higher in GYE than for other interior populations (Hilderbrand et al. 1999).

Use of ungulates abates during summer as bears use habitats that supply a variety of graminoids, forbs, and root crops (Mattson et al. 1991a). Yellowstone lacks significant berry-producing habitats. Consequently, bears use high-elevation sites to feed on whitebark pine (*Pinus albicaulis*) nuts (Blanchard and Knight 1991, Mattson et al. 1991a). Pine nuts are high in fat and one of the most energy-rich foods consumed by bears. When abundant, bears use pine nuts to the exclusion of most other foods. Throughout much of its range, however, whitebark pine has been severely impacted by an exotic fungus, white pine blister rust (*Cronartium ribicola*). The rust is present and spreading in the Yellowstone area (Smith and Hoffman 1998).

Army cutworm moths (*Euxoa auxiliaris*) are also valuable seasonal foods (Klaver et al. 1986, Mattson et al. 1991b, White 1996), as they are high in lipid and calorie content (Kevan and Kendall 1997, White et al. 1999). Studies from Glacier National Park (White et al. 1999) indicate that a foraging bear can consume as many as 40,000 moths/day.

During failure of key natural food items, the search for alternative foods often results in an increase in the number of bear-human conflicts and an increase in human-caused bear mortality

(Blanchard 1990, Riley et al. 1994, Blanchard and Knight 1995). Additionally, development (e.g., summer homes, resorts, campgrounds) may result in a loss of habitat, while the attraction to these sites from poor sanitation practices may result in increased human conflict and bear mortality.

Causes of mortality in grizzly bears include natural death, illegal killing, defense of life or property killings, management actions, accidents, and unknown. Human-caused mortality is the primary cause of grizzly bear deaths (Fig. 2, Schwartz et al. in press), with the majority of deaths occurring near human facilities and access routes (Knight et al. 1988). Research has shown that grizzly bears avoid areas with high open road densities (Lloyd and Fleck 1977, Schallenberger and Jonkel 1980, Brannon 1984, Aune and Kasworm 1989). No human-caused bear mortalities have been documented in the past 17 years in Idaho. Recreational developments and various other human concentration areas can increase mortality rates of grizzly bears. Additionally, diverse attractants such as apple orchards, outfitter camps, and locations where people have persistently fed individual bears or unlawfully disposed of garbage have enticed bears into conflict situations, especially during periods of natural food shortage. The primary situations that result in human/grizzly conflict are: 1) food related – improper food storage or sanitation in either a backcountry, rural, or urban setting; 2) surprise encounters (e.g., sow defending cubs, bear defending a kill/carcass, bears surprised in close quarters and acting defensively); 3) human encroaching on a bear's space (e.g., photographer or tourist approaching a bear close enough to precipitate a defensive reaction; and 4) bears responding to a noise attractant (e.g., bear attracted to a hunter attempting to bugle or cow-call an elk, bears associating gunshots with a food source [carcass or gut pile]).

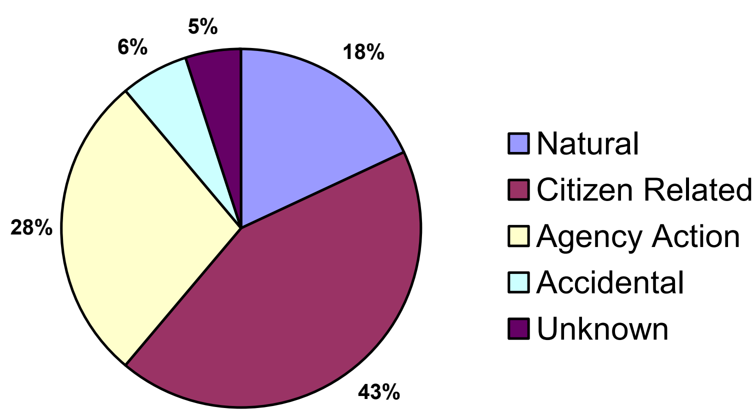

Figure 2. Causes of mortality in grizzly bears from unhunted populations in northwestern Montana and the Greater Yellowstone Ecosystem, 1975 – 1985 (Schwartz et al. in press).

In hunted populations, harvest tends to be greater in areas with access (Miller 1990a). Hunting impacts population composition in different ways, and regulations can impact the composition of harvests (Miller 1990b, Van Daele et al. 1990). Because bears are promiscuous, regulations that direct harvests toward males and away from adult females permit higher hunter quotas (Taylor et al. 1987). Not all bear deaths are detected and recorded. Miller (1990a) indicated that unreported sport or nuisance kills and wounding losses could represent significant sources of mortality that managers should consider.

Sustainable grizzly bear mortality levels are derived from estimates of population size and reproduction data (Miller 1990b). Because grizzly bears can sustain only very low mortality rates (a maximum of 5.7% was estimated by Miller [1990b]), most managers adopt conservative regulations to avoid overharvest.

Grizzly bears have a low reproductive rate relative to other mammals, a trait that critically impacts the species' survival in the presence of humans (Pasitschniak-Arts 1993, Craighead et al. 1995). The age of first litter production is dependent on maturation and body size (Blanchard 1987, Stringham 1990), which is positively related to diet quality (Hilderbrand et al. 1999). Mean age of first litter production from a sample of 15 females observed in Yellowstone National Park was 5.9 years (range = 5 – 9; Craighead et al. 1995). Cub litter size varies among individuals and populations but on average ranges between 1 and 3 young. Mean litter size has been correlated with adult female body mass; intake of dietary meat, primarily salmon and ungulates (Bunnell and Tait 1981, Stringham 1990, McLellan 1994, Hilderbrand et al. 1999); garbage (Stringham 1986); latitude (Bunnell and Tait 1981, Stringham 1984); climate; and a climate-carrion index (Picton 1978, Picton and Knight 1986). Litter size is also related to age, with young and old females producing fewer cubs per litter than prime-age adults (Craighead et al. 1974, 1995; Sellers and Aumiller 1994). The proportion of cubs in any population is a reflection of reproductive performance and early mortality and should be higher for more fecund populations. Although sex ratio at birth can favor males (Craighead et al. 1974; Craighead and Mitchell 1982; Knight and Eberhardt 1985, 1987), males generally have a lower rate of survival. The overall sex ratio in bear populations tends to be skewed towards females.

Agency Responsibilities

Idaho Dept. of Fish and Game (IDFG), under the direction of the Idaho Fish and Game Commission, will be the primary agency responsible for management of Yellowstone grizzly bears in Idaho. The Department, upon approval of the Idaho Legislature, will implement management actions within the financial, staffing, and legal limits that exist. Given that the grizzly bear population within the PCA includes parts of Idaho, Wyoming, Montana, Yellowstone National Park, and Grand Teton National Park jurisdictions, a highly coordinated and cooperative management effort among the management agencies will be necessary.

After delisting of the Yellowstone grizzly bear, the existing Yellowstone Ecosystem Subcommittee of the Interagency Grizzly Bear Committee will be renamed and operate as the management body responsible for coordination, implementation and evaluation of grizzly bear conservation within the Primary Conservation Area as specified in the Conservation Strategy. This group will continue as the 'Yellowstone Grizzly Bear Management Committee' and be responsible for:

1. Implementing the Conservation Strategy.
2. Ensuring that population and habitat data specified in the Conservation Strategy are collected and evaluated annually to monitor the current status of the grizzly bear population.
3. Sharing information and implementing management actions in a coordinated fashion.

4. Proposing management policy changes as necessary.
5. Establishing necessary task forces to implement management reviews and approved actions when necessary.
6. Identifying research needs and financial needs for management.
7. Implementing management and status reviews as necessary to ensure responsiveness of the agencies to changing circumstances of the grizzly or its habitat in Yellowstone.
8. Directing and coordinating information and education efforts.

The Governors of Idaho, Montana, and Wyoming have recommended that the Yellowstone Grizzly Bear Committee be expanded to include nine non-voting, governor-appointed members in order to provide local citizen perspectives to management.

The Idaho Legislature directs the Idaho Fish & Game Commission to coordinate with the IGBC and YES to incorporate citizen members with voting privileges into the Yellowstone Grizzly Bear Committee. Further, the legislature recognizes this would require an agreement by the majority of the Yellowstone Grizzly Bear Committee.

DISTRIBUTION AND OCCUPANCY

Goal: To manage a recovered grizzly bear population within suitable grizzly bear habitat in eastern Idaho and to provide for a population that is in a biologically suitable area and socially acceptable. Social acceptance of grizzly bears will depend on how management issues are approached and how much faith people have in managers.

The management direction established in the Draft Conservation Strategy is designed to maintain grizzly bear distribution and occupancy within the PCA and to keep mortalities at low levels. Management direction in the PCA has met the goals of the grizzly bear recovery plan. This management direction will allow for the grizzly bear population to occupy some limited areas outside of the PCA.

Outside of the PCA, the objective is to maintain existing resource management and recreational use and to develop a process whereby local publics can respond to demonstrated problems with appropriate management actions. By maintaining existing uses, people will feel less threatened both economically and in their lifestyles. The key to successful management of grizzly bears lies in bears utilizing lands that are not managed solely for them but in which their needs are considered along with other uses.

The majority of the biologically suitable habitat occurs on the Caribou-Targhee National Forest. A lesser amount of biologically suitable habitat occurs on public and state lands adjacent to the National Forest land. It is also anticipated that grizzly bears will occasionally occur on private lands.

During the next five to ten years, it is expected that grizzly bears will occur within the PCA and outside of the PCA in the following general areas: west through the Centennial Mountains; through the Island Park Caldera and out through the Bishop Mountain area and Big Bend Ridge areas; south along the Westslope of the Tetons and into the Palisades and Big

Hole Mountain areas (Fig. 1). Primarily roadless, these areas are the most likely to be inhabited by grizzly bears.

Grizzly bears are unique animals in their ability to exist in a wide range of habitats and habitat conditions. It would be premature to identify specific suitable habitats, given the bears flexibility in habitat use. Furthermore, it is anticipated that grizzly bears can successfully occupy a wide range of habitats in eastern Idaho and that compatible co-existence with traditional uses will be a major determining factor for their future. Grizzly bears will not be tolerated in areas with high human activity and/or development.

Bears that are trapped and relocated will only be relocated into the PCA, other grizzly bear occupied areas in Idaho, or acceptable areas outside the state. There will be no relocations into unoccupied areas in Idaho. In areas with high potential for human/grizzly bear conflicts, a variety of management options are available, including management for lower numbers of bears.

Motorized Access and Habitat Management

Inside the PCA, land management agencies will incorporate and maintain the motorized access management direction contained in the Draft Conservation Strategy. Outside of the PCA, IDFG will work with the land management agencies to achieve direction contained in approved federal land management plans, considering the needs of all wildlife species.

While IDFG recognizes the need to minimize negative impacts, it has no direct jurisdiction over land management activities on a majority of the land adjacent to the PCA. Therefore, IDFG will act in an advisory capacity with regard to potential impacts on grizzly bear habitat, and request federal land management agencies to consider the following grizzly bear issues in their land management plans for federal lands:

1. Identify and evaluate for each project proposal the cumulative effects of all activities, including past, current, and future projects.
2. Recommend management of human activities or combinations of activities on seasonally important wildlife habitats that minimize adverse impacts on the species or reduce the habitat effectiveness.
3. Continue to provide input into the planning process for all roads and new construction; recommend minimum road and site construction specifications, and construction times, based on the needs of grizzly bears and other wildlife species.
4. Recommend that roads, trails, drill sites, landing zones, etc., be located to avoid habitat components important to grizzly bears, based on site-specific evaluations.
5. Recommend that new roads that are not compatible with area management objectives and are no longer needed for the purpose for which they were built be restricted or decommissioned.
6. Recommend that native plant species be used whenever possible to provide proper watershed protection on disturbed areas. Wildlife forage and/or cover species will be used in rehabilitation projects where deemed appropriate.
7. For roads and/or trails that remain open, recommend seasonal closures and/or vehicle restrictions based on grizzly bear or other resource needs.

Livestock Conflicts

Inside the PCA, IDFG will support land management agencies in achieving the livestock management direction established in the Draft Conservation Strategy. The Targhee National Forest Land Management Plan recognizes livestock grazing as an important multiple use inside the PCA, and should be respected in the final Conservation Strategy.

On public lands outside of the PCA, while IDFG recognizes the need to coordinate wildlife and livestock management, it has no direct jurisdiction over livestock management activities. Therefore, IDFG will act in an advisory capacity with regard to impacts on grizzly bears and their habitat, encouraging land management agencies to consider the grizzly bear in their livestock management plans.

Habitat Monitoring

Inside the PCA, IDFG will adhere to the habitat monitoring requirements established in the Draft Conservation Strategy.

Outside the PCA:

1. IDFG will continue their normal monitoring programs for elk, deer, moose, kokanee, cutthroat trout, and other identified important food sources for grizzly bears.
2. On public lands, IDFG will encourage and work with land management agencies to monitor wetland and riparian habitats, whitebark pine, and important berry-producing plants.
3. On public lands, IDFG will encourage and work with land management agencies to monitor changes in motorized access. Monitoring efforts will focus on those areas that currently provide security for bears (areas that have no motorized access routes or motorized access route densities less than or equal to 1.0 mile per square mile).
4. In eastern Idaho, private lands are generally at lower elevations than most of the public lands. Undeveloped private lands may provide important spring habitat for some bears because they will provide early green-up. In addition, many of these undeveloped lower elevation lands provide important winter ranges for deer, elk, and moose, and winter-killed animals are an important food source for bears in the spring. On private lands, IDFG will work with citizens, counties, and other agencies to monitor development activities.
5. IDFG will identify important spring habitat for bears, then work with landowners to minimize impacts to bears during their period of use.

Habitat Restoration

Inside the PCA, IDFG will adhere to the habitat restoration measures as called for in the Draft Conservation Strategy.

Outside of the PCA, IDFG will encourage the public land management agencies in implementing existing management direction in land use plans. IDFG will identify site-specific changes that may be needed in existing land use plans, and will work with the public agencies through existing procedures and agreements to modify and amend land management plans. Examples of site-specific changes that may be considered include changes in motorized access, changes in livestock allotments, increasing productive whitebark pine stands, control of noxious weeds, and improvements in riparian and wetland habitats. Through this process the public will be able to have full participation in the decisions.

IDFG will assist private land owners who want to improve habitat conditions for wildlife (including the grizzly bear) on their lands by providing education materials and technical assistance.

POPULATION MONITORING

Goal: To develop and implement a science-based monitoring program that results in the data and tools necessary for IDFG to successfully manage grizzly bears.

The Draft Conservation Strategy states that human caused mortality for grizzly bears in the PCA should be limited to no more than 4% of the calculated population size (USFWS 2000). This means that mortalities in the three states and inside Yellowstone National Park must be recorded. State agencies would record all known mortalities and coordinate with the other jurisdictions to help with this assessment. Also, the Interagency Grizzly Bear Study Team will continue to monitor grizzly populations in accordance with the Draft Conservation Strategy. IDFG efforts will be coordinated with the efforts of the Interagency Grizzly Bear Study Team to ensure that the entire range of grizzly bears is monitored in Idaho and no unnecessary overlap in efforts occur. Outside the PCA, data analysis units will be established to facilitate monitoring distribution, abundance and mortality. This will be done in coordination with Wyoming and Montana.

Monitoring grizzly bears is complicated by their secretive nature and widely dispersed, low-density distribution. However, a number of techniques are available to assess population status and trend. Techniques that attempt to enumerate individuals can provide the most precise estimates of abundance. Mark-recapture estimates and DNA profiling currently provide quantitative estimates of abundance and require the greatest dedication of resources (personnel and operating dollars). These methodologies would be appropriate when finite estimates of the population are required for intensive management purposes. More qualitative assessments of populations can be accomplished by using techniques currently employed by the Interagency Grizzly Bear Study Team. Observations of females with young are documented, including results from organized aerial surveys. Distribution is further monitored by recording verified sightings of sign and/or bears. Additionally, cause-specific mortality is monitored. Although absolute estimates of abundance generally cannot be generated using observational data, relative population status and trend can be ascertained. A monitoring program that primarily uses observational data would require fewer resources to implement than those for generating precise population estimates. Finally, a monitoring program could consist of simply documenting verified sightings to assess distribution, with population trend inferences made from changes in distribution. This framework would cost the least in resources, but the opportunities for intensive management of grizzly bears would be limited due to the lack of quantifiable information.

Preferred Monitoring Framework

Monitoring will be directed at estimating females with young, bear distribution, and mortality. Estimation of population size using observations of sows with young is used in the Yellowstone Ecosystem (Knight et al. 1995) and has been validated (Boyce et al. 2001). Since sows produce approximately two (2) cubs once every three years, a minimum estimate of the adult female breeding population can be obtained with these observations (Eberhardt and Knight 1996). The percentage of adult females in the population is 27.4% (Eberhardt and Knight 1996), so the number of unduplicated females with cubs of the year summed over a three-year period can be divided by the percentage of females in the population to obtain a minimum population estimate. This system could be extended to the known range of the population in Idaho, using the same methodologies in order to make the information-gathering process comparable with ongoing assessments.

The preferred monitoring framework is to collect data on females with young; record other bear observations, including sign, to estimate known distribution; and document cause-specific mortality. It is believed that the density of grizzly bears in Idaho during the next few years will be so low that aerial surveys would provide little if any information. Instead, IDFG shall concentrate on soliciting and recording incidental sightings. This framework is generally consistent with what is currently being collected throughout the Yellowstone Ecosystem and therefore allows for uniformity and comparability with other data collection efforts. More intensive monitoring efforts such as capture and collaring and/or DNA profiling could be used to provide more precise information as needed and when adequate funding is available. Monitoring efforts will be coordinated with the Interagency Grizzly Bear Study Team to minimize overlaps.

As with other managed wildlife species, analysis units will be established. Habitat criteria, although monitored within each analysis unit, will not be established strictly for grizzly bears.

Additional Monitoring Activities

Additional, more intensive population monitoring will depend upon need and will be coordinated with adjacent states and Yellowstone National Park, through the Interagency Grizzly Bear Study Team, since grizzly bears occupying southeastern Idaho may be expected to travel into other jurisdictions.

Trapping and radio-collaring individual bears could be conducted when needed. Radio-collared individuals allow assessment of population size, home range, habitat use, activity patterns, survival, and productivity, depending upon objectives. Census using marked bears involves extensive field effort over several years. Trapping efforts that include previously marked bears and unmarked bears can be used to estimate population, using several mark-recapture procedures (Pollock et al. 1990). A minimum population estimate, plus a sex/age composition of the trapped population, would then be available. This method has been successfully used on both species of bears in Yellowstone National Park (Craighead et al. 1995), southcentral Idaho (Beecham 1983), northwestern Montana (Jonkel 1971), southcentral Alaska (Miller et al. 1997), and many other areas representing a wide variety of habitat conditions and is thus applicable to southeastern Idaho. These efforts will be incorporated into other monitoring efforts on associated species.

A bear census using hair sample collections and DNA analysis to identify individual bears is in the developmental stages (Woods et al. 1999). This technique uses a random sampling procedure stratified according to bear density across the entire occupied bear habitat at intervals throughout the period when bears are active. Strips of barbed wire to collect hair would be placed in areas frequented by bears. Hair would first be identified by species, and if grizzly hair was collected, then a thorough analysis of the DNA would be made to identify the individual bear. Different laboratories may produce different results, so selection of a reliable analytical laboratory is important.

Bears that are captured during management activities may be sexed, aged, and marked and/or radio-collared. While these individuals will not likely provide population characteristics, changes in composition and bear distribution may imply change in population status and suggest more intensive survey effort is needed.

Hunter harvest will be intensively monitored. When hunting opportunity for grizzly bears is established, a mandatory check may be implemented for all harvested bears as is done with black bears, mountain lions, bighorn sheep, mountain goat, and moose. Locations of harvested bears may be compared with distributions obtained by other means, and may help guide hunter harvest to more effectively compensate for and reduce management actions. Reproductive tracts from females may also be collected to assess reproductive status.

PUBLIC INFORMATION AND EDUCATION

Goal: To develop, implement and disseminate a coordinated information and education program that is understandable and useful for the people who live, work, and recreate in bear habitat so as to minimize human/grizzly bear conflicts and to provide for the safety of people.

Management strategies are unlikely to succeed without useful, state-of-the-art public information and education programs. A partnership information and education approach involving IDFG, as well as other agencies, local communities, and private interests, can result in minimizing human/bear conflicts.

Information on human safety should be included in hunter education classes. Human safety is of utmost concern when hunting in grizzly bear country. Hunters and other visitors in bear country should consider carrying pepper spray or other bear-deterrent devices. Outfitters and guides will be encouraged to provide training and certification in human safety in bear country.

It is recommended that Idaho Dept. of Fish and Game:

1. Create or designate a position responsible for providing educational programs through schools, community presentations, workshops, news releases, magazine articles, videos, and radio and television announcements.
2. Continue to cooperate with federal resource management agencies in providing safety literature at trailheads and offices in bear country.
3. Sponsor a program aimed at development of "Bear Smart Communities."
4. Develop a multi-media program based on the "Living in Bear Country" program.
5. Produce and share educational materials and audio/video programs with other bear management agencies and organizations.
6. Coordinate with other agencies to develop bear education programs for specific user groups such as hunters, anglers, wood cutters, scout groups, communities, ranchers, 4-H, etc.
7. Coordinate with other entities involved in the management of Yellowstone grizzly bears to ensure that the development and use of educational materials, signs, brochures, etc., be consistent and similar throughout the tri-state area.

CONFLICT MANAGEMENT

Goal: To minimize the potential for human/grizzly conflicts while maintaining traditional residential, recreational, and commercial uses within Eastern Idaho, and to respond quickly, appropriately, and efficiently when conflict situations arise. Conflict reporting procedures will be made available to the public through personal contacts and a variety of media channels.

As previously stated in the introduction, the Governors' Roundtable recommended and the Governors endorsed that state management plans be developed for areas outside the PCA. Therefore, Idaho Code, Title 36-2404 (Appendix II) becomes applicable and requires that a state management plan provide for the management and conservation of the species once it is delisted. The plan shall contain sufficient safeguards to protect the health, private property, and economic well-being of the citizens of the State of Idaho.

Potential conflicts emerge when managing the needs of the grizzly bear while protecting human health and safety, minimizing private property damage and livestock depredation, allowing timber harvest and recreational and hunting opportunities, and providing for other wildlife species. A goal of the management plan is to provide a management framework that is quick to respond to conflicts when they arise, while providing for the welfare of the grizzly bear.

Land management agencies and local county governments are encouraged to include the grizzly bear and its interaction with other land uses in their land-use plans to avoid creating human/grizzly bear conflicts (e.g. disposal issues). Efforts are encouraged to minimize restrictions on other land uses, while providing for the needs of the grizzly bear. Expanded habitat areas for the grizzly bear are possible when the bears co-exist on land managed for other uses. This also encourages local support for increased habitat and bear populations.

Human/Grizzly Bear Conflicts

Human safety is a high priority, and the risk to human safety must be minimized. As bear numbers and distribution increase, the potential for human/grizzly conflicts will also increase. The increase in human/grizzly encounters may jeopardize the safety of humans as well as the safety of the bears. Adequate response to human safety concerns will increase local support for the grizzly bear.

There will be no prosecution of any individual who injures or kills a grizzly bear while acting in self-defense if the bear is molesting, assaulting, killing, or threatening to kill a person.

IDFG shall provide timely information to the public and land management agencies about current bear distribution, including relocations, food conditions, activity, potential and current conflicts, and behaviors. Land management agencies are encouraged to contact their permittees with information that will help them avoid conflicts.

Proper education of those who live, work, and recreate in bear-occupied areas will help to minimize human/bear conflicts. Grizzly bears are highly attracted to potential food sources. Gardens, orchards, garbage, human and pet foods, game carcasses, and septic treatment systems are attractants to bears. IDFG will work with private property owners and others to reduce the source of attractants and provide technical advice for the protection of property and the reduction of human/grizzly conflicts. Preventative measures must be given priority, as they are more effective than simply responding to problems as they occur. IDFG will encourage the development of preventative management tools and techniques as bears expand into available habitat.

Bear-resistant food storage containers, meat poles, and bear-resistant garbage containers should be provided at campsites and other bear areas. Federal and State agencies should assist in securing grant-funding for local governments to develop bear-proof garbage containers and bear-proof landfills.

The Idaho Fish and Game Commission should consider promulgating a regulation which prohibits the baiting of grizzly bears for any purpose, including hunting, photography, viewing, etc.

Livestock/Grizzly Bear Conflicts

Livestock operations that maintain large blocks of open rangeland can provide many benefits to the long-term conservation of the grizzly bear through maintenance of open space and habitats that sustain a variety of wildlife species. Livestock grazing at long time established historical levels in the PCA and surrounding areas is important to maintain, especially following delisting of the grizzly bears. Livestock operations will continue to have access to their facilities and animals regardless of the other sections of this plan. In all cases, F&G will seek permission from affected landowners and work cooperatively with them and other stakeholders.

Livestock operators can suffer significant losses from bear depredation. Upon delisting, every individual has the right to protect their person and their property, including livestock, on private, state and federal land. If outside funding is available and the landowner is willing, efforts may include preventative programs aimed at minimizing livestock conflicts.

In cases involving livestock depredation, management actions will follow the Memorandum of Understanding (MOU) between the Idaho State Animal Damage Control Board and IDFG which states that "*The Board is responsible for prevention and control of damage caused by predatory animals and other vertebrate pests, including threatened and endangered species within the State of Idaho as described in Section 25-128, Idaho Code, and has delegated such responsibility to Wildlife Services."* The MOU also states that *"Both parties (IDFG and WS) shall consult and cooperate in any trapping efforts. WS will be the lead agency on capture and the Department shall be responsible for immobilization, handling, and release of grizzly bears."*

Programs will be developed to provide private landowners and livestock operators with incentives or benefits if they implement preventative measures and maintain opportunities for wildlife, including bears. Federal and State agencies should assist in securing funding sources to provide for incentives.

Upon federal delisting, the Idaho Fish and Game Commission will reclassify the grizzly bear as a game animal. The grizzly bear will be included in the big game depredation program Idaho Code, 36-1109 (Appendix III). In the future, claims for compensation shall be based on confirmed, suspected or probable losses, decrease in weaning or pregnancy rates, damage to facilities and equipment, and labor or other expenses required to resolve disruption of ranch activities. Currently this program provides for compensation from the secondary depredation account, which does not include license/tag funds, for depredation of livestock and damage to berries and bees from black bears and mountain lions. The program will be administered by the appropriate IDFG Regional Landowner Sportsman Coordinators and Regional Supervisors.

Nuisance Grizzly Bear Management

Successful management of nuisance grizzly bears is paramount to the success of overall grizzly bear conservation. When conflicts occur they must be addressed in a timely, efficient manner. Public acceptance of grizzly bears is dependent on the prevention and alleviation of conflicts with humans, livestock, and private property. The management of nuisance bears must allow flexibility in response to a broad range of conflicts.

Inside the PCA, the nuisance guidelines presented in the Draft Conservation Strategy will be followed (Appendix III).

Outside the PCA, significant consideration will be given to humans when grizzly bears come into contact with people or private property including livestock . The focus and intent of nuisance grizzly bear management, damage management, and hunter/grizzly bear conflicts outside the PCA will be predicated on strategies and actions to prevent human/livestock/grizzly bear conflicts. It is recognized that active management aimed at individual nuisance bears will be required as part of the management program. Nuisance grizzly bears will be controlled in a timely and effective manner. Location, cause of incident, severity of incident, history of bear, and health/age/sex of bear will all be considered in any management action.

Grizzly bears occupying areas where the potential for conflicts are high (e.g., subdivisions) will be actively discouraged and/or removed to prevent damage and provide for human safety.

Criteria for Nuisance Grizzly Bear Determination and Control Outside of the PCA (see Appendix IV for definitions):

1. IDFG will investigate reported human/livestock/grizzly bear conflicts immediately. IDFG will communicate investigation findings to the affected parties or their representatives promptly.
2. Following the verification of property damage and consultation with the property owner or owner's representative and/or land management agency, IDFG will determine what management action will be initiated.
3. Grizzly bears captured during a management action that have a high probability of being chronic depredators will be removed from the population.
4. When relocation is not possible or practicable, or when it is likely it will not solve the problem, the bear will be removed from the population.
5. Grizzly bears displaying unnatural aggression or considered a threat to human safety will be removed from the population.
6. Grizzly bears displaying natural aggression will only be removed from the population when the particular circumstances warrant removal.
7. Grizzly bears displaying food conditioned or habituated behaviors, or damaging property may be relocated, aversively conditioned, or removed based on specific details of the incident. IDFG will inform the affected people and land management agencies of the management decision.
8. Grizzly bears may be preemptively moved when they are in areas where they are likely to come into conflict with humans or their property, including livestock.
9. Grizzly bears relocated because of nuisance activities will be released in a location where the probability to cause additional conflicts is low.
10. All sub-adult and adult grizzly bears that are captured in management actions and are to be relocated/released will be permanently marked and may be radio-collared.

IDFG will have the management flexibility to deviate from these nuisance protocols when extraordinary circumstances dictate a need. IDFG will prepare an annual report of these exceptions for the Commission.

Response Actions :

1. No Action: IDFG may take no action after the initial investigation if the circumstances of the conflict do not warrant immediate control or if the opportunity for control is low.

2. Averse conditioning and deterrence: IDFG may use various options to prevent grizzly bear depredation. Such options should include but are not limited to bear-proof garbage containers, scare devices, electrical fencing, etc.
3. Capture: when other options are ineffective or when human safety is a concern, IDFG will initiate capture and relocate offending animals. IDFG in consultation with appropriate entities will determine the proper relocation areas so as to minimize further conflicts.

4. Removal: lethal control of nuisance grizzly bears will be used when other options are not viable and when human safety and protection of personal property including livestock warrant such action. Kill permits will be issued under the supervision of IDFG to affected property owners or their agents.

Any bear causing a human fatality outside the PCA will be removed from the population. Appendix III outlines the actions for incidences inside the PCA.

All reported grizzly bear conflicts and subsequent IDFG corrective actions must be documented.

HARVEST MANAGEMENT

Goal: To allow for regulated harvest of grizzly bears while maintaining a viable and self-sustaining population.

Although this plan provides general guidance for the management of grizzly bear hunting opportunity, the Idaho Fish & Game Commission has ultimate authority and discretion for establishment of take seasons and methods of take for game animals.

The success of grizzly bear recovery in the Yellowstone Ecosystem justifies a management paradigm shift from one of preservation to one of conservation. The basis of conservation is sustainable use, which for wildlife resources includes regulated hunting. Recognition of the grizzly bear as a game animal will ensure that the proper resources for population and mortality monitoring will be allocated. This will benefit the long-term viability of the bear, as it has for Idaho's other hunted, large mammal species. Classification of the grizzly bear as a game animal can also be expected to improve the level of acceptance of the bear by the public living within grizzly bear range and to increase the number of stakeholders favoring grizzly bear conservation. Hunters have been long-term supporters of conservation, and the presence of legal hunters in the field may minimize the poaching of bears by those opposed to their recovery. Additionally, hunting may act as a form of reverse habituation, thus decreasing the likelihood of human/bear conflicts. The removal of individual bears will open up home ranges for subadults, also minimizing conflicts with bears that might otherwise disperse to human-use areas. Thus, hunting tends to reduce the number of management actions needed. Management actions that involve capturing bears are expensive to conduct and, to the extent that hunter harvest can substitute for this, costs will be reduced.

The hunting of grizzly bears by members of the Shoshone-Bannock Tribes is a traditional and cultural issue, which will be determined by the Governing Body of the Shoshone-Bannock Tribes after delisting of the grizzly bear is finalized. Discussions between the Shoshone-Bannock Tribal Council and the Idaho Fish & Game Commission will be held on the management of the Yellowstone grizzly bear. [1]

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1 For purposes of future litigation, nothing herein shall be construed as recognition or endorsement of off reservation treaty rights of the Shoshone-Bannock Tribes by the State of Idaho.

It is unlikely that grizzly bear hunting seasons will be established immediately upon delisting. Establishment of grizzly bear hunting seasons will be conducted using the same process, including public meetings, as for other game species. There are three situations when hunting should be considered as a management tool for grizzly bears:

A well-conserved population is one that can sustain a harvest. As the bear population expands in accordance with the goals of this plan, a harvestable component may be produced. This situation will be identified through the monitoring protocols established elsewhere in this plan, and a hunting quota will be determined by IDFG, based on criteria outlined below.

Chronic depredation problems may indicate a bear population that is socially unacceptable for a given location. Chronic problems involve repetitive events of property damage or frequent repetitive bear use of areas of high human use, which might reasonably be expected to lead to conflict. The hunting option would be considered in conjunction with other mechanisms, such as sanitation and public education.

Individual bears may become the objects of a lethal control action per the guidelines set forth elsewhere in this plan. Such an animal, under occasional circumstances, may provide an opportunity for a hunt, at the discretion of the local IDFG office. Factors to consider when choosing to use a private hunter would be the urgency of timely action, safety, high probability of harvesting the appropriate individual, and attention to the principles of fair chase. A list of hunters desiring to participate should be maintained by IDFG, to be contacted as an opportunity occurs. It is expected that this option would be used sparingly.

All animals harvested as described above will count toward total allowable mortality quotas for the population. Harvest management will thus be considered as one component of an integrated management program for grizzly bears. It will be highly regulated, directed at individual bears as needed, and considered in annual mortality targets that will be established by IDFG in conjunction with other states and the Interagency Grizzly Bear Study Team.

Grizzly bears may be hunted in any portion of their distribution within Idaho, on any lands typically open to hunting. However, since portions of Idaho fall within the area to be managed under the Conservation Strategy, the number of grizzly bears to be removed from that area by hunting must be consistent with the established goals. That document stipulates that the sum of human-caused mortalities can not exceed 4% of the total estimated minimum population, with no more than 30% of that number being female grizzly bears. Thus, hunting mortality must be coordinated among IDFG and the other agencies that are signatory to the Conservation Strategy. A mechanism for allocation of bear quotas among the states must be negotiated among wildlife agencies of Idaho, Montana, and Wyoming. One such method may allocate tags based on the percentage of the total PCA population estimated to reside within the respective state.

Areas not covered by the Conservation Strategy may be managed less conservatively with regard to grizzly bears, in keeping with their multiple use designations. However, this plan also recognizes that the grizzly bear is a desirable component of Idaho's wildlife heritage. In general, for areas in which it is desirable to have the grizzly bear population remain stable or continue to expand, total human-caused mortality should be maintained at no more than 5.7% (as calculated by a running 6-year average) of the total estimated minimum population, with only 30% of that number being female. Different total allowable harvest, percentage female mortality, and/or population estimate methodologies may be used in the future as new information and technology become available. A higher percentage of the male or female population may be harvested as desirable for management goals in areas where grizzly bears should be maintained at low population densities. Thus, harvest management is one of the tools used for managing the grizzly bear population.

A spring grizzly bear season is recommended to protect the female cohort. Spring bear seasons typically have a lower percentage of female harvest than do fall seasons. Population data from the previous field season may be used to establish the harvest quota. The quota will be the appropriate percentage of the population as described above, less known mortality from other sources, including accidental, natural, and control actions, as well as treaty hunting mortalities. Therefore, the size of the quota will be limited by the reliability of the population monitoring data. Uncertain data will result in conservative population estimates and harvest quotas smaller than the population might otherwise allow. Since legal harvest is one of the sources of grizzly bear mortality that can readily be managed, this plan recognizes that harvest may be suspended in years of excessive mortality from other sources.

Because grizzly bear populations are very sensitive to the level of female mortality, every effort should be made to focus the harvest on male bears in areas where it is desirable to have a stable or increasing population. Methods to ensure a predominantly male harvest may include:

1. There could be a mandatory check requirement similar to that required for mountain lions and black bears.
2. Females with young may not be harvested. Neither may cubs or young accompanying a female be harvested.
3. Early closure of hunting seasons when the allowable female quota has been harvested. The IDFG Director may enforce emergency season closures at his/her discretion.
4. A tag fee structure that would include a refund for hunters harvesting a male bear.
5. Early timing of the spring hunt. Boars typically emerge from the den earlier than sows and sows with cubs.
6. Promotion of the use of hunting methods intended to allow the hunter a better opportunity to determine sex.

The Commission could consider a once per lifetime controlled hunt limitation for grizzly bear hunts similar to the controlled hunt limitation for mountain goat, bighorn sheep, and moose hunts. The Commission could also consider mandatory training for hunters, outfitters, and guides who hunt grizzly bears. The training could include information on methods to distinguish between a grizzly bear and a black bear, clean camp rules, and safety, including the use of pepper spray.

Currently, the use of bait and hounds is not permitted for black bear hunting in Idaho 'Bear Management Units' inside the PCA. To minimize accidental grizzly bear mortality within the PCA, this practice will be continued. There will be no additional restrictions on black bear hunting methods outside of the PCA as a result of grizzly bear distribution and occupancy. It will be illegal for a hunter to take a grizzly bear using bait and/or hounds. Grizzly bear hunters may be guided or unguided.

There will be no additional restrictions on the hunting/trapping of other legally harvested animals inside or outside of the PCA as a result of grizzly bear distribution and occupancy.

Big game, including black bear, hunters desiring to hunt in known grizzly bear range will receive information on methods to distinguish between a grizzly bear and a black bear, clean camp rules, and safety, including the use of pepper spray. Any time the identification of the species of bear is in doubt, the animal should not be harvested. The rate of accidental grizzly bear kills should be monitored and additional training implemented as necessary to keep this rate acceptably low.

PROGRAM COSTS & FUNDING

Grizzly bear management is an Idaho activity that exists because grizzly bear conservation is a national priority. Idaho and a few other western states contain suitable habitat to support grizzly bears. They are managed not just for Idaho citizens, but also for the rest of the nation. It is entirely logical that all those who benefit from the presence of grizzly bears in Idaho should pay for their management. While it is beyond the scope of a state management plan to provide assurances that all agencies involved with grizzly bear management have adequate funding, it is recognized that tasks associated with assisting individuals and/or communities with preventative measures, population enumeration, depredations, and information/education could add significantly to the monetary resources needed. Monitoring population indices, habitat conditions, providing technical assistance, and interagency coordination are currently being conducted with minimal increases in funding requirements anticipated for future management.

We recommend that the Idaho legislature and Governor encourage the Congressional delegation to seek federal appropriations and funds from national business and conservation groups to fund grizzly bear management activities in Idaho. A trust or endowment concept has been developed through the Interagency Grizzly Bear Committee. This proposal is a good starting point from which to seek a stable funding mechanism for grizzly bear management.

The use of hunting license, federal aid to fish and wildlife, and nongame funds should be continued at historic levels, but additional management obligations created when the grizzly bears are returned to state management should be funded with new revenue sources.
The Department will implement approved management actions within the financial, staffing, and legal limits that exist. In the event that funding is insufficient, further direction should be

provided by the legislature in order to prioritize agency efforts in the most efficient and most needed manner. Critical tasks include monitoring mortalities and response to human/livestock/grizzly bear conflicts.

Current annual expenditures for Yellowstone grizzly bear management activities in Idaho amount to approximately $21,000. Recommended management actions outlined in this document are expected to increase those costs to approximately $145,000 per year (Table 1) based on current grizzly bear population levels. With increases in both human and grizzly bear populations and inflation, future management costs will likely increase accordingly and shall be federally funded.

Table 1. Current IDFG estimated costs for management of grizzly bears in eastern Idaho and future estimates for implementation of recommendations presented within this document.

1 TASK		Personnel Costs*	Operating Costs	Capital Outlay Costs	Total Costs
Annual Aerial Observation Flights	Current Costs	1,000	3,000	0	4,000
	Future Costs	1,000	3,000	0	4,000
Monitor Key Food Sources	Current Costs	0	0	0	0
	Future Costs	1,000	250	0	1,250
Radio Telemetry & Monitoring	Current Costs	0	0	0	0
	Future Costs	500	3,500	1,500	5,500
Hair Snaring & DNA Sampling	Current Costs	0	0	0	0
	Future Costs	15,000	10,000	0	25,000
Document Distribution	Current Costs	1,000	100	0	1,100
	Future Costs	4,000	1,000	0	5,000
Monitor Mortalities	Current Costs	250	100	0	350
	Future Costs	500	200	0	700
Respond to Human/Grizzly Bear Conflicts	Current Costs	1,500	500	0	2,000
	Future Costs	3,000	1,000	0	4,000
Respond to Livestock Depredations	Current Costs	250	100	0	350
	Future Costs	500	200	0	700
Livestock Depredation Payments	Current Costs	0	0	0	0
	Future Costs	1,000	5,000	0	6,000
Trapping & Relocation	Current Costs	1,500	250	0	1,750
	Future Costs	2,500	500	1,000	4,000
Provide Materials and/or Technical Advice for Preventative Actions	Current Costs	500	0	500	1,000
	Future Costs	8,000	2,500	25,000+**	35,500+
Seek/Solicit Grants and Other External Funding Sources	Current Costs	0	0	0	0
	Future Costs	8,000	1,000	0	9,000
Provide Education Materials	Current Costs	1,000	250	0	1,250
	Future Costs	9,000	2,500	5,000	16,500
Develop and Present Education Materials	Current Costs	1,000	250	0	1,250
	Future Costs	9,000	2,500	5,000	16,500
Monitor Habitat Conditions	Current Costs	500	0	0	500
	Future Costs	500	0	0	500
Provide Technical Assistance for Habitat Restoration on Private Land	Current Costs	0	0	0	0
	Future Costs	500	100	0	600
Interagency Coordination	Current Costs	6,000	1,000	0	7,000
	Future Costs	8,000	1,500	0	9,500
TOTAL	Current Costs	14,500	5,550	500	20,550
	Future Costs	72,000	34,750	37,500+	144,250+

* Personnel costs based on $25.00/hour including benefits.
** Private, public, and/or corporate funding to be solicited based on future identified needs.

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APPENDICES

APPENDIX I - Idaho Code

36-106(e)5. Director of Idaho Dept. of Fish and Game

A. The director, or any person appointed by him in writing to do so, may take wildlife of any kind, dead or alive, or import the same, subject to such conditions, restrictions and regulations as he may provide for the purpose of inspection, cultivation, propagation, distribution, scientific or other purposes deemed by him to be of interest to the fish and game resource of the state.

B. The director shall have supervision overall of the matters pertaining to the inspection, cultivation, propagation and distribution of the wildlife propagated under the provision of title 36, Idaho Code. He shall have the power and authority to obtain, by purchase or otherwise, wildlife of any kind or variety which he may deem most suitable for distribution in the state and may have the same properly cared for and distributed throughout the state of Idaho as he may deem necessary.

The director is hereby authorized to issue a license/tag/permit to a nonresident landowner who resides in a contiguous state for the purpose of taking one (1) animal during an emergency depredation hunt which includes the landowner's Idaho property subject to such conditions, restrictions or regulations as the director may provide. The fee for this license/tag/permit shall be equal to the costs of a resident hunting license, a resident tag fee and a resident depredation permit.

36-1107. Wild animals and birds damaging property.

Other provisions of this title notwithstanding, any person may control, trap, and/or remove any wild animals or birds or may destroy the houses, dams, or other structures of furbearing animals for the purpose of protecting property from the depredations thereof as hereinafter provided.

The director may delegate any of the authority conferred by this section to any other employee of the Department.

(a) Director to Authorize Removal of Wildlife Causing Damage. Except for antelope, elk, deer or moose when any other wildlife, protected by this title , is doing damage to or is destroying any property or is likely to do so, the owner or lessee thereof may make complaint and report the facts to the director or his designee who shall investigate the conditions complained of. If it appears that the complaint is well-founded and the property of such complainant is being or is likely to be damaged or destroyed by any such wildlife protected under this title, the director may:

1. Send a representative onto the premises to control, trap, and/or remove such protected wildlife as will stop the damage to said property. Any animals or birds so taken shall remain the property of the state and shall be turned over to the director.
2. Grant properly safeguarded permission to the complainant to control, trap and/or remove such protected wildlife or to

destroy any houses, dams, or other structures erected by said animals or birds. Any protected wildlife so taken shall remain the property of the state and shall be turned over to the director.

3. Whenever deemed to be in the public interest, authorize or cause the removal or destruction of any dam, house, structure or obstruction erected by any forbearing animals, provided that no liability whatever shall accrue to the Department or the director by reason of any direct or indirect damage arising from such destruction or removal.

4. Issue a permit to any bona fide owner or lessee of property which is being actually and materially damaged by furbearing animals, to trap or kill or to have trapped or killed such animals on his own or leased premises. Such permit may be issued without cost to a landholder applicant and shall designate therein the number of furbearing animals that may be trapped or killed, the name of the person who the landowner has designated to take such furbearers and the valid trapping license number of the taker. Furbearers so taken shall be the property of the taker. Beaver so taken shall be handled in the manner provided in section 36-1104, Idaho Code. The term "premises" shall be construed to include any irrigation ditch or right-of-way appurtenant to the land for which said permit is issued.

(b) Control of Depredation of Black Bear, Mountain Lion, and Predators. Black bear, mountain lion, and predators may be disposed of by livestock owners or their employees when same are molesting livestock and it shall not be necessary to obtain any permit from the Department. Mountain lion so taken shall be reported to the director. Livestock owners may take steps they deem necessary to protect their livestock.

(c) Taking of Muskrats in Irrigation Systems Authorized. Muskrats may be taken at any time in or along the banks of irrigation ditches, canals, reservoirs or dams, by the owners, their employees, or those in charge of said irrigation ditches or canals.

APPENDIX II - Idaho Code

36-2402. Delisting Advisory Team – Duties - Membership

(1) Director of the Idaho Dept. of Fish and Game…in cooperation and consultation with the Governor's Office of Species Conservation, may establish a Delisting Advisory Team (DAT) of no more than nine members for a threatened species or endangered species, to recommend an appropriate state species management plan for a listed species in response to a notification from the Secretary of the Interior…of intent to delist the species or sooner if deemed appropriate.

(2) The delisting advisory team members shall be broadly representative of the constituencies with an interest in the species and its management and conservation and in the economic or social impacts of management or conservation including, where appropriate, depending on the specific species, representatives of tribal governments, local government, academic institutions, private individuals and organizations and commercial enterprises. The delisting advisory team members shall be selected based upon:

a. Their knowledge of the species;
b. Their knowledge and expertise in the potential conflicts between species' habitat requirements or management and human activities;
c. Their knowledge and expertise in the interests that may be affected by species management or conservation; or
d. Other factors that may provide knowledge, information, or data that will further the intent of this act.

36-2404. State Delisting Management Plan Requirements

(2) The delisting advisory team shall develop a state management plan for a species in response to all notification of intent to delist the species by the Secretary of the Interior or sooner if deemed appropriate. The state management plan shall provide for the management and conservation of the species once it is delisted, and contain sufficient safeguards to protect the health and safety, private property, and economic well-being of the citizens of the state of Idaho.

(3) The Department…shall provide the delisting advisory teams, the informational, technical or other needs and requirements of those teams in the performance of their duties.

(4) In developing a state delisting management plan, the delisting advisory team shall consult with the appropriate state agencies, commissions and boards.

36-2405. Recommendation of Management Plans

(1) The delisting advisory team shall submit the management plan to the director of the Department…for review and recommendation.

(2) The director shall review the management plan and make a recommendation to the fish and game commission…The director may recommend either approval of the management plan, or recommend to return the management plan to the delisting advisory team for further study or review.

(3) If the Fish and Game Commission…finds that the management plan provides for the management and conservation of the species when it is delisted…and that reasonable safeguards are included in the management plan to protect the health, safety, private property, and economic well-being of the citizens of the state of Idaho, the Fish and Game Commission…shall approve the management plan.
(4) If the Fish and Game Commission…makes the finding required in subsection (3) of this section, the Fish and Game Commission shall forward the state management plan to the governor's Office of Species Conservation and the legislature. The management plan is subject to legislative approval.
(5) The governor's Office of Species Conservation may petition the responsible public agencies to initiate rule making to facilitate the implementation of the approved management plan.
(6) Each management plan developed pursuant to this chapter shall include a public education component that shall be developed and implemented in cooperation with other appropriate bureaus of the Department of Fish and Game…
(7) Nothing in this act shall be interpreted as granting the Department of Fish and Game…with new or additional authority.

APPENDIX III - Idaho Code

36-1109. Control of Damage by Black Bears or Mountain Lions – Compensation for Damage.

(a) Prevention of depredation shall be a priority management objective of the Department, and it is the obligation of landowners to take all reasonable steps to prevent property loss from black bears or mountain lions or to mitigate damage by such. The director, or his representative, will consult with appropriate land management agencies and land users before transplanting or relocating any black bear or mountain lion.

(b) When any black bear or mountain lion has done damage to or is destroying livestock on public, state, or private land, whether owned or leased, or when any black bear has done damage to or is destroying berries or honey on private land, the owner or his representative of such livestock shall, for the purposes of filing a claim, report such loss to a representative of the U.S. Department of Agriculture animal plant and health inspection services/animal damage control (APHIS/ADC) who shall, within seventy-two (72) hours, investigate the conditions complained of. For purposes of this section, livestock shall be defined as domestic cattle and sheep. If it appears that the complaint is well founded and livestock, berries or honey of the complainant has been damaged or destroyed by such black bear or mountain lion, APHIS/ADC shall so inform the director or the Department's regional office of the extent of physical damage or destruction in question. The physical damages, without establishing a monetary value thereon, as determined by the APHIS/ADC representative shall be final, and shall be binding upon the owner or his representative and on the Department.

(c) Any claim for damages must be in written form, shall be in the form of a claim for damages substantially the same as required in section 6-907, Idaho Code, shall be attested to by the claimant under oath, and the claim shall be for an amount of at least one thousand dollars ($1,000) in damages per occurrence. The Department shall prepare and make available suitable forms for claims for damages. Claims may be submitted only for the fiscal year (July 1 through June 30) in which they occurred. Any person submitting a fraudulent claim shall be prosecuted for a felony as provided in section 18-2706, Idaho Code.

1. Upon receipt by the Department, the Department shall review the claim, and if approved, pay it as provided in section 36-115, Idaho Code. Failure on the part of the owner or representative to allow on-site access shall negate the claim for damages.
2. If the Department accepts the claim for damages as submitted by the owner or his representative, the Department may approve the claim for payment, or may make a counter offer. If the owner or his representative rejects the Department's counter offer, this rejection or refusal must be in writing and submitted within five (5) working days. The value of the damage or destruction will then be determined by arbitration as set forth in section 36-1108, Idaho Code. Any claim received by the Department under the provisions of this section must be finally decided within sixty (60) calendar days of receipt by the Department. If the claim is approved

for payment, the claim must be immediately forwarded to the Department of administration for payment.

APPENDIX III – Nuisance Bear Guidelines from the Draft Conservation Strategy for the Grizzly Bear in the PCA (see Appendix IV for definitions)

The focus and intent of nuisance grizzly bear management inside and outside the PCA will be predicated on strategies and actions to prevent human/bear conflicts. It is recognized that active management aimed at individual nuisance bears will occasionally be required in both areas. Management actions outside the PCA will be implemented according to State management plans. These actions will be compatible with grizzly bear population management objectives for each State for the areas outside the PCA.

Within the PCA, management of nuisance bears will be addressed according to the following criteria.

Criteria for Nuisance Grizzly Bear Determination and Control Inside the PCA

Bears displaying unnatural aggression will be removed from the population.

Bears displaying natural aggression are not to be removed, even if the aggression results in human injury or death, unless it is the judgment of management authorities that the particular circumstances warrant removal.

Bears displaying food conditioning and or habituation may be either relocated or removed based on specific details of the incident. This judgment will be made by management authorities after considering the cause, location and severity of the incident or incidents.

Bears may be preemptively moved when they are in areas where they are likely to come into conflicts with site-specific human activities, but only as a last resort. Such preemptive moves will not count against the bear as nuisance moves.

Bears may be relocated as many times as judged prudent by management authorities. No bear may be removed for any offense, other than unnatural aggression, without at least one relocation unless the reason is documented in writing by representatives of affected agencies.

Bears preying on lawfully present livestock (cows, domestic sheep, horses, goats, llamas, etc.) on public lands will be managed according the following criteria:

1. No male grizzly bear involved in livestock depredations inside the PCA shall be removed unless it has been relocated at least one time and has been found to return and continue livestock depredations.
2. No females involved in livestock depredations inside the PCA shall be removed, even after relocation and subsequent continued depredation on livestock. The only exception to this could be in the case of animals considered dangerous to human safety through their behavior and use of livestock grazing areas where humans are present.

Management of all nuisance bear situations will emphasize removal of the human cause of the conflict, when possible, or management and education actions to limit such conflicts. Relocation and removal of grizzly bears may occur if the above actions are not successful.

Prior to any removal, except in cases of human safety, involved management authorities will consult by phone or in person to judge the adequacy of the reason for removal and the current level of human-caused mortality to avoid exceeding mortality limits through such removals.

The basis for decisions on relocation and removal inside the PCA will be criteria for management of nuisance bears in the Conservation Strategy and best biological judgment of authorities.

Authorized State authorities outside of YNP and GTNP will do removals inside the PCA. Authorized National Park Service authorities will do removals within YNP and GTNP.

Authorities will cooperate to provide adequate and available sites for relocations.

General criteria: Location, cause of incident, severity of incident, history of bear, health/age/sex of bear, and demographic characteristics of animals involved will all be considered in any relocation or removal. Removal of nuisance bears will be conservative and consistent with mortality limits outlined for the population in the PCA in the Draft Conservation Strategy.

Recognizing that conservation of female bears is essential to maintenance of a grizzly population, removal of nuisance females will be minimized. Management actions inside the PCA will be carried out only with conservation of the grizzly bear population in mind, and consistent with State regulations, policy, and State and Federal laws.

Specific criteria for removals: Captured grizzly bears identified for removal may be given to public research institutions or public zoological parks for appropriate non-release educational or scientific purposes as per regulations of States and National Parks. Grizzly bears not suitable for release, research, or educational purposes will be removed as described in appropriate State management plans or in compliance with National Park rules and regulations.

Individual nuisance bears deemed appropriate for removal may be taken by a sport hunter outside of National Parks in compliance with rules and regulations promulgated by the appropriate State wildlife agency commission, as long as such taking is in compliance with existing State and Federal laws, and as long as mortality limits specified for the PCA and within ten (10) miles outside the PCA boundary as described in this Draft Conservation Strategy are not exceeded.

All grizzly bear relocations and removals will be documented and reported annually in the IGBST annual report. Such actions may be subject to the Management Review process if requested by a member of the Yellowstone Grizzly Management Committee. Management of nuisance bears outside the PCA will be the sole responsibility of appropriate State wildlife management agencies and is not regulated by the Draft Conservation Strategy.

APPENDIX IV – Definitions used for Nuisance Bear Guidelines.

Aversive conditioning: the application of techniques that are intended to change a bear's behavior.

Capture: any action to catch a bear for management purposes.

Depredation: damage to any property, including agricultural products.

Deterrence: the application of techniques that are designed to discourage a bear from causing further damage or inhabiting undesirable areas.

Food conditioned bear: a bear that has received a significant food reward of non-natural foods such as garbage, camp food, pet food, or processed livestock food and persistently seeks these foods.

Habituated bear: a bear that does not display avoidance behavior around humans or in human-use areas such as camps or town sites or within 100 meters of open roads.

Human/grizzly bear conflict: a confrontation between a human and/or his property and bear(s) in which the safety of the human and/or bear(s) is jeopardized and/or property loss occurs.

Management authorities: are the designated representatives of the agencies in the PCA including Yellowstone National Park (YNP), Grand Teton National Park (GTNP), Wyoming Game and Fish Department, Montana Fish Wildlife and Parks, IDFG, Interagency Grizzly Bear Study Team, each of the National Forests – Gallatin, Custer, Shoshone, Bridger-Teton, Targhee, and Beaverhead, and the U.S. Fish and Wildlife Service Grizzly Bear Recover Coordinator, as requested. These authorities will make the decision to classify a bear as "nuisance" inside the PCA in compliance with the nuisance bear criteria. Outside YNP and GTNP within the PCA, subsequent management actions will be coordinated and completed by State wildlife agencies, after discussing with the appropriate management authorities. When nuisance bears are in YNP or GTNP, decisions will be made by park representatives, and coordinated with State and Forest Service representatives when necessary (e.g. for bear relocations).

Natural aggression: grizzly bear behavior resulting from defense of young or food, during a surprise encounter, or self-defense.

Non-natural foods: includes, but is not limited to garbage, gardens, livestock carrion, game meat in possession of humans, and human, pet, and livestock foods.

Nuisance grizzly bear: a grizzly bear that depredates livestock, causes property damage, or uses unnatural food that has been reasonably secured from the grizzly bear; or, a grizzly bear that displays unnatural aggression toward humans that constitutes a demonstrable immediate or potential threat to human safety and/or a human injury.

Property damage: damage to any property including agricultural products.

Protection: the application of any device or techniques to protect humans and property from bear damage.

Relocation: the capture and movement of a grizzly bear involved in a conflict with humans or their property by management authorities to a remote area away from the conflict site.

Removal: the capture and placement of a bear in an authorized public zoological or research facility or destruction of that bear. Removal can also involve killing the bear through active measures in the wild when it is not otherwise possible to capture the bear.

Repeat offense: the involvement of a bear that has been previously relocated in a nuisance situation or, if not relocated, continues to repeat a behavior that constitutes a human/bear conflict.

Unnatural aggression: grizzly bear behavior that includes active predation on humans, approaching humans or human use areas, such as camps, in an aggressive way, or aggressive behavior when the bear is unprovoked by self-defense, defense of cubs, defense of foods, or in a surprise encounter.

APPENDIX V – Grizzly Bear Delisting Advisory Team Response to Public Commission Concerns (January 22, 2002)

The Grizzly Bear Delisting Advisory Team (DAT) met on January 10, 2002, to address the concerns and recommendations received from the Idaho Fish and Game Commission, as outlined in their letter to Rod Sando, dated November 30, 2001. The following summarizes the changes that have been incorporated into the "Recommendations for Grizzly Bear Management in Eastern Idaho" (hereafter referred to as the Draft Plan).

1. Commission Concern: "The possibility of immediate hunting by Native American tribal members within treaty areas needs elaboration and appropriate action, such as a Department/Tribal M.O.U., prior to delisting."

> Response: Dan Christopherson, a member of the DAT, is a biologist working for the Shoshone-Bannock Tribes. Dan met with tribal leaders to discuss the Commission's concerns. At the Jan. 10 meeting, Dan said the tribal leaders did not want any changes in the wording that currently exists in the Draft Plan. We had considerable discussion at the meeting, and finally agreed to add this to the Draft Plan: "While IDFG does not have authority to regulate tribal harvest, discussions between the Shoshone-Bannock Tribal Council and the Idaho Fish & Game Commission will be held on the management of the Yellowstone grizzly bear."

2. Commission Concern: "The relationship and effect of the Draft Conservation Strategy to the Delisting Plan needs greater explanation and definition, in particular as it affects or defines Department of Fish and Game management authority and obligations."

> Response: We added the following to the Introduction Section of the Draft Plan to help clarify the relationship and effect of the Conservation Strategy: "The final Conservation Strategy will have two primary roles. First, it will describe and summarize the coordinated efforts to manage the grizzly bear population and its habitat, and the public education/involvement efforts that will be applied to ensure continued conservation of the grizzly bear in the greater Yellowstone area. Secondly, it will document the regulatory mechanisms that exist to maintain the Yellowstone population as recovered through the legal authorities, policy, guidelines, management programs, monitoring programs, and the commitment of participating agencies."

3. Commission Concern: "The Idaho Fish and Game would be placed in the position of bearing major increased costs for monitoring, handling problem bears, evaluating habitat, performing cumulative effects analysis on a multiplicity of federal and other projects, and so on. We feel that the specific costs and proportionate share to be borne by the Federal government, Idaho Fish and Game, and others must be clearly indicated, with the prerequisite that adequate assurance of funding from all sources and parties must be in place prior to delisting."

Response: The DAT recognizes the concerns of the Commission regarding funding grizzly bear management. We had much discussion about what to say in the Draft Plan about funding. We added wording and reworked several paragraphs in the Program Costs and Funding Section of the Draft Plan to read as follows: "While it is beyond the scope of a state management plan to provide assurances that all agencies involved with grizzly bear management have adequate *funding, it is recognized that tasks associated with assisting individuals and/or communities with preventative measures, population enumeration, depredations, and information/education could add significantly to the monetary resources needed. Monitoring population indices, habitat conditions, providing technical assistance, and interagency coordination are currently being conducted with minimal increases in funding requirements anticipated for future management.*

"We recommend that the Idaho legislature and Governor encourage the Congressional delegation to seek federal appropriations and funds from national business and conservation groups to fund the majority of grizzly bear management activities in Idaho. A trust or endowment concept has been developed through the Interagency Grizzly Bear Committee. This proposal is a good starting point from which to seek a stable funding mechanism for grizzly bear management.

"It is also logical that the legislature appropriate state revenues from general sources to fund some portions of grizzly bear management. It would be preferable to use state funds rather than federal funds to investigate, confirm, and pay depredation losses and damage claims to private property. State funds are not subject to National Environmental Protection Act and other federal oversight requirements. The use of hunting license, federal aid to fish and wildlife, and nongame funds should be continued at historic levels, but additional management obligations created when the bears are returned to state management should be funded with new revenue sources."

We addressed the concern about cumulative effects analysis. We deleted the paragraph that caused confusion about who was responsible for cumulative effects analysis. The Draft Plan now reads as follows: "While IDFG recognizes the need to minimize negative impacts, it has no direct jurisdiction over land management activities on a majority of the land adjacent to the PCA. Therefore, IDFG will act in an advisory capacity with regard to potential impacts on grizzly bear habitat, encouraging land management agencies to consider the following grizzly bear issues in their land management plans:…"

4. Commission Concern: "The authority of the Idaho Fish and Game Commission and Department to actually mange the grizzly population within the state is difficult to discern. We recognize it would be exercised in cooperation and coordination with the affected adjacent states and national park. (Note: Yellowstone National park exclusive jurisdiction is understood) but the role and authority of the continuing federal structure seems undiminished and dominant even after delisting. This complex relationship needs full and detailed explanation.

> Response: The DAT reviewed the Agency Responsibilities section of the Draft Plan. We modified the first sentence of that section to read as follows: "Idaho Dept. of Fish and Game (IDFG), under the direction of the Idaho Fish and Game Commission, will be the primary agency responsible for management of Yellowstone grizzly bears in Idaho." The Agency Responsibilities section also contains additional discussion about the Yellowstone Grizzly Bear Management Committee of which IDFG is a member.

5. Commission Concern: "Perhaps the central concern of the Commission is the fact that very significant obligations and costs would be placed on the Department, with relatively little latitude of management. Department costs, of course, would have to be borne by the State's license and tag revenues from species other than grizzly. While other potential sources of revenue are

suggested, they do not actually exist and may or may not ultimately come to pass. A strategy to limit Department obligation and costs in the absence of other funding sources is essential. The role of Wildlife Services in the handling of problem bears should be considered and discussed."

> Response: In the Agency Responsibilities section, the following statement is made: "The Department will implement approved management actions within the financial, staffing, and legal limits that exist." Also see item number 3 above.

With regard to the role of Wildlife Services, the following was added to the Draft Plan: "IDFG working with Wildlife Services (WS) will be the responsible agency dealing with livestock depredation in the same manner as other livestock depredation policies."…"In cases involving livestock depredation, management actions will follow the Memorandum of Understanding (MOU) between the Idaho State Animal Damage Control Board and IDFG which states that "The Board is responsible for prevention and control of damage caused by predatory animals and other vertebrate pests, including threatened and endangered species within the State of Idaho as described in Section 25-128, Idaho Code, and has delegated such responsibility to Wildlife Services." The MOU also states that "Both parties (IDFG and WS) shall consult and cooperate in any trapping efforts. WS will be the lead agency on capture and the Department shall be responsible for immobilization, handling, and release of grizzly bears."

6. Commission Concern: "The plan should provide for the option of hunting as a management tool at the discretion of the Idaho Fish and Game Commission whenever the population is above a specific well defined threshold, and other biological circumstances and criteria do not preclude the action. The bear population needs to be managed in the same manner as other state species by using hunting as an active tool. This is a very critical consideration and bears directly on the question involving costs to the Department."

> Response: The DAT reviewed the Harvest Management section in the Draft Plan. We believe this section clearly provides for the option of hunting as a management tool. When we reviewed this section, we realized that we used verbs such as "will" and "shall," which may have taken away necessary flexibility in providing for hunting opportunity. The DAT replaced some of those verbs with "could" and "may." The following wording was also added to this section: "Although this plan provides general guidance for the management of grizzly bear hunting opportunity, the Idaho Fish & Game Commission has ultimate authority and discretion for establishment of take seasons and methods of take for game animals."

7. Commission Concern: "The issue of geographic expansion of the population needs refinement. The specific localities should be defined, with rational stated, rather than using "conflict" as the determining factor."

> Response: The DAT reviewed the Distribution and Occupancy section of the Draft Plan. The Draft Plan provides the following with regard to geographic expansion of the population: "The majority of the biologically suitable habitat occurs on the Caribou-Targhee National Forest. A lesser amount of biologically suitable habitat occurs on public and state lands adjacent to the National Forest land. It is also anticipated that grizzly bears will occasionally occur on private lands."

"During the next five to ten years, it is expected that grizzly bears will occur within the primary PCA and will continue to expand outside of the PCA to the following general areas: west through the Centennial Mountains; through the Island Park Caldera and out through the Bishop Mountain area and Big Bend Ridge areas; south along the Westslope of the Tetons and into the Palisades and Big Hole Mountain areas (Fig. 1)."

The DAT added the following statement to the Draft Plan in the Distribution and Occupancy section: "Grizzly bears are unique animals in their ability to exist in a wide range of habitats and habitat conditions. It would be premature to identify specific suitable habitats given their flexibility in habitat use. Furthermore, it is anticipated that grizzly bears can successfully occupy a wide range of habitats in eastern Idaho and that compatible co-existence with traditional uses will be a major determining factor for their future distribution. Grizzly bears will not be tolerated in areas with high human activity and/or development.

8. Commission Concern: "The "10-mile buffer" need and rationale needs full discussion. Why does the PCA not in itself accomplish the purpose?"

> Response: The DAT reviewed the 10-mile buffer concept in detail. At the present time, the Draft Conservation Strategy for the Grizzly Bear in the Yellowstone Area requires population and mortality monitoring in the 10-mile buffer and to be included in the population monitoring and mortality within the PCA. The rationale for this is that some grizzly bears inside the PCA will have home ranges that extend into the 10-mile buffer, and therefore population and mortality monitoring should extend into the 10-mile buffer. The DAT notes that the Governor's Roundtable and currently the states of Montana and Wyoming are recommending elimination of the 10-mile buffer. However, doing away with it depends on the development of the Final Conservation Strategy for the Grizzly Bear in the Yellowstone Area (i.e., a decision on whether production and mortality will be counted within a 10mile buffer awaits completion of the Final Conservation Strategy.) We have removed all references to the 10-mile buffer in the Draft Plan except where specifically referred to in the Draft Conservation Strategy for the Grizzly Bear in the Yellowstone Area.

9. Commission Concern: "The full authority and discretion of the Commission to regulate and define hunting methods for all game species within the state (excluding YNP) should be clearly stated. Reference to specific practices should be deleted."

> Response: See item number 6 above.

APPENDIX VI – Grizzly Bear Delisting Advisory Team Response to Public Comments Summary (January 22, 2002)

Idaho Wildlife Federation

1. Motorized Access and Habitat Management. No change was made in the Draft Plan. The DAT believed the wording in the Draft Plan was OK regarding motorized access and habitat management inside the PCA versus outside the PCA.
2. Livestock/Grizzly Bear Conflicts. The DAT added wording to clarify that compensation for depredation would come from the secondary depredation account.
3. Needing a definition for the word 'promptly' in investigating human/grizzly bear conflicts. The DAT changed the word 'promptly' to 'immediately,' but declined to specify or define an exact number of minutes or hours. Each situation is going to be different depending on many site-specific variables.
4. Harvest Management. The DAT did not believe the Draft Plan should be held up while the States of Montana, Wyoming and Idaho develop a mechanism for allocating harvest of grizzly bears. The Draft Plan recognizes the need to do this and directs the State to do it.
5. Harvest Management - Fee Structure. The DAT deleted the paragraph that recommended a high fee structure.
6. Program Costs and Funding. The DAT changed this section to respond to Commission concerns, and these changes address Idaho Wildlife Federation comments.
7. Program Costs and Funding, as they relate to depredation claims. Wording for item number 2 above responds to this concern.

Michael Adams

1. Trapping and Relocating Bears. The DAT clarified the wording on trapping and relocating bears in response to his comments and other comments received from the public.
2. Confusion over removing bears causing a human fatality. The DAT made no changes in the Draft Plan. Careful reading shows that wording on page 17 is for outside the PCA, and wording on page 35 is for inside the PCA.

Idaho Farm Bureau Federation (IFBF)

1. IFBF opposes the 10-mile buffer. This was also a concern expressed by the Commission. See the DAT response to Commission concerns about the 10-mile buffer and how the DAT has responded to it.
2. IFBF recommends that the term 'publics' be expanded to include 'citizens of Eastern Idaho.' No change was made, as the DAT believes the term 'publics' includes citizens of Eastern Idaho.
3. IFBF recommends rewriting the section on motorized access and habitat management so it is more user friendly. The DAT made no changes in the Draft Plan, as the existing wording was worked out with a variety of interests who were represented on the Team.
4. IFBF objects to the statement 'IDFG will encourage land management agencies to consider the grizzly bear in their livestock management plans.' The DAT made no changes in the Draft Plan, as the existing wording was worked out with a variety of interests who were represented on the Team.

5. IFBF objects to IDFG monitoring private land development activities. The DAT made no changes in the Draft Plan, as the existing wording was worked out with a variety of interests who were represented on the Team.
6. IFBF does not support IDFG funding an I&E position for grizzly bears (they will withdraw their objection if the USFWS or Congress appropriate money). This appears to be a funding issue. The DAT made some changes in the Cost and Funding section of the Draft Plan in response to Commission concerns (see the DAT response to Commission concerns).
7. IFBF does not support license fund expenditures for creating 'Bear Smart Communities.' This appears to be a funding issue. The DAT made some changes in the Cost and Funding section of the Draft Plan in response to Commission concerns (see the DAT response to Commission concerns).
8. IFBF is concerned how IDFG will help resolve conflicts between bears and those who live, work, or recreate in bear occupied areas. No changes were made to the Draft Plan, as the DAT believes the Public Information and Education section and the Conflict Management section of the Draft Plan give direction on resolving conflicts.
9. IFBF prefers that USFWS bear the costs of securing grant funding and/or expenditures for implementing bear proof garbage containers & landfills. This appears to be a funding issue. The DAT made some changes in the Cost and Funding section of the Draft Plan in response to Commission concerns (see the DAT response to Commission concerns).
10. IFBF is concerned that aversive conditioning will not work. Aversive conditioning is still being tried and studied. The DAT did not make any changes in the Draft Plan based on this comment, and believes that aversive conditioning should be an optional management tool.
11. IFBF suggests that the statement 'Grizzly bears occupying areas where the potential for conflicts are high (i.e. subdivisions) will be proactively managed to prevent damage and provide for human safety' be clarified to mean that the bears will be 'removed quickly and permanently.' While the DAT did not use the suggested terminology, the wording in the conflict section was re-worked to clarify the DAT's intent.
12. IFBF would prefer clarification between the terms 'unnatural aggression' and 'natural aggression.' Those definitions are already in the Draft Plan in Appendix IV.
13. IFBF objects to the Shoshone-Bannock tribe exercising their treaty hunting rights off of the reservation. The DAT made no changes in the Draft Plan, as Native American treaty rights are beyond the scope of the plan.
14. IFBF opposes the use of state general funds for grizzly bear management. This appears to be a funding issue. The DAT made some changes in the Cost and Funding section of the Draft Plan in response to Commission concerns (see the DAT response to Commission concerns).

Brian Rogers

1. Harvest Management. The DAT believes the section on Harvest Management in the Draft Plan adequately addresses all of the concerns raised by Brian Rogers.
2. Maintaining Roadless Habitat on the Caribou-Targhee National Forest. The DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan and Federal land management agencies.

Predator Conservation Alliance

1. Motorized Access and Habitat Management – Protection of Roadless Areas – Habitat Restoration – Developments on Private Lands. No changes were made in the Draft Plan, as the DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan, Federal land management agencies, and private landowners.
2. Population Monitoring – should not be confined to just the 10-mile buffer. No changes were made in the Draft Plan as the population monitoring section does not confine monitoring to just the 10-mile buffer.
3. Public Information and Education. The DAT made some wording changes in the Public Information and Education section to strengthen the management direction in this section.
4. Nuisance Grizzly Bear Management – what does ‘proactively managed’ mean? The DAT reworded this to clarify what was meant.
5. Nuisance Grizzly Bear Management – too much emphasis on moving and killing bears. The DAT made no changes in the Draft Plan, as the existing wording was worked out with a community of interests who were represented on the Team.
6. Harvest Management. Several opinions were expressed by Predator Conservation Alliance. The DAT reviewed the Harvest Management section, and no changes were made.
7. Harvest Management – we do not understand the final line of this section about the cost of hunting fees. The DAT deleted the entire paragraph discussing the cost of hunting fees.

The Fund for Animals

1. The Fund for Animals basically said the Plan must focus first and foremost on the bears’ interests, not on human interests. They wanted more direction in the Plan to restrict human activities to accommodate the grizzly bear. They stated, ‘As distasteful as it may be to some, the interests of the public’s wildlife should always take precedence over the interests of private domestic livestock or other commercial interests on public lands.’ The DAT reviewed all of the recommendations and opinions stated in their letter, and decided that no changes were needed in the Draft Plan for the following reasons: The Draft Plan was developed with a community of interests who were represented on the Team. The DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan, Federal land management agencies, and private landowners. The DAT believes that by maintaining existing uses, people will feel less threatened both economically and in their lifestyles, thus building support and increasing tolerance for a greater expansion of the bear population. The key to a greater expansion of the grizzly bear population lies in bears utilizing lands that are not managed solely for them but in which their needs are adequately considered along with other uses.

National Wildlife Federation

1. Establishment of some kind of numerical or occupancy objectives for the species. The DAT believes the 'Grizzly Bear Recovery Plan' and the 'Draft Conservation Strategy' establish numerical and occupancy objectives for the purposes of recovering and delisting the bear from the Endangered Species Act. The Draft Plan allows for the expansion of the grizzly bear population into biological suitable and socially acceptable areas, and it establishes population and habitat monitoring criteria. The DAT does not believe it is possible to develop numerical or occupancy objectives at this time for areas outside of the PCA. It will take time to see and document how grizzly bears continue to expand and where conflicts occur before meaningful numerical or occupancy objectives can be established.
2. Translocating bears into unoccupied habitat. The DAT believes the Draft Plan is a bold plan in that it allows for the natural expansion of grizzly bears into areas that are biologically suitable and socially acceptable. No changes were made in the Draft Plan to allow for the translocating of bears into unoccupied habitat in the state of Idaho, however, the plan was altered to allow for relocation of bears to 'acceptable areas outside the state'.
3. Management on Federal Lands. No changes were made in the Draft Plan, as the DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan and Federal land management agencies.
4. Livestock grazing on public lands. No changes were made in the Draft Plan, as the DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan and Federal land management agencies.
5. Establishing habitat criteria for grizzly bears. The DAT believes that by maintaining existing uses, people will feel less threatened both economically and in their lifestyles, thus building support and increasing tolerance for a greater expansion of the bear population. The key to a greater expansion of the grizzly bear population lies in bears utilizing lands that are not managed solely for them but in which their needs are adequately considered along with other uses. No changes were made in the Draft Plan.
6. Thank you for acknowledging that the public information and education program is well designed.
7. Suggested modification to the statement that there will be no prosecution of any individual who injures or kills a grizzly bear while acting in self-defense. No changes were made in the Draft Plan, as the DAT believes the existing statement helps build public support for expansion of the grizzly bear. The Federation acknowledges that the public information and education program is well designed, and the DAT believes this will reduce human/grizzly bear conflicts.
8. Recommendation to change the statement about no additional restrictions on the hunting/trapping of other legally harvested animals inside or outside the PCA as a result of grizzly bear distribution and occupancy. The Federation would like a statement saying that some restrictions may be necessary to avoid creating problems. No changes were made in the Draft plan.

Defenders of Wildlife

1. Defenders of Wildlife basically said the Plan must focus first and foremost on the bears' interests, not on human interests. They wanted more direction in the Plan to restrict human activities to accommodate the grizzly bear. They wanted the Draft Plan to give more direction to the management of State Lands, increased population monitoring emphasis, incorporation of 'Living with Carnivores Program,' concerns about harvest

management, a section added on enforcement, and establishment of linkage zones. The DAT reviewed all of the recommendations and opinions stated in their letter, and decided that no changes were needed in the Draft Plan for the following reasons: The Draft Plan was developed with a community of interests who were represented on the Team. The DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan, Federal land management agencies, and private landowners. The DAT believes that by maintaining existing uses, people will feel less threatened both economically and in their lifestyles, thus building support and increasing tolerance for a greater expansion of the bear population. The key to a greater expansion of the grizzly bear population lies in bears utilizing lands that are not managed solely for them but in which their needs are adequately considered along with other uses. The Commission declined to participate in the 'Living with Carnivores Program.' State lands are managed as set forth by the State Constitution, and they are only a very small part of the area bears are expected to occupy. Enforcement concerns will be taken care of when the grizzly bear becomes a big game animal. Also, the State legislature sets fines, and it is not the place to do that in this Draft Plan.

Idaho Cattle Association

1. General Thoughts – recommendation that the DAT include representation from stakeholders especially livestock operators and county officials. The DAT did include a member representing livestock operators and two former county commissioners. Upon delisting, grizzly bears will not be managed by the DAT. Management of the population, including responsible parties, is discussed in the Draft Plan.
2. Size and Scope of Habitat and Distribution and Occupancy – focus only on the existing Recovery Zone or PCA. The DAT believes the grizzly bear can expand into areas that are biologically suitable and socially acceptable. The Draft Plan provides direction for maintaining existing uses, with site-specific evaluations where necessary to deal with conflicts. The DAT believes that by maintaining existing uses, people will feel less threatened both economically and in their lifestyles, thus building support and increasing tolerance for a greater expansion of the bear population. The key to a greater expansion of the grizzly bear population lies in bears utilizing lands that are not managed solely for them but in which their needs are adequately considered along with other uses.
3. The ICA had several concerns related to habitat management, native plant species, livestock conflicts, habitat monitoring, habitat restoration, and population monitoring. The DAT reviewed all of these concerns, and decided that no change was needed in the Draft Plan. The Draft Plan was developed with a community of interests who were represented on the Team.
4. Public Information and Education – need to add ranchers and/or livestock operators. The DAT did add ranchers to the list of groups in this section.
5. Conflict Management – include Wildlife Services and additional detail to allow livestock owners or their agents to remove a bear that is in the presence of their livestock. The DAT added additional wording referencing the MOU between IDFG and Wildlife Services. The DAT did not add additional detail to allow livestock owners or their agents to remove a bear that is in the presence of their livestock. Those details can be worked out between the IDFG and livestock owners as State grizzly bear management is implemented.

6. Nuisance Grizzly Bear Management – preemptive removal when necessary. The DAT added additional wording in this section of the plan to better explain when preemptive removal could be used.
7. Program Cost and Funding. The DAT added and changed wording in this section to address concerns that were raised by the Commission and others about cost and funding.

USDA – APHIS – Wildlife Services

1. Nuisance Grizzly Bear Management – clearly indicate which agencies will respond to nuisance grizzly bear problems. The DAT changed wording in the document to clearly indicate that IDFG would be the lead agency responding to problems.
2. Existing MOU between the Idaho State Animal Damage Control Board and the IDFG. The DAT added a paragraph describing the MOU and clarifying responsibilities between Wildlife Services and IDFG.

Alliance for the Wild Rockies

1. Alliance for the Wild Rockies wanted more direction in the Plan to restrict human activities to accommodate the grizzly bear. They said: "We feel that the current proposal fails to use the best available science to protect the bear and maintain long-term viability. "In general, we feel the plan relies far to heavily on managing the bears as opposed to managing the people." "We strongly request that IDFG seek expansion of food storage orders statewide." Regarding motorized access and habitat management, they said, "This statement is so weak as to be meaningless." Regarding livestock conflicts, they wanted a MOU to be developed between IDFG and land management agencies. They said, "It is critical for the long-term viability of the population that habitat protections be applied to all areas that could be reoccupied within the GYE" They recommended keeping all roadless areas roadless for the future of the grizzly bear. They wanted to see more creative ideas in addressing livestock conflicts. For nuisance grizzly bear management, they said "We are concerned that too much latitude is afforded in situation where non-habituated bears could be moved." They said: "The plan does not adequately address future uncertainties. Grizzly bear require large blocks of unfragmented undeveloped wilderness and roadless areas in order to survive. They require entire ecosystems to meet their habitat needs for sustaining their life cycles. Clear cutting, road building, oil and gas development, mining and real estate development continue to degrade important grizzly bear habitat, reducing their ability to forage and increasing their changes of conflict with humans." The DAT reviewed all of the recommendations and opinions stated in their letter, and decided that no changes were needed in the Draft Plan for the following reasons: The Draft Plan was developed with a community of interests who were represented on the Team. Many of their opinions and recommendations pertained to responsibilities of Federal land management agencies, and not the state or IDFG. The DAT believes the section on Distribution and Occupancy addresses the proper relationship between a State Management Plan, Federal land management agencies, and private landowners. The DAT believes that by maintaining existing uses, people will feel less threatened both economically and in their lifestyles, thus building support and increasing tolerance for a greater expansion of the bear population. The key to a greater expansion of the grizzly bear population lies in bears utilizing lands that are not managed solely for them but in which their needs are adequately considered along with other uses.

Caribou-Targhee National Forest

1. Provide more clarification on the relationship between the Recovery Plan, Conservation Strategy, Recovery Zone or PCA. The DAT added a paragraph in the Introduction to help clarify this relationship.
2. Clarify the membership and relationship of the various management committees. The DAT did not believe this was needed in the Draft Plan.
3. Clarify the purpose of the 10-mile buffer. The DAT reviewed the 10-mile buffer concept in detail. At the present time, the Draft Conservation Strategy for the Grizzly Bear in the Yellowstone Area requires population monitoring and mortality to occur in the 10-mile buffer and to be included in the population monitoring and mortality within the PCA. The rationale for this is that some grizzly bears inside the PCA will have home ranges that extend into the 10-mile buffer, and therefore population and mortality monitoring should extend into the 10-mile buffer. The DAT notes that the Governor's Roundtable and currently the states of Montana and Wyoming are recommending elimination of the 10-mile buffer. However, doing away with it depends on the development of the Final Conservation Strategy for the Grizzly Bear in the Yellowstone Area. We have removed all references to the 10-mile buffer in the Draft Plan except where specifically referring to the Draft Conservation Strategy for the Grizzly Bear in the Yellowstone Area.
4. "Given that the bear had a large historical range of habitats that it occupied, it seems that social acceptance, not biological suitability is the limiting factor to the bear's recovery." The DAT believes that this statement is correct, but no additional wording or changes were made in the Draft Plan.
5. "Why is livestock management singled out for coordination outside the PCA? The DAT believes there is a long history with scientific documentation that grizzly bears like livestock. Given the distribution of livestock grazing in areas that are likely to see grizzly bear expansion, we anticipate increased management and coordination.
6. Habitat Monitoring – add the following: "IDFG will identify important spring habitat for bears, the work with landowners to minimize impacts to bears during their period of use." The DAT added this wording to the Draft Plan.
7. Habitat Restoration – add "…introducing prescribed fire to achieve more diverse landscapes and early seral vegetation…" The DAT did not add this to the Draft Plan, as we thought it was a 'method' and we did not list all methods that could be used to do habitat restoration.
8. Population Monitoring – clarify all the various teams and committees working on this. The DAT did not believe this was needed in the Draft Plan.
9. Harvest Management – define 'surplus animals.' The DAT changed the wording in the Draft Plan, as the term 'surplus animals' was confusing to many publics who reviewed the Plan.

Idaho Conservation League

1. Relocation of grizzly bears. The DAT did change the wording in the Draft Plan about relocating grizzly bears to clarify where it applied.
2. Public Information and Education – list of 7 items. The DAT changed the wording as recommended by ICL.
3. Conflict Management – add the word 'quickly.' The DAT changed the wording as recommended by ICL.
4. Sanitation – the Draft Plan does not address it adequately. The DAT reviewed this concern and decided that the Draft Plan addresses it adequately.

5. Restrict kinds of baits used for management and research activities by IDFG. The DAT did not change the Draft Plan. It is important that IDFG be able to respond quickly to management needs and to be able to use the most effective baits to resolve a conflict situation.
6. Shoshone-Bannock Tribes. The DAT did not change the Draft Plan as recommended by ICL.
7. Hunting methods. The DAT did not add this to the Draft Plan, as we thought it was a 'method' and we did not list all methods that could be used.
8. Add human/grizzly bear conflicts to the definitions. The DAT agreed, and this was added to the Draft Plan.

Appendix K. Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear

Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear[1]

Report detailing discussion of issues covered during workshops at Fort Collins, Colorado, 1–4 February, and Bozeman, Montana, 23–25 March and 11 May 2005

photo by Dan Stahler, YNP

[1] This document is the product of team work. All participants contributed to its production. Please cite as follows: Interagency Grizzly Bear Study Team. 2005. Reassessing methods to estimate population size and sustainable mortality limits for the Yellowstone grizzly bear. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

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CONTENTS

SUMMARY AND MANAGEMENT RECOMMENDATIONS

Workshop Objectives: Our objectives were to (1) evaluate current information to establish methods to estimate total population size and sustainable mortality, and (2) address issues of unknown and unreported mortality for the grizzly bear population in the Greater Yellowstone Ecosystem.

Results of this workshop will be used to revaluate the basis and application rules for sustainable mortality limits. Our goal is to ensure that mortality management of the Greater Yellowstone Ecosystem grizzly bear population is based on the best available science and will maintain long-term population viability. This effort was undertaken as per the commitment of all management agencies to employ adaptive management using the best available science to manage the Greater Yellowstone Ecosystem grizzly bear population.

The Yellowstone Grizzly Bear Demographics Team in cooperation with the Interagency Grizzly Bear Study Team (IGBST) will use the following procedures to establish and track sustainable mortality for grizzly bears (*Ursus arctos*) in the Greater Yellowstone Ecosystem (GYE) and recommends the following specific demographic targets for management.

Independent Females
***Population estimate*.**—We will estimate the number of independent (age ≥2 years) female grizzly bears in the population for the GYE using methods outlined in this document. Counts of unduplicated females with cubs-of-the-year (FCOY) and sighting frequencies will follow methods outlined by Knight et al. (1995). The total number of FCOY will be estimated using the $Chao_2$ estimator (Keating et al. 2002) with observed count frequencies. Estimates of FCOY represent a segment of the female population ≥4 years of age. Total females ≥4 years of age (with and without cubs-of-the-year) will be estimated by dividing the $Chao_2$ estimator by 0.289, the estimated proportion of females ≥4 years of age in the population with cubs-of-the-year based upon transition probabilities calculated from the telemetry sample (Appendix C). The resulting estimate represents, on average, the total number of females ≥4 years of age in the GYE population. This value will be divided by 0.773, the estimated proportion of female bears ≥4 years of age in the population of females ≥2 years of age. The resulting value represents the best estimate of total independent female bears (age ≥2 years old) in the GYE.

For example, using 2004 data, we estimate 57.5 total FCOY using the $Chao_2$ estimator (Table 1) based on the observed count of 48 unique females with cubs. This results in an estimate of 199 (57.5/0.289 = 199) females ≥4 year old and 257 (199/0.773 = 257) females in the female population ≥2 year old.

Table 1. Example of empirical data and calculated estimates of total independent (age ≥2 years old) female grizzly bears in the Greater Yellowstone Ecosystem, 1999–2004.

Year	Observed count	$Chao_2$	Females ≥4 years old	Females ≥2 years old
1999	30	36.0	125	161
2000	34	51.0	176	228
2001	39	48.2	167	216
2002	49	58.1	201	260
2003	35	46.4	161	208
2004	48	57.5	199	257

Sustainable mortality limit.—The mortality limit for independent female bears will be set at 9% (equivalent to a survival rate of 91% for these age classes) of the population estimate for females ≥2 years old based on Harris et al. (2005). All mortalities will be counted including: (1) known and probable human-caused deaths, (2) reported deaths due to natural and undetermined causes, and (3) estimated unknown and unreported losses. The 9% mortality threshold was chosen because simulations suggest that with survival ≥0.91, the annual growth rate (λ) of the population is ≥1.0 with a 95% level of certainty (Harris et al. 2005, Schwartz et al. 2005*c*).

Unknown and unreported mortality.—Unknown and unreported mortality will be estimated based on the method of Cherry et al. (2002). This method assumes that all deaths associated with management removals (sanctioned agency euthanasia or removal to zoos) and deaths of radiomarked bears are known. It calculates the number of reported and unreported mortalities based on counts of reported deaths from all other causes. To demonstrate this method, using 2004 data of 5 reported deaths, we estimated that 13 actually died (reported plus unknown and unreported; Table 2). We add to this estimate bears that died as a result of agency removal (4) and deaths of radiomarked bears that were not sanctioned removals (0), to estimate total mortality from all causes = 17 (4 + 0 + 13 = 17). Details of the method and application can be found in Cherry et al. (2002). The number of publicly reported deaths of uncollared bears, together with the beta distribution estimated from the observed reporting rate (0.37 reported:0.63 unreported), are used to estimate a posterior distribution for total annual reported and unreported mortality (Appendices B and D).

Table 2. Example of empirical data and calculated estimates of unreported mortality for female grizzly bears ≥2 years old in the Greater Yellowstone Ecosystem, 1999–2004.

Year	Agency removal	Telemetry	Reported	Reported and unreported	Estimated total mortality
1999	0	0	1	2	2
2000	1	1	3	7	9
2001	5	3	1	2	10
2002	2	2	4	10	14
2003	1	0	5	13	14
2004	4	0	5	13	17

Allowable mortality limits.—To dampen variability and provide managers with inter-annual stability in the threshold, allowable mortality limits will be based on a 3-year running average of the 9% annual limit. For example, the female population estimate in 2004 was 257 female bears

≥2 years old (Table 3). The 9% annual mortality limit based on this estimate = 23 female bears (257 x 0.09). The 3-year average of allowable female mortality = 22 ([23 + 19 + 23]/3). Estimated total mortality for 2004 = 17. Therefore the estimated female mortality for 2004 was 5 bears below the allowable mortality limit of 22.

Table 3. Independent female population size, annual mortality limit based on 9% mortality, allowable female mortality limit based on the 3-year running average, and estimated total female mortality for the Greater Yellowstone Ecosystem, 1999–2004.

Year	Estimated population of females ≥2 years old	9% annual mortality limit	Allowable mortality (3-year average)	Estimated total mortality
1999	161	14		2
2000	228	21		9
2001	216	19	18	10
2002	260	23	21	14
2003	208	19	20	14
2004	257	23	22	17

Independent Males

***Population estimate*.**—An estimate of independent males (age ≥2 year old) will be based on the estimate of independent females and the modeled sex ratio of the population (Harris et al. 2005). Based on current estimates of reproduction and survival, the modeled sex ratio is 0.377:0.623 M:F. Therefore the male segment represents 60.5% (0.377/0.623 = 0.605) of the female population (there are 0.605 male bears for every female bear).

***Sustainable mortality limit*.**—The mortality limit for independent male bears will be set at 15% of the population estimate for males ≥2 years old based on Harris et al. (2005). All mortalities will be counted including: (1) known and probable human-caused deaths, (2) reported deaths due to natural and undetermined causes, plus (3) calculated unknown and unreported losses. The 15% mortality threshold was chosen because it approximates what occurred in the GYE from 1983–2001 (Haroldson et al. 2005), a period when population was estimated to have increased around 4–7% per year (Harris et al. 2005).

***Unknown and unreported mortality*.**—Estimates of unknown and unreported mortality for independent males will be based on the method of Cherry et al. (2002).

***Allowable mortality limits*.**—To dampen variability and provide managers with inter-annual stability in the mortality threshold, allowable mortality limits will be based on a 3-year running average of the 15% annual limit (Table 4). For example, the female population estimate in 2004 = 257 female bears ≥2 years old. The number of independent males (age ≥2 years) is estimated at 156 (257 x 0.605 = 156). The 15% limit based on this estimate = 23 (156 x 0.15 = 23) male bears. The 3-year average = 22 ([24 + 19 + 23]/3) and the estimated total mortality for 2004 = 23. Therefore, estimated mortality in 2004 was 1 bear above the allowable mortality limit (23 - 22 = 1).

Table 4. Independent female and male population size, annual 15% mortality limit for independent males, allowable male mortality limit based on the 3-year running average, and estimated total male mortality for the Greater Yellowstone Ecosystem, 1999–2004.

Year	Estimated population of females ≥2 years old	Estimated population of males ≥2 years old	Estimated 15% annual mortality limit	Allowable mortality (3-year average)	Estimated total mortality
1999	161	97	15		11
2000	228	138	21		35
2001	216	131	20	18	11
2002	260	157	24	21	12
2003	208	126	19	21	12
2004	257	156	23	22	23

Dependent Young

Population estimate.—The number of cubs in the annual population estimate will be calculated directly from estimates of FCOY as determined by the $Chao_2$ estimator. We assume average litter size of 2 cubs (Schwartz et al. 2005*a* estimated mean litter size = 2.04), and a 50:50 sex ratio. The number of yearlings in the population will be estimated from the number of cubs the previous year that survived. We assume cub survival = 0.638 (Schwartz et al. 2005*b*). We estimate the number of yearlings in the population in a given year by taking the estimated number of cubs the previous year times 0.638. For example, we estimate dependent young in 2004 to be 115 cubs-of-the-year (57.5 x 2 = 115) and 59 yearlings (93 cubs in 2003 x 0.638 = 59) and 115 + 59 = 174 (Table 5).

Table 5. Annual estimated number of females with cubs-of-the-year ($Chao_2$), cubs, yearlings, and dependent young in the Greater Yellowstone Ecosystem, 1999–2004.

Year	$Chao_2$	Number cubs	Number yearlings	Number dependent young
1999	36.0	72	47	119
2000	51.0	102	46	148
2001	48.2	96	65	162
2002	58.1	116	62	178
2003	46.4	93	74	167
2004	57.5	115	59	174

Sustainable mortality limit.—The mortality limit for dependent bears of both sexes will be set at no more than 9% of the total estimate in the population (4.5% for each sex assuming 50:50 sex ratio). Only reported known and probable human-caused deaths will be tallied against the threshold. Most recorded mortality of dependent young is from natural causes (Schwartz et al. 2005*b*) and is accommodated for in this limit. The 9% threshold (4.5% for each sex) approximates what was observed historically. From 1983–2001, survival to age 2 years was estimated to be 0.52 (0.638 x 0.817). Human-caused mortality was estimated at 14.4% (approximately 30% of the 48%) for each sex (Schwartz et al. 2005*a*).

***Unknown and unreported mortality*.**—We lack empirical data to estimate unknown and unreported mortality for dependent young. To be conservative, we assumed it was similar to that for independent bears (empirical data 0.37 reported:0.63 unreported, we simplified that to approximate 1 reported:2 unreported). Allowing for 4.5% recorded mortality for each sex and assuming an additional 9% unreported (4.5% reported: 2 x 4.5% unreported = 9%), resulted in 13.5% (4.5 + 9.0 = 13.5%) total human caused mortality for each sex. This is less than the 14.4% human-caused documented mortality for each sex from 1983–2001 as discussed above.

***Allowable mortality limit*.**—To dampen variability and provide managers with inter-annual stability in the threshold, allowable mortality limits will be based on a 3-year running average of the 9% annual limit (Table 6).

Table 6. Annual estimated number of dependent young, estimated 9% mortality limit, allowable mortality limit based on a 3-year running average, and reported human-caused mortality from 1999–2004.

Year	Number of dependent young	Estimated 9% annual mortality limit	Allowable mortality (3-year average)	Reported human-caused losses
1999	119	11		2
2000	148	13		7
2001	162	15	13	6
2002	178	16	15	5
2003	167	15	15	3
2004	174	16	16	11

Total Population Size

Total population size will be estimated annually from the sum of independent female, independent male, and dependent bears (Table 7).

Table 7. Annual estimates of independent female, independent male, dependent young, and total population size for the grizzly bear population in the Greater Yellowstone Ecosystem, 1999–2004.

Year	Estimated population of females ≥2 years old	Estimated population of males ≥2 years old	Number of dependent young	Total population size[a]
1999	161	97	119	378
2000	228	138	148	514
2001	216	131	162	508
2002	260	157	178	595
2003	208	126	167	500
2004	257	156	174	588

[a] Slight differences in total due to rounding.

Demographic Objectives

Under the Conservation Strategy, the IGBST is responsible for carrying out a biology and monitoring review. Such reviews are triggered by negative deviations from the desired conditions established in the Conservation Strategy for population, mortality reduction, and habitat parameters. The Conservation Strategy (USFWS [U.S. Fish and Wildlife Service] 2003:6) states that "it is the goal of the agencies implementing this Conservation Strategy to manage the Yellowstone grizzly population in the entire GYA [Greater Yellowstone Area] at or above 500 grizzly bears." Because of the increased level of uncertainty in estimating total population size using the methods we propose here, and because long-term survival of the GYA grizzly bear is most closely linked to survival of adult females (Eberhardt 1977, 1990, 2002; Knight and Eberhardt 1987; Harris et al. 2005), we recommend a demographic target ≥48 adult females (age ≥4 years) be maintained annually. This target of 48 females, when extrapolated, is equivalent to a population of approximately 500 individuals.

This target of 48 will be derived from the point estimate of the $Chao_2$ estimator using frequency counts of unduplicated females with cubs. We recommend the point estimate because: (1) the $Chao_2$ estimator is either accurate relative to actual bear numbers or biased low, and (2) statistically, the point estimate is the best unbiased estimate of the mean. Because we observe normal variation about counts of females related to reproductive performance and foods (Schwartz et al. 2005*b*), we anticipate some natural variation to occur. Short-term fluctuation in counts is therefore expected. We are most concerned with long-term chronic declines in counts which might reflect a declining population. We recommend a biology and monitoring review should the estimate decline below this threshold of 48 for any 2 consecutive years. We make no effort to define all possible management scenarios that might need review. We likewise make no effort to outline in detail recommendations that might come from a biology and monitoring review because each would have its own unique combination of circumstances and data that must be evaluated in light of other information.

Management agencies lack complete control over female mortality. Hence, if the lower one-tailed 80% bound of the $Chao_2$ estimate is <48 in any given year, agencies should attempt to limit female mortality the following year as a proactive measure to help minimize exceeding the point estimate recommendation above. To illustrate these recommendations, we provide data from 1999–2004 (Table 8).

Although male mortality has no impact on population trajectory over the long run (Harris et al. 2005), we feel that some limits are necessary. We therefore recommend that managers try not to exceed established mortality limits for males as set forth in this document. We recommend that a management review be considered should male limits be exceeded in any 3 consecutive years.

Table 8. Estimated number of females with cubs based on the $Chao_2$ estimator applied to frequency counts of females with cubs-of-the-year in the Greater Yellowstone Ecosystem, 1999–2004.

Year	$Chao_2$ estimated population of females ≥4 years old with cubs-of-the-year	Lower 80% confidence interval of the $Chao_2$ estimate	Biology and monitoring review required	Management threshold exceeded
1999	36	33	–	–
2000	51	44	no	yes
2001	48	44	no	yes
2002	58	54	no	no
2003	46	41	no	yes
2004	58	53	no	no

BACKGROUND

This project began in 2000, following a review of the current methods used to estimate sustainable mortality and issues facing management of the GYE grizzly bear. The IGBST, in cooperation with the U.S. Fish and Wildlife Service, prepared a series of proposals soliciting funding to address the following objectives: (1) evaluate the unduplicated female rule set established by Knight et al. (1995), (2) explore and evaluate techniques to generate an annual estimate of adult females (>3 years of age) incorporating uncertainty, (3) explore and evaluate techniques to generate an annual estimate of total population size incorporating uncertainty, and (4) establish a sustainable mortality quota based on recent demographic information from the GYE. Funding was obtained in FY2001. We established a demographics working group and began to address these issues. Much of the demographics work identified was completed in 2003 and 2004 and submitted for publication. This document summarizes the final phase of this research, namely establishing and recommending sustainable mortality limits for the GYE grizzly bear.

We focus on 3 components: (1) developing methods to estimate total population size, (2) establishing limits on mortality, and (3) addressing unknown and unreported mortality.

Considerable time and effort have been invested in each of these 3 components. We previously explored the application of capture–mark–recapture (CMR) techniques used to estimate bear population size. As described by White (1996), more technologically advanced approaches to CMR estimation have incorporated animals marked with radiotransmitters. The initial sample of animals is captured and marked with radios, but recaptures of these animals are obtained by observing them, not actually recapturing them. The limitation of this procedure is that unmarked animals are not marked on subsequent occasions. The advantage of this procedure is that resighting occasions are cheaper to acquire than physical captures of animals. The CMR procedure has been tested with both black (*Ursus americanus*) and grizzly bears (Schwartz and Franzmann 1991, Miller et al. 1997). We tested the applicability and accuracy of a CMR technique developed for bears in Alaska (Miller et al. 1997) to the GYE in 1998 and 1999 (Schwartz 1999, 2000). We concluded that our recapture rate was too small to return a population estimate with a reasonable confidence interval.

We also explored the application of DNA hair snaring techniques to estimate population size in the GYE. In the past 20 years, there have been significant advancements in the extraction, amplification, and analysis of DNA from hair and scats from various carnivore species (Waits 2004, Waits and Paetkau 2005). Coupled with these advances has been the application of CMR hair snaring techniques to bears (Woods et al. 1999; Mowat and Strobeck 2000; Boulanger et al. 2002, 2004). Issues with these methods include changes in behavioral responses of individuals and the effect on capture probability (Boulanger et al. 2002), genotyping and associated errors (Woods et al. 1999; Mills et al. 2000; Paetkau 2003, 2004; McKelvey and Schwartz 2004), detection rates and grid sizes (Boulanger et al. 2002), and costs (K. Kendall, U.S. Geological Survey, personal communication). We estimated that to accurately sample the GYE with population size at ±20% level of certainty would cost $3.5–5.0 million (based on 2002 data from

K. Kendall, U.S. Geological Survey, Northern Rocky Mountain Sciences Center, Glacier National Park). We ruled out subsampling a representative area due to issues of randomness and violations of statistical sampling theory. At the December 2001 meeting of the Yellowstone Ecosystem Subcommittee in Jackson Hole, Wyoming, the opportunity to pursue funding to partially cover such a population estimate was presented to the group. After considerable discussion centering on costs and potential benefits, the committee recommended the IGBST not pursue funding nor conduct DNA hair snaring in the GYE. The group unanimously felt funds could be better spent addressing management issues including bear-proof dumpsters, sanitation, and other on-the-ground activities that improved survival of bears. As a result of discussions at this meeting, we did not consider DNA CMR further.

CURRENT METHOD

For grizzly bears in the GYE, the 1982 Recovery Plan recommended the development of population monitoring methods and the establishment of mortality thresholds (USFWS 1982); these were developed and reported in the 1993 plan (USFWS 1993) and are summarized below:

- A minimum of 15 FCOY over a running 6-year average both inside the Recovery Zone and within a 10-mile area immediately surrounding the Recovery Zone.
- 16 of 18 Bear Management Units (BMUs) occupied by females with young (cubs, yearlings, or 2-year-olds) for a running 6-year sum of observations, with no 2 adjacent BMUs unoccupied.
- Known human-caused mortality not to exceed 4% of the minimum population estimate based on the most recent 3-year sum of unduplicated FCOY.
    - This rule was amended in 2000 to include probable human-caused mortalities, and cubs accompanying known and probable human-caused female deaths.
- No more than 30% of the 4% mortality shall be females.
- These mortality limits cannot be exceeded during any 2 consecutive years for recovery to be achieved. The threshold is based on a 6-year running average of mortality contrasted with the annual limit established from the 3-year sum of FCOY.

Minimum population size and allowable numbers of human-caused mortalities are calculated as a function of the number of unique FCOY. Identification and separation of FCOY follow methods reported by Knight et al. (1995).

Knight et al. (1995) developed the rule set used to distinguish sightings of unique females from repeated observations of the same female. Females were judged to be different based on 3 criteria: (1) distance between sightings, (2) family group descriptions, and (3) dates of sightings.

Minimum distance for 2 groups to be considered distinct was based on annual ranges, travel barriers, and typical movement patterns. A movement index was calculated using standard diameter of annual ranges (Harrison 1958) of all radiomarked FCOY monitored from 1 May–31 August (Blanchard and Knight 1991). The mean standard diameter for all annual ranges of FCOY was 15 km (SD = 6.7 km). They estimated the average maximum travel distance as twice the standard diameter, or 30 km, and used this distance to distinguish sightings of unique FCOY from repeat sightings of the same female.

Family groups within 30 km of each other were distinguished by other factors. The Grand Canyon of the Yellowstone, from the lower falls to the confluence of Deep Creek, was considered a natural barrier. Females on either side of this canyon were considered unique. Knight et al. (1995) also discussed paved highways as impediments to travel and cite data presented by Mattson et al. (1987) which showed that grizzlies tended to stay >500 m from roads during spring and >2 km during summer. They provided one example where 2 families considered unique were separated by 2 major highways and were 30 km apart (see Knight et al. 1995:Table 1). Family groups were also distinguished by size and number of cubs in the litter. Once a female with a specific number of cubs was sighted in an area, no other female with the same number of cubs in that same area was regarded as distinct unless (1) the 2 family groups were seen by the same observer on the same day, (2) the 2 family groups were seen by 2 observers at different locations but similar times on the same day, or (3) 1 or both of the females were radiomarked. Because of the possibility of cub mortality, no female with fewer cubs was considered distinct in an area unless (1) she was seen on the same day as the first female, (2) both were radiomarked, or (3) a subsequent observation of a female with a larger litter was made. Knight et al. (1995) assumed that all cubs in a litter were observed and correctly counted. This assumption was strengthened by only considering observations from qualified agency personnel. Observations from the air were only included if bears were in the open and easily observed. Ground observers watched family groups long enough to insure all cubs were seen; observers reported any doubt. Finally, Knight et al. (1995) reference a time–distance criteria but did not provide specific rules for its application. The only example they provided was the separation of 2 sightings of 2 family groups observed 1 day apart and 25 km apart.

Calculations to determine the minimum population size sum the number of FCOY seen during a 3-year period minus the number of recorded adult female mortalities during that period. This value is divided by the estimated proportion of adult females in the population to extrapolate to a population estimate. Because the 3-year sum of FCOY is based on an observed number of unduplicated individuals, it provides a minimum estimate of population size (actually seen), rather than a total estimate. As such, it potentially underestimates both total population size and sustainable mortality limits. As currently used, it does not permit calculation of valid confidence bounds. Estimates of minimum population size in year t ($\hat{N}_{\min,\,t}$) are calculated as:

$$\hat{N}_{\min,\,t} = \sum_{i=t-2}^{t} \frac{\hat{N}_{obs,\,i} - d_i}{0.274} \qquad (1)$$

where $\hat{N}_{obs,\,i}$ (following notation of Keating et al. 2002) is the number of unique FCOY observed in year i (as per Knight et al. 1995), and d_i is the number of known and probable human-caused mortalities of adult females (age >4) in year i.

Mortality limits are set at 4% of $\hat{N}_{\min, t}$ with no more than 30% of this 4% (1.2% of the population) being females. The 1993 recovery plan provides the following example: counts of unduplicated females from 1990–92 were 24, 24, and 23, respectively. Four adult female mortalities were recorded during this period. Following notation in Equation 1, 24 + 24 + 23 - 4 = 67. The original proportion of adult females with cubs was listed as 0.284 in the 1993 plan. That value was updated and changed to 0.274 by Eberhardt et al. (1994:Table 2:362). Using 0.274, we get a population estimate of 67/0.274 = 244, and total and female mortality limits of 9.8 and 2.9 individuals, respectively.

The current method has benefits and limitations. These include:

Benefits

- The method is conservative because limits of mortality are based only on observed females and the minimum population rather than the total population.
- The method has been used since 1993, and during that period the population is estimated to have increased between 4% and 7% per year (Harris et al. 2005:Table 18). Also, during this same period, grizzly bear distribution expanded (Schwartz et al. 2002), lending support to a growing population.

Limitations

- The constant 0.274 (Eberhardt and Knight 1996:417) represents the proportion of adult females in the population, defined as bears $\geq$5 years of age (USFWS 1993:Appendix C:156; Eberhardt et al. 1994:Table 2:362). Because some 4-year-old females produce cubs (Eberhardt and Knight 1996, Schwartz et al. 2005*a*), their inclusion into the above equation could result in an overestimation of total population size because the constant 0.274 represents only females $\geq$5 years of age. Additionally, not all females of age class 5 produce first litters, as some delay until ages 6–8 (Eberhardt and Knight 1996: Table 1:361, Schwartz et al. 2005*a*). Consequently, the proportion used to extrapolate FCOY to total population size contains an unknown amount of error.
- It is assumed that on average, adult female grizzly bears produce a litter once every 3 years. Deviations from this assumption can overestimate (interval <3 years) or underestimate (interval >3 years) population size. The estimated proportion of FCOY in any given year based upon a sample of radiocollared bears (age >3) ranges from 0.05 to 0.60 (Fig. 1). The reciprocal of this value is the years between litters for this age group (i.e., 1/0.333 = 3). During this period (1983–2003), we monitored 352 females and documented 110 cub litters. This equates to 0.315 litters/female/year or 3.2 years between litters (1/0.315), suggesting that summing over 3 years creates a small underestimation of minimum population size.

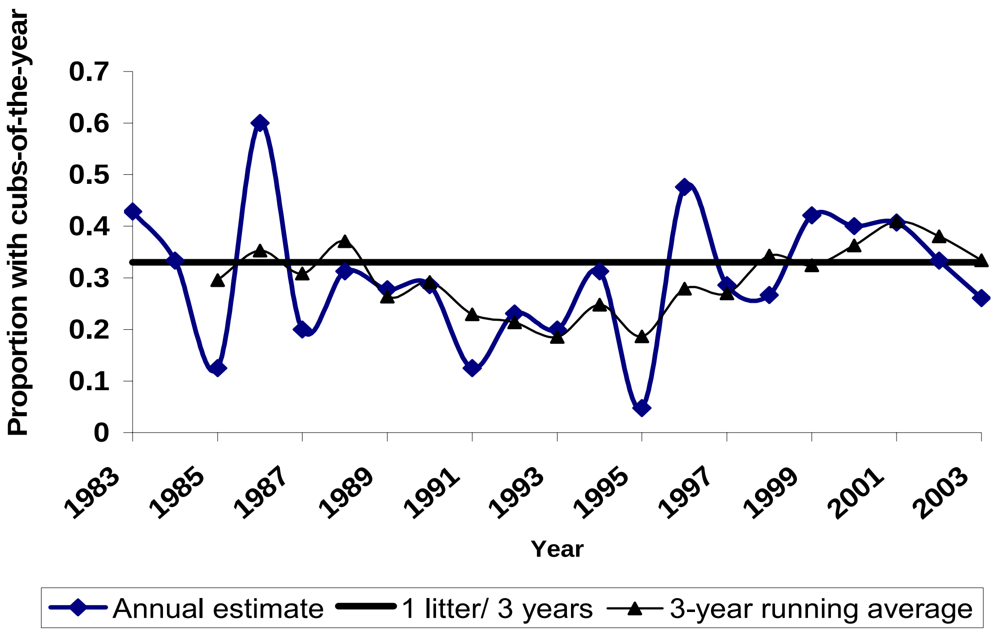

Figure 1. Proportion of radiomarked female bears >3 years old with cubs-of-the-year in the Greater Yellowstone Ecosystem, 1983–2003. The bold horizontal line represents the mean proportion if females produced exactly 1 litter every 3 years. The 3-year running average represents deviations from the assumption that females produce a litter exactly once every 3 years. Deviations above the line result in an overestimation of population size because some females produce cubs more often than once every 3 years and are therefore counted twice in the sum of 3 years. Deviations below the line result in an underestimation when summing over 3 years because some females with longer intervals (>3 years) may not be counted.

- Subtracting all known human-caused mortalities of adult females adds additional bias in the estimate of population size. Mortality limits should be calculated using the number of bears alive at the start of the season (den emergence). Therefore, any female bear killed in the year of calculations (year = *t*) should not be subtracted. Additionally, because the population estimate is calculated based on the sum of females with cubs, any lone female killed in year *t* - 2 or *t* - 1 should not be subtracted. A lone female killed in year *t* - 2 is no longer available and cannot be seen or counted in year *t* - 1 or year *t* with cubs because she is gone from the population. Therefore she cannot enter into the calculations and there is no need to subtract her. Doing so underestimates adult females in year *t*. The only dead females that should be subtracted are FCOY in year *t* - 2 and FCOY and females with yearlings in year *t* - 1. These females theoretically could have been part of the count of FCOY but are no longer alive in year *t* when the number of females in year *t* is estimated. This does not account for unreported loss of FCOY in *t* - 2 and *t* - 1 or for FCOY in *t* - 2 or *t* - 1 that might have lost her cubs and then died the next year when alone. There is no way of telling the reproductive history of a lone bear killed in year *t*. Consequently no matter how we attempt to "adjust" the 3-year sum to account for dead females no longer alive in year *t*, there is potential for error. Additionally, because the counts of FCOY only represent "observed" bears, subtracting a dead female likely reduces the sum of FCOY by removing females never observed and not part of the minimum count.

- Mortality limits were based on original work by Harris (1984) which was developed using input from a generic grizzly bear population for the continental U.S. These values may not remain valid for the GYE population, and more recent data are now available.
- Harris (1984) estimated maximum human-caused mortality limits of 6%. This level was reduced to 4% in the Recovery Plan to account for unknown unreported mortality. This was based on the assumption that for every 2 reported mortalities there was 1 additional unreported death. This ratio of 2:1 was an approximation that may no longer be appropriate for the GYE population today.

Group Discussion

The group unanimously agreed that we have new peer reviewed scientific information (Cherry et al. 2002; Keating et al. 2002; Haroldson et al. 2005; Harris et al. 2005; Schwartz et al. 2005*a*, *b*, *c*) that can be used to improve existing methods, develop new methods for these management approaches, or both. The group agreed that we follow Dr. Gary White's recommendation whenever feasible to "stay as close to the data as possible." Because survival of independent females (age ≥2 years) was identified as the most important determinant of lambda (λ) with elasticity equal to 73% (Harris et al. 2005), we considered methods that allowed us to estimate independent female bears directly from the FCOY data.

WORKSHOP OBJECTIVES

Once we decided to focus our efforts on developing a new method to set sustainable mortality limits for the GYE grizzly bear, we identified a number of components that needed to be considered in this process. Our objectives were to develop scientifically defensible methods to:

1. Refine methods to estimate total population size, adult female population size, and/or total female population size and address uncertainty.
2. Establish a biologically sustainable limit on total and female mortality. The group felt it necessary to explicitly define "biologically sustainable" so it was clear how we defined, established, and evaluated this important term.
3. Account for unknown and unreported mortality and if necessary, modify the 2:1 reported:unreported ratio based on empirical data.
4. Prepare a document that details this process and present our findings and recommendations to the Yellowstone Ecosystem Subcommittee for acceptance and approval.

ALTERNATIVE POPULATION ESTIMATION METHODS

Method 1.

Replace the number of unique females observed ($\hat{N}_{obs,\,i}$) in Equation 1 above (see also Table 9) with one of the nonparametric estimators discussed by Keating et al. (2002). This is the method proposed in the Conservation Strategy (USFWS 2003) and should return an estimate of total population size given by the following equation:

$$\hat{N}_t = \sum_{i=t-2}^{t} \frac{\hat{N}_{keating} - d_i}{0.274} \tag{2}$$

where $\hat{N}_t$ is an estimate of total population size, and $\hat{N}_{keating}$ is one of the nonparametric estimators discussed by Keating et al. (2002).

Benefits

- Provides an unbiased estimate of total FCOY, not just those observed.
- Provides an annual estimate of uncertainty about FCOY.
- Is unbiased by changes in observer effort.
- Is a non-parametric estimator and thus avoids assumptions about form and constancy of distribution of individual sighting probabilities.
- $\hat{N}_t$ approximates the total population rather than the minimum population size. Consequently, mortality limits are a function of the total bear population.

Limitations

- Application of $\hat{N}_{keating}$ to estimate FCOY assumes Knight et al. (1995) correctly identifies individuals.
- Application of $\hat{N}_{keating}$ to estimate FCOY assumes clustering of sightings to be correct.
- Variation among individual sighting probabilities (CV) affects performance of $\hat{N}_{keating}$. It requires $n/N \geq 2$, where *n* is the total number of sightings and *N* is the population size.
- Replacing $\hat{N}_{keating}$ in the numerator of Equation (1) does not eliminate the other problems associated with it (i.e., assume 3-year breeding cycle, subtraction of all dead adult females, and the proportion of females in the population).

Discussion

Although the group felt that Equation 2 was an improvement over Equation 1 because of the value of the $\hat{N}_{keating}$ estimators, we concluded that we could develop alternative methods that would not only address switching from a minimum count to a total population estimate, but would also deal with other limitations of Equation 1. At this point our discussion shifted and we focused on $\hat{N}_{keating}$ estimators, their limitations, and recommendations for improvement.

Discussion of the Keating Estimator

The group had considerable discussion about the application of the nonparametric estimators proposed by Keating et al. (2002). The bullets below capture that discussion.

- In Keating et al. (2002), the modeled simulations only investigated CVs ≤ 1. The estimate made from the empirical data collected in 2004 had an estimated CV = 1.1. Further, the estimator of CV used is known to be biased low. This exceeded the limits of the simulations, and the group recommended that Dr. Keating run additional simulations to investigate models with CV ≥ 1.0 and possibly up to 1.5.
- Also, in 2004, the population was estimated as $\hat{N}_{SC2}$ = 72.6 (CV = 1.1) based on 202 sightings of 49 unique bears, where $\hat{N}_{SC2}$ is the population estimate using the second-order sample coverage estimator. Contained in these sightings were observations from 7 individuals inside Yellowstone National Park where the sighting frequency was ≥10 sightings/individual. Chao et al. (1993, 2000) proposed an alternate method when some sighting frequencies were very common (suggesting that these individuals would be "known" to the population). We reapplied the estimator excluding these 101 sightings from these 7 unique bears. The estimate resulted in 51.9 unique bears, from 101 sightings; with these 7 females added back into the estimate as known individuals, the population estimate is 59 bears with estimated CV = 0.45.
- To illustrate how we might use information from the modeling, Dr. Keating used Figure 5b from Keating et al. (2002) (which shows the bias in CV) and extrapolated an estimated CV based on true CV = 1.1 and $n/\hat{N}$ = 2.8. He plugged that value into Figure 1 from Keating et al. (2002) considering *n/N* and estimated the original bias for the estimate of 72.6 to be about 20% too large. With this bias correction, the new estimate was $\hat{N}_{SC2}$= 58.
- After our discussions, it was decided that Dr. Keating would investigate the following:
  - the Chao estimators relative to the possible removal of sighting of FCOY with sighting frequencies $n \geq 10$, or some other number
  - bias in estimates with CVs > 1.0
  - a bias correction factor
  - using a model weighted approach or alternative methods under certain circumstances (of those discussed by Keating et al. [2002])
  - Use the initial Keating estimate of $\hat{N}_{SC2}$ ($\hat{N}_{SC2}$ or a model weighted approach) to refine the total females with cubs in the population. Attempt to minimize the root mean square error. Explore using $\hat{N}_{SC2}$ estimator, which requires an initial estimate of population size, run the model, then take the resulting population estimate and put it back into the model and run it again until convergence.
  - Report results to the group at our second meeting.
- At our second workshop, Dr. Keating presented his results. During those discussions, we discovered that there was additional parameter space (distribution of sighting

probabilities) that had not been explored in the original Keating et al. (2002) simulations. Further investigation suggested that $\hat{N}_{\mathrm{SC2}}$ could be either positively or negatively biased depending on the probability distribution modeled. This prompted a reevaluation of the $\hat{N}_{\mathrm{SC2}}$ estimator. Further simulations confirmed the problem. Additional work based on simulation of sighting probabilities using a beta distribution with equal beta parameters and selecting from the extremes of the parameter space confirmed that $\hat{N}_{\mathrm{SC2}}$ can take either a positive or negative bias, and in some cases quite a large positive bias. On the other hand, it was also confirmed that the Chao_2 estimator preformed well over the range of simulated population sizes and CVs ($\hat{N}$ = 20–80, CV = 0.0–1.75) and consistently returned estimates that were correct or biased low. Chao_2 did a reasonable job when sighting probabilities were high, but returned low estimates when probability sightings were quite small, likely because bears with extremely low sighting probabilities were not part of the "effective population size" from which the sample of sightings was actually drawn.

Method 2.
Use $\hat{N}_{keating}$ as the best approximation of total FCOY in the population in any given year.

Estimate the annual proportion of FCOY ($\hat{P}_{FCOY}$) in the adult female population from the telemetry sample (Table 9). The number of adult females in the population (≥4 years old) would be estimated as:

$$\hat{N}_{females} = \frac{\hat{N}_{keating}}{\hat{P}_{FCOY}} \qquad (3)$$

We looked at data from 1986 to 2002 and estimated $\hat{N}_{females}$. A graph of these values (Fig. 2) indicates large variation among annual estimates. Some of this noise is probably associated with poor estimates of the proportion of females with cubs from the telemetry sample due to small sample size and sampling bias (Table 9). But some noise may also be associated with the $\hat{N}_{keating}$ estimator (i.e., 1995) when $n/N < 1$. All these issues affect the usefulness of this method.

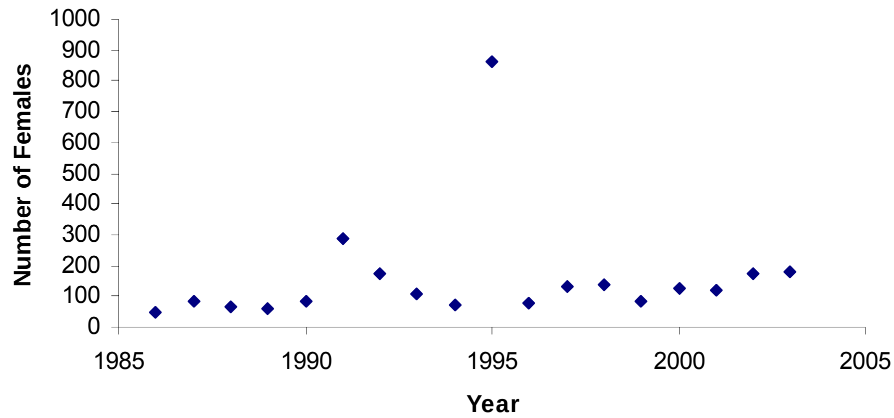

Figure 2. Estimated annual number of adult females in the Greater Yellowstone Ecosystem population based on the annual proportion of collared females ≥4 years old that produced cubs-of-the-year ($\hat{P}_{FCOY}$) divided into the annual $Chao_2$ estimator.

Benefits

- Avoids the assumption that females produce cubs exactly once every 3 years.
- Stays close to the real data. This method estimates females from empirical data.
- Avoids the need to know the sex ratio of the population.
- Avoids the need to subtract dead females.
- Estimates the "total" number of females ≥4 years old.
- The method could also be used to estimate number of independent females by calculating the proportion of "independent females" (≥2 years old) in the telemetry sample, but estimates become more extreme in 1991 (345) and 1995 (1,427).

Limitations

- $\hat{P}_{FCOY}$ depends on the telemetry sample, which in most years is small with a resulting high variance component.
- Assumes the distribution of females in the telemetry sample is the same as the distribution in the population (i.e., we have the same proportion of 4-year-olds in the sample as in the population). This assumption may not be correct. To investigate this, we plotted the proportion of collared females by age in the telemetry sample against the modeled distribution (Harris et al. 2005) of females by age class using our best estimates of reproduction (Schwartz et al. 2005a) and survival (Haroldson et al. 2005, Schwartz et al. 2005b) (Figs. 3 and 4). Results suggest the age structure based on our best estimates of survival and reproduction differ from the age-structure of our captured sample. The proportion of females ages 2 and 3 are underrepresented, whereas females ages 6–8 appear overrepresented in the telemetry sample. The proportion of females in the telemetry sample with cubs-of-the-year was 0.267 and 0.311 for females ≥4 years old and ≥2 years old, respectively.

Table 9. Number of observed unique unduplicated females (N_{obs}) with cubs-of-the-year (FCOY) based on the rule set of Knight et al. (1995), the estimated total number of unique FCOY ($\hat{N}_{Chao2}$) based on the $Chao_2$ estimator of Keating et al. (2002), the number of radiocollared females (age ≥4 years), and the proportion ($\hat{P}_{FCOY}$) and standard error (SE) of FCOY, estimated number of female bears age ≥4 or ≥2 year old, dependent young, and independent males.

						Population index					
						Female age					
						≥4	≥2				
			Annual telemetry sample						Dependent young		
Year	N_{obs}	$\hat{N}_{Chao2}$	(n)	($\hat{P}_{FCOY}$ [a])	(SE[b])	$\hat{N}_{Chao2}$ / $\hat{P}_{FCOY}$	$\hat{N}_{Chao2}$ / 0.248	($\hat{N}_{Chao2}$ / 0.289)/ 0.7734	$[\hat{N}_{females\ 2+}(0.415)]2$	$\{\hat{N}_{Chao2,t} + [(\hat{N}_{Chao2,t-1})(0.636)]\}2$	Males age ≥2
1983			7	0.43	0.19						
1984			6	0.33	0.19						
1985			8	0.13	0.12						
1986	25	27.5	15	0.60	0.13	46	111	123	102		74
1987	13	17.3	15	0.20	0.10	86	70	77	64	70	47
1988	19	21.2	16	0.31	0.12	68	85	95	79	64	57
1989	16	17.5	18	0.28	0.11	63	71	78	65	62	47
1990	25	25.0	14	0.29	0.12	86	101	112	93	72	68
1991	24	37.8	8	0.13	0.12	290	152	169	140	107	102
1992	25	40.5	13	0.23	0.12	176	163	181	150	129	110
1993	20	21.1	15	0.20	0.10	106	85	94	78	94	57
1994	20	22.5	16	0.31	0.12	73	91	101	84	72	61
1995	17	43.0	21	0.05	0.05	860	173	192	160	115	116
1996	33	37.5	21	0.48	0.11	78	151	168	139	130	102
1997	31	38.8	21	0.29	0.10	134	156	173	144	125	105
1998	35	36.9	15	0.27	0.11	137	149	165	137	123	100
1999	33	36.0	19	0.42	0.11	86	145	161	134	119	97
2000	37	51.0	30	0.40	0.09	128	206	228	189	148	138
2001	42	48.2	27	0.41	0.09	118	194	216	179	162	131
2002	52	58.1	24	0.33	0.10	176	234	260	216	178	157
2003	38	46.4	23	0.26	0.09	178	187	208	172	167	126
2004	49	57.5					232	257	214	174	156

[a] Calculated as the sum of telemetered bears observed over 3 years with cubs/total telemetered bears observed in the same 3-year period.

[b] Calculated as $\sqrt{\frac{P(1-P)}{n}}$.

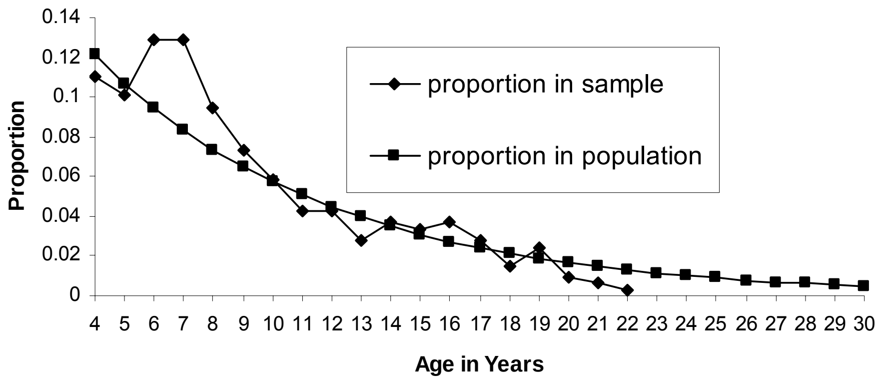

Figure 3. The proportion of female bears ≥4 years old in the telemetry sample (1983–2001) in the Greater Yellowstone Ecosystem and the proportion of these age classes in the population based on simulation modeling using empirical data on reproduction and survival (Appendix A).

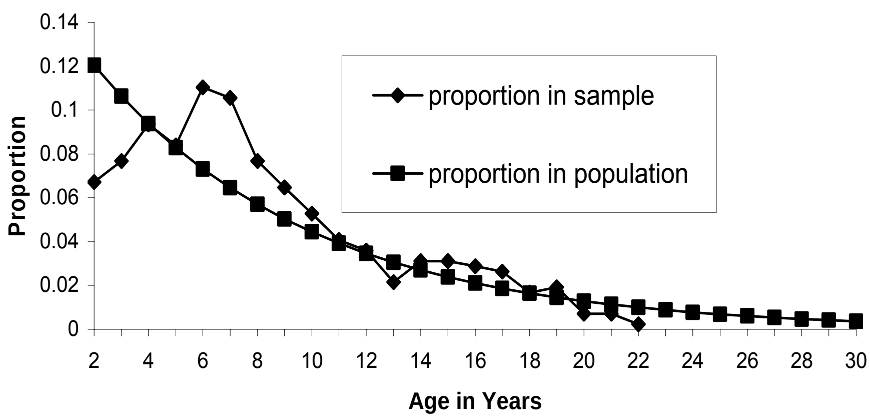

Figure 4. The proportion of female bears ≥2 years old in the telemetry sample (1983–2001) in the Greater Yellowstone Ecosystem and the proportion of these age classes in the population based on simulation modeling using empirical data on reproduction and survival (Appendix A).

Discussion

Dr. White presented information on transition rates among various states for female bears ≥4 year old (Appendix C). These transitions are unbiased relative to sampling and would help resolve the telemetry sample bias problem discussed above. His results suggest that we tend to capture more bears in the "N" state (no offspring) than those in the "C", "Y", or "T" states (with cubs, yearlings, or 2-year-olds). Consequently, the proportion of females with cubs in the telemetry sample appears biased low. Based on these discussions, we concluded we should not recommend using the telemetry sample to estimate the proportion of FCOY in any given year as the denominator of Equation 3.

We also looked at the SEs of the proportion of females with cubs in the telemetry sample (Table 9) and concluded that nearly all annual estimates were not statistically different, suggesting we could use a constant in the denominator.

Method 3.
Use the logic described in Method 2 above, but base estimates on a 3-year (or even a 6-year) running average of $\hat{N}_{keating}$ and $\hat{P}_{FCOY}$ (Table 9).

Benefits
- Running average dampens the noise in the estimate.
- Running average increases sample size.

Limitations
- Still assumes the distribution of females in the telemetry sample is the same as the distribution in the population.
- Running average is influenced by the number of years in the average. If we use a 6-year average, the variance is dampened even more than with a 3-year average. However, for a declining population, the average estimate will be greater than the true population (i.e., the previous 5 years elevate the mean). This works in reverse for a growing population and becomes equivocal for a flat trajectory. Hence the running average is conservative for a growing population but may result in over-harvest for a declining population. Alternatively, we could consider a 6-year average for a growing population but recommend it be shortened to a 3-year average should trends suggest the population is declining.

Discussion
We rejected this approach for reasons discussed under Method 2. We also had a long discussion on assumptions and issues associated with using a “running average” to smooth data. The group felt uncomfortable with such an approach because of possible unknown statistical biases.

Method 4.
Use an estimate of the proportion of females with cubs (age ≥4 years or ≥2 years) relative to an estimate of total “adult” or “independent” females in the GYE population. For example, Harris (Appendix A) estimated the proportion of females ≥2 years old accompanied by cubs based upon stochastic simulation modeling was 0.248 of all females ≥2 years of age in the GYE population. Using this value, we estimate total independent females in the GYE population with the following equation:

$$\hat{N}_{females} = \frac{\hat{N}_{keating}}{0.248} \qquad (4)$$

where ($\hat{N}_{keating}$) is the number of FCOY based on one of the estimators reviewed by Keating et al. (2002), and $\hat{N}_{females}$ is an estimate of females age ≥2 years old in the population. Harris (Appendix A) estimated that on average over a 10-year simulation, FCOY in the population constitute 0.247 (CV = 0.110) and 0.248 (CV = 0.105) of the female population ≥2 years of age when adult female survival is set at 0.949 or 0.922, respectively. He also calculated the number of females in the population age ≥4 years old as 0.314 and 0.315 (adult female survival = 0.922 or 0.948).

Benefits

- Simple to calculate.
- Avoids bias associated with the sample of collared females.
- Based on empirical data.

Limitations

- Constant in the denominator does not allow for temporal changes in reproductive rates.
- Constant in the denominator requires periodic updates.

Discussion

The group felt this was the best method. We had considerable discussion on what value to use for the denominator. Dr. White offered an alternative for estimating total number of females ≥4 years of age in the population. He used the telemetry dataset and determined the proportion of females (age ≥4) in the population with cubs-of-the-year in this sample using a multi-state model (results are in Appendix C). His estimate (0.289) was quite similar to the Harris estimate of 0.314 (Appendix A) based on modeling. Because Dr. White's estimate was based on empirical data, we chose to use it.

We discussed the value of developing an index of the female population ≥4 years of age using the constant 0.289 directly. Because analyses by Haroldson et al. (2005) found no statistical or biological difference in survival for independent subadult (ages 2–4 years) and adult (ages ≥5 years) bears, we concluded that it would be simpler to derive a single population estimate of independent females. Using data from Harris et al. (2005), we estimated the proportion of females ≥4 years and older in the population of females ≥2 years old (Tables 10 and 11). Because Harris et al. (2005) estimated the stable age distribution using both high and low survival estimates for independent females (0.92 and 0.95) which considered both high and low process variance, we evaluated both and the magnitude of difference between the 2 estimates. Results (Tables 10 and 11) indicated that there was virtually no difference in the proportional estimates when using the low or high survival rate for independent females (0.773421 vs. 0.773392). Consequently, we used 0.7734 as the proportion of females ≥4 years old in the population of independent females ≥2 years old. We used this to convert our estimate with the following equation:

$$\hat{N}_{females\ 2+} = \frac{\hat{N}_{Chao2}}{(0.289 * 0.7734)} \quad (5)$$

where ($\hat{N}_{Chao2}$) is the number of FCOY based upon the Chao2 estimator, and 0.289 is the proportion of females ≥4 years of age accompanied by cubs-of-the-year (Appendix C) in the telemetry sample, and 0.7734 is the proportion of female bears ≥4 years of age in the standing population of females ≥2 years of age.

Table 10. Deterministic projections of stable age structure of the Greater Yellowstone Ecosystem grizzly bear population. Data from Harris et al. (2005:Table 18) and lx = survivorship schedule.

	Adult female survival = 0.92			Adult male survival = 0.823		
Age years	lx	Stable age distribution	Proportion by years 0–30	lx	Stable age distribution	Proportion by years 0–30
0	1.000	1.000	0.1831	1.000	1.000	0.2624
1	0.630	0.605	0.1107	0.630	0.605	0.1587
2	0.504	0.464	0.0850	0.504	0.464	0.1218
3	0.464	0.410	0.0750	0.415	0.367	0.0962
4	0.427	0.362	0.0662	0.341	0.290	0.0760
5	0.392	0.319	0.0585	0.281	0.229	0.0600
6	0.361	0.282	0.0516	0.231	0.181	0.0474
7	0.332	0.249	0.0456	0.190	0.143	0.0374
8	0.306	0.220	0.0403	0.157	0.113	0.0296
9	0.281	0.194	0.0355	0.129	0.089	0.0234
10	0.259	0.171	0.0314	0.106	0.070	0.0184
11	0.238	0.151	0.0277	0.087	0.056	0.0146
12	0.219	0.134	0.0245	0.072	0.044	0.0115
13	0.201	0.118	0.0216	0.059	0.035	0.0091
14	0.185	0.104	0.0191	0.049	0.027	0.0072
15	0.170	0.092	0.0168	0.040	0.022	0.0057
16	0.157	0.081	0.0149	0.033	0.017	0.0045
17	0.144	0.072	0.0131	0.027	0.013	0.0035
18	0.133	0.063	0.0116	0.022	0.011	0.0028
19	0.122	0.056	0.0102	0.018	0.008	0.0022
20	0.112	0.049	0.0090	0.015	0.007	0.0017
21	0.103	0.044	0.0080	0.012	0.005	0.0014
22	0.095	0.038	0.0070	0.010	0.004	0.0011
23	0.087	0.034	0.0062	0.008	0.003	0.0009
24	0.080	0.030	0.0055	0.007	0.003	0.0007
25	0.074	0.026	0.0048	0.006	0.002	0.0005
26	0.068	0.023	0.0043	0.005	0.002	0.0004
27	0.063	0.021	0.0038	0.004	0.001	0.0003
28	0.058	0.018	0.0033	0.003	0.001	0.0003
29	0.053	0.016	0.0029	0.003	0.001	0.0002
30	0.049	0.014	0.0026	0.002	0.001	0.0002

Proportion of the population ≥4 years of age	0.5462
Proportion of the population ≥2 years of age	0.7062
Proportion of females ≥4 years of age of females ≥2 years of age	0.773421
Proportion of the population ≤1 years of age	0.294
Proportion of females ≤1 years of age of females ≥2 years of age	0.416
Male:female ratio (age≥2)	0.3638:0.6362

Table 11. Deterministic projections of stable age structure of the Greater Yellowstone Ecosystem grizzly bear population. Data from Harris et al. (2005:Table 18) and lx = survivorship schedule.

	Adult female survival = 0.95			Adult male survival = 0.874		
Age years	lx	Stable age distribution	Proportion by years 0–30	lx	Stable age distribution	Proportion by years 0–30
0	1.000	1.000	0.1826	1.000	1.000	0.2451
1	0.650	0.604	0.1103	0.650	0.604	0.1481
2	0.540	0.466	0.0851	0.540	0.466	0.1142
3	0.513	0.411	0.0751	0.472	0.379	0.0928
4	0.487	0.363	0.0663	0.412	0.307	0.0753
5	0.463	0.321	0.0586	0.360	0.250	0.0612
6	0.439	0.283	0.0517	0.315	0.203	0.0497
7	0.417	0.250	0.0457	0.275	0.165	0.0404
8	0.397	0.221	0.0403	0.240	0.134	0.0328
9	0.377	0.195	0.0356	0.210	0.109	0.0266
10	0.358	0.172	0.0314	0.184	0.088	0.0216
11	0.340	0.152	0.0277	0.161	0.072	0.0176
12	0.323	0.134	0.0245	0.140	0.058	0.0143
13	0.307	0.118	0.0216	0.123	0.047	0.0116
14	0.292	0.105	0.0191	0.107	0.038	0.0094
15	0.277	0.092	0.0169	0.094	0.031	0.0077
16	0.263	0.081	0.0149	0.082	0.025	0.0062
17	0.250	0.072	0.0131	0.072	0.021	0.0050
18	0.237	0.064	0.0116	0.063	0.017	0.0041
19	0.226	0.056	0.0102	0.055	0.014	0.0033
20	0.214	0.050	0.0090	0.048	0.011	0.0027
21	0.204	0.044	0.0080	0.042	0.009	0.0022
22	0.193	0.039	0.0070	0.036	0.007	0.0018
23	0.184	0.034	0.0062	0.032	0.006	0.0014
24	0.175	0.030	0.0055	0.028	0.005	0.0012
25	0.166	0.027	0.0049	0.024	0.004	0.0010
26	0.158	0.023	0.0043	0.021	0.003	0.0008
27	0.150	0.021	0.0038	0.019	0.003	0.0006
28	0.142	0.018	0.0033	0.016	0.002	0.0005
29	0.135	0.016	0.0029	0.014	0.002	0.0004
30	0.128	0.014	0.0026	0.012	0.001	0.0003

Proportion of the population ≥4 years of age	0.547
Proportion of the population ≥2 years of age	0.707
Proportion of females ≥4 years of age of females ≥2 years of age	0.773392
Proportion of the population ≤1 years of age	0.293
Proportion of females ≤1 years of age of females ≥2 years of age	0.414
Male:female ratio (age ≥2)	0.3901:0.6099

Our annual index of population size for females ≥2 years of age is then $= \hat{N}_{females\ 2+}$. The denominator of 0.224 is not statistically different from the estimate of Harris (Appendix A) of 0.248.

We also discussed the variation in our annual estimates and how we might dampen this variation to reduce the wide swings in allowable mortality limits based on this population index. We considered using a 3-year running average of $\hat{N}_{females\ 2+}$ to dampen variation, but the group felt there were potential statistical problems with any such calculations. Consequently, we elected to generate an annual population size of independent females ≥2 years of age and use that estimate to establish an annual mortality quota.

Finally, we discussed the stable age structure and the appropriate number of age classes to consider. In their modeling, Harris et al. (2005) used 31 age classes. We evaluated this number relative to known longevity of bears and concluded it was probably quite close to the maximum life expectancy of bears in the GYE. We came to this conclusion based on the following:

Justification for using 31 Age Classes (Ages 0–30)
The IGBST documented 19 individual grizzly bears living ≥20 years in the GYE during 1975–2004. Twelve of these were known to have died, while the fates of an additional 7 were unknown (Table 12).

Table 12. Fate of radiocollared grizzly bears in the Greater Yellowstone Ecosystem, ≥20 years of age, 1975–2004.

	Last known fate		
Age	Alive	Dead	Total
20	2	3	5
21	1	3	4
22	2	3	5
24	1	1	2
25	1	1	2
28	0	1	1
Total	7	12	19

The oldest bears documented in the GYE were 25 and 28 for females and males, respectively (Table 13). The oldest female known to have produced cubs was 25. We currently (2005) have a 25-year-old female radiomarked.

Table 13. Age and sex of oldest known grizzly bears in the Greater Yellowstone Ecosystem, 1975–2004.

	Sex		
Age	Female	Male	Total
20	3	2	5
21	2	2	4
22	2	3	5
24	1	1	2

25	1	1	2
28	0	1	1
Total	9	10	19

Estimating Numbers of Cubs, Yearlings, and Independent Males:
Because our index of abundance only addressed independent females, we explored additional ways to estimate abundance of cubs, yearlings, and male bears. We elected to treat cubs and yearlings as a group because dependent young are exposed to different mortality causes, and if there is ever a hunting season, cubs and yearlings would be protected. Keeping them separate from any quota of independent female and male bears facilitates managing a hunt. We explored 2 alternative methods to estimate the cubs and yearlings in the population:

1. The first was based on the stable age distribution (Tables 10 and 11). We determined that for every female ≥2 years of age, there were 0.414 or 0.416 dependent females (cubs and yearlings), using low and high survival rates of adult females. We used the mean value (0.415) to estimate numbers of dependent females in the population by multiplying our estimate of $\hat{N}_{females\ 2+}$ from Equation 5 by 0.415

$$\hat{N}_{dependent\ young} = [\hat{N}_{females\ 2+}(0.415)]2 \qquad (6)$$

   Finally, we chose to consider both sexes of cubs and yearlings together so we multiplied our estimate of dependent female bears by 2 to estimate the total number of dependent offspring in the population ($\hat{N}_{dependent\ young}$).

2. We assumed average litter size was 2 cubs (Schwartz et al. 2005*a* estimated mean litter size = 2.04), with a 50:50 sex ratio. We also assumed cub survival = 0.638 (Schwartz et al. 2005*b*). We calculated the number of cubs and yearlings in the population using the following equation:

$$\hat{N}_{dependent\ young} = \{\hat{N}_{Chao2,\,t} + [(\hat{N}_{Chao2,\,t-1})(0.638)]\}2 \qquad (7)$$

   where $\hat{N}_{dependent\ young}$ is an annual estimate of dependent offspring, $\hat{N}_{\text{Chao2, t}}$ number of FCOY in year *t*, and $\hat{N}_{\text{Chao2, t-1}}$ is the number of females with cubs in year *t* - 1.

   Results using this method yield fewer cubs and yearlings on average than Method 1. We used this method because the number of dependent young is calculated directly from field data.

3. We estimated the number of males directly from our estimate of independent females. Based on simulation modeling, Harris et al. (2005) estimated that the ratio of male:female bears ≥2 years old in the GYE population was

0.377:0.623. This effectively means that for each female in the population, there are 0.605 males (0.377/0.623 = 0.605). We calculated the number of independent males using the following equation (Table 9):

$$\hat{N}_{males\ 2+} = \hat{N}_{females\,2+}(0.605) \qquad (8)$$

Area of inference

During our second workshop we discussed the area of inference and application of our estimators to segments of the GYE population. The population estimators reviewed by Keating et al. (2002) are for closed populations. We concluded that our estimates are appropriate at the GYE population level. As a consequence, our estimates of sustainable mortality are also appropriate at the population level.

SUSTAINABLE MORTALITY LIMITS

To address objective 2 we considered the current method and evaluated and discussed other options.

Current Method

To facilitate recovery and to account for unknown, unreported, human-caused mortality, known human-caused mortality was set by the USFWS Grizzly Bear Recovery Plan at 4% of the minimum population estimate (USFWS 1993). Female mortality was set at 30% of this 4% limit. Limits of acceptable mortality were derived from Harris (1986) using a model of a generic bear population in the Rocky Mountains. Harris (1986) suggested that grizzly bear populations could sustain approximately 6% human-caused mortality without population decline. The difference between the 4% in the Recovery Plan and 6% of Harris (1986) allowed for an unreported loss of 2% from human causes.

Benefits

- Under the current mortality limits, the GYE population has increased at an average rate of between 4–7% per year. It appears conservative (at least when coupled with the minimum population estimate).
- It can be applied to any of the proposed population methods discussed above.

Limitations

- Estimates are based on generic grizzly bear population, not specific to the GYE.
- More updated and detailed information is available to model the population.
- Method assumed an unstated reporting rate of 2:1 (reported:unreported), which is inconsistent with current estimates for GYE grizzly bears.

Discussion

We discussed several issues. The current method only considers known and probable human-caused mortality. The 6% limit does not consider undetermined or natural mortality. This is an issue when cause of death is reported as "undetermined" because these deaths are not counted against the threshold.

However, it is likely that many of these mortalities were in fact human-caused deaths.

The 6% limit was reduced to 4% to account for an unknown and unreported mortality of 2%. This can be interpreted as 1 unreported loss for every 2 known losses. However, Knight and Eberhardt (1985:330) stated that actual mortality in the GYE "appears to be approximately double that recorded." This result is consistent with current estimates of reporting rate (Appendix B).

The recent analysis by Harris et al. (2005) suggests that the 6% sustainable mortality limit is very conservative and can be increased.

The group decided to explore alternate methods of establishing mortality limits using all of the most recent information published by Cherry et al. (2002), Harris et al. (2005), Haroldson et al. (2005), and Schwartz et al. (2005*a*, *b*).

ALTERNATIVE MORTALITY THRESHOLDS

Independent Females ≥2 Years Old

Adjust sustainable mortality limits to match what is required to maintain $\lambda \geq 1$ based on more recent simulation models by Harris et al. (2005). The GYE grizzly bear population is likely to maintain a positive trajectory as long as survival of independent females (aged ≥2 years) remains above approximately 0.91 (i.e., 9% annual mortality from all causes).

Benefits

- This would bring the limits in line with empirical data from the GYE as discussed by Schwartz et al. (2005*c*). Additionally, Harris et al. (2005) indicated regarding this 9% mortality that: It would seem, at first blush, to suggest a radical departure from current guidelines. For example, Harris (1986:273) recommended that 'the proportion of the female segment of the population that can be removed annually…without causing chronic decline should not exceed 3% of the female segment.' More recently, McLoughlin (2002:33) suggested that 'most grizzly bear populations in North America can tolerate approximately 3% total annual kill before declines…accelerate to unsatisfactory levels.' Careful reading, however, reveals that, beyond some minor differences in assumptions and procedures, the apparent increase in tolerable mortality we report here arises not from real discrepancies in models or parameter values but rather from different ways of expressing a similar underlying dynamic.

  Comparing our results with those of Harris (1986) is important because current management guidelines in the Yellowstone Grizzly Bear Recovery Zone (USFWS 1993, 2003) adopt an annual mortality limit derived largely from that work. First, our approach here differed fundamentally in that the earlier work attempted to estimate the mortality level associated with sustainability indefinitely. That is, Harris (1986) used a model of grizzly bear population dynamics that was self-regulating. Thus, bear populations in

Harris (1986) equilibrated (rather than growing exponentially) in the absence of killing by humans. Adding human-caused deaths to this model engaged compensatory responses that were assumed to characterize grizzly bear populations (although parameters used to build the responses were not based directly on data, but rather were interpolated from general principles). Here, our aims were more modest: to project short-term growth rates applied under a range of plausible survival rates, making no assumptions about density-dependent (or other possible) regulating mechanisms that would, no doubt, intercede to change those trajectories. Second, Harris (1986) assumed that natural mortalities, although decreasing as hunting increased, would never be entirely substituted by human-caused mortality. That is, even at the population level producing the highest sustainable yield indefinitely, background levels of natural mortality would continue. Harris' (1986) objective was to estimate the maximum human-caused mortality rate that, when embedded into the assumed compensatory structure, equilibrated the population with its carrying capacity. Here, we declined to suppose any particular relationship between human- and nonhuman-caused mortalities (to say nothing of carrying capacity). Indeed, we had no data to do otherwise, given that not a single independent female mortality in GYE attributable to non-human causes was documented during 1983–2001 (Haroldson et al. 2005). Dependent young experienced natural mortality, but because cubs and yearlings were not collared, cause of death was undetermined in many cases (Schwartz et al. 2005*b*).

Thus, contrasting our results directly with the 3% sustainable mortality rate of females estimated by Harris (1986) is inappropriate. Harris (1986) also assigned survival rates to 3 subadult female classes (ages 2, 3, and 4 years) in addition to 3 adult age classes, complicating any attempt to compare the total mortality rate sustained by adult females in his model populations with those we report here. Fortunately, we were able to rehabilitate the Harris (1986) model for application here and develop a common currency for comparison with results reported here. We discovered that maximum hunting rates he found consistent with sustainability (i.e., 6.85 female kills/year from a population of 193.5 females, or 3.54% of the female component killed annually; Harris 1986:276) corresponded to an annual survival rate of all females (cubs through the oldest class) of 0.851 (SD = 0.035, n = 3,000). For comparison, our survival rates of all females (irrespective of age) consistent with low probability of decline were 0.847 (SD = 0.022, n = 3,000) when independent female survival was 0.91 (under low process variation) and 0.852 (SD = 0.077, n = 6,000) when independent female survival was 0.92 (under high process variation). Thus, although the approaches and presentation of results were quite divergent, overall female survival rates consistent with nondeclining populations in both Harris (1986) and our present effort were almost identical.

McLoughlin (2002) reported that a simulated population modeled approximately on GYE grizzly bear data through 1995 displayed a breakpoint (at which persistence probability declined rapidly with additional kills) at a mortality rate of about 2.8%. However, human-caused mortalities in his model were assumed additive to natural mortality, which was set at 4.9% for females aged ≥6 years and 11.4% for females aged 2–5 years (McLoughlin 2002:Table 2.1). With approximately 30% of the female population in ages 2–5 years and 46% ≥6 years old (approximately the case if the population had achieved its stable age distribution prior to additional harvest), the mean natural mortality rate for females ≥2 years would thus be approximately 6.4%. This, added to the 2.8% annual kill, yields 9.2% total mortality of females age ≥2 years (i.e., annual survival of 0.908), which is again similar to our conclusion that λ will be ≥1 with high probability when annual female (age ≥2 years) survival rates were approximately 0.90–0.91.

Eberhardt (1990) also provided a simple deterministic model relating grizzly bear life history rates to stable trajectories. Application of the mean survival rates from our simulations to (Eberhardt 1990:587) produced $r = 0$ (i.e., $\lambda = 1.0$) with independent female (≥2 years old) survival of 0.898 and age of first reproduction set to 5 years, as well with as with independent female survival of 0.906 and age of first reproduction set to 6 years (GYE mean during 1983–2002 was 5.81 years, but Eberhardt's [1990] equation did not allow for fractional ages). Although abstract, his model further confirmed our estimates of female survival rates consistent with nondeclining trajectories.

The current approach to grizzly bear management in GYE is for management agencies to consider all forms of mortality, but to establish an annual mortality limit only for human-caused mortality. We propose that rather than counting human-caused mortalities, management agencies should focus on female survival rates irrespective of the cause of death. By counting all deaths, it becomes unnecessary to determine exactly how a bear died (which often requires subjective judgments). It also minimizes the importance of knowing the proportion of human-caused deaths not documented (e.g., Cherry et al. 2002). As long as an active monitoring program is in place (including radiotelemetry of a random sample of bears to update life-history rates as conditions change), demographic analyses can augment counts of reproductively-active females (Knight et al. 1995, Mattson 1997, Keating et al. 2002) as an indicator of overall population health.

- This limit is based on survival estimates for females ≥2 years of age. It will allow us to set limits for independent females using methods discussed above to estimate independent females in the population.
- Allows for separate limits for male bears.

Limitations

- This is a total mortality limit for independent female bears. It includes both natural and human-caused deaths. We were unable to estimate the rate of

"natural mortality" for independent female bears because we did not document any natural mortality in the telemetry sample of females from 1983–2002. This must be considered when using this method.
- The limit only addressed independent females and requires we consider dependent young separately.
- Requires we establish limits for males separately or establish a geographically-based limit system.

Discussion
The group felt it was essential to distinguish between a mortality limit that is not to be exceeded and a mortality target that is a management objective. Consequently, we defined a sustainable mortality limit for female grizzly bears (≥2 years of age) in the GYE as the maximum allowable mortality that the female population can sustain over time and maintain population stability (stability is defined as $\lambda = 1.0$) with a 95% level of confidence. Based on Harris et al. (2005), if we set independent female survival = 0.89, the point estimate of $\lambda = 1.005$ with a 95% confidence interval 0.97–1.04. Because this estimate overlaps 1.0, and there is a chance that when survival = 0.89, $\lambda < 1$, we recommended the following:

i. Use a survival rate of 0.91 ($\lambda = 1.03$, CI 1.0–1.05), which allows for increased confidence that $\lambda \geq 1.0$. We did this because the estimate accounts for process variation inherent in annual female survival in the GYE.

ii. The States of Wyoming, Montana, and Idaho set the near-term objective for the GYE bear population to continue expanding into suitable habitat. To assure population health with an acceptable level of risk, we chose a point estimate of survival for females that has the lower 95% CI of $\lambda = 1.0$.

We also discussed mortalities to include for tabulation of total independent female mortality. The group recommended we consider all forms of mortality, including human-caused, natural, and undetermined, against the quota. This eliminated the need to determine cause of death, eliminated the possibility of misclassification, and stays closer to our estimate of 9% total mortality from all causes. Natural mortality appears quite low for independent females in the GYE. Results presented by Haroldson et al. (2005) indicated no recorded natural deaths for independent female bears based on telemetry from 1983–2001 from a sample of 3,420 radio-months (285 bear-years). We determined the binomial confidence bounds for these data with $x = 0$, $n = 285$, where $p = x/n$ using the formula: $0 \leq p \leq 1 - \alpha^{1/n}$ (van Belle 2002). At $\alpha = 0.05$ and $n = 285$, the upper bound of the confidence interval = 0.0105. This suggests that although we did not document natural mortalities over the 19-year-period with a sample of 285 bear-years, there was a small chance we missed one. Regardless, the data suggest that natural mortalities are rare and would not contribute much to the total mortality limit whether included or excluded in the tally. Consequently, we elected to count all forms of mortality for independent female bears.

Results of these calculation and thresholds are shown in Table 14.

Dependent Offspring (Cubs And Yearlings)

We discussed the establishment of a limit on mortality for cubs and yearlings.

1. Because we often lack information on the sex of dead cubs and yearlings, we elected to establish a limit for both sexes. Although survival estimates for cubs-of-the-year (0.638) and yearlings (0.817) were lower than survival of independent bears, we elected to set the mortality limit the same for the following reasons:
    - Only human-caused mortalities would be counted. We decided this because numbers of recorded cub and yearling mortalities are linked to the number of adult female bears collared. Most of the documented deaths of offspring of collared bears are of undetermined cause. Data presented by Schwartz et al. (2005*b*) suggests these are likely natural deaths. We cannot limit natural deaths but need to consider human-caused mortality and ensure it does not exceed sustainability. From the sample of dependent young, 10 of 32 cubs, and 1 of 5 yearlings died from human related causes. This equated to 11 of 37 (0.297) mortalities recorded as human-caused, or about 30% of recorded mortality was human-caused.

      The method of Cherry et al. (2002) to estimate unknown and unreported mortalities is based on reporting rate from a sample of telemetry bears. Dependent young were not radiomarked. We therefore elected to count only known and probable human-caused deaths for dependent young and set the limit at 9% for both sexes. We will assume reporting rates for dependent young are similar to reporting rates of independent bears (which is likely because most dependent young, especially cubs, die if their mother dies). Reporting rates for independent bears are roughly 1 reported for 2 unreported. The 9% reported limit is then roughly equivalent to a 27% total mortality rate (9% reported:18% unreported). Total mortality from birth to recruitment as a 2-year-old is 0.48 (1 - [0.638 x 0.817]). Assuming human-caused mortality remains about the same, one would expect about 14.3% of this recorded mortality to be human caused (0.48 x 0.297 = 0.143). Accounting for both sexes, this equates to about 28.6% mortality (0.143 x 2 = 0.286), which approximates the proportion of recorded human-caused mortality rates from 1983–2001 (0.297).
    - We also discussed the implications of error in our estimates. A 9% limit is conservative for dependent young. Secondly, survival of dependent young only contributed 17.8% to the elasticity of lambda calculations (Harris et al. 2005)

Alternatively, we estimated from transition probabilities (Appendix C) that approximately 0.529 females ≥4 years of age were accompanied by either cubs or yearlings in any given year. A simpler approach would set a limit that no more than half of all females ≥4 years old tallied in the mortality quota could be accompanied by cubs or yearlings. We did not choose this alternative because it does not allow for consideration of dependent young that die independently of their mothers.

Table 14. Estimated number of females with cubs-of-the-year ($\hat{N}_{Chao2}$) and independent females aged ≥2 years old in the Greater Yellowstone Ecosystem, 1986–2004. Mortalities were listed by cause (management removal [MGMT], known because of telemetry [TELE], reported by the public [PUBL], estimates of known, unknown, and unreported [KNO:UNR), and total. The annual mortality limit from all causes was set at 9% of the annual female estimate. The 3-year running average of mortality smoothed the limit and was used as a threshold. Status indicates if threshold was exceeded and the probability of exceeding the threshold based on the credible interval used to calculate unknown and unreported mortality.

			Female mortality								
Year	$\hat{N}_{Chao2}$	Females ≥2 years	MGMT	TELE	PUBL	KNO:UNR[a]	Total	9% mortality limit	3-year running average limit	Status	$\hat{P}$ of exceeding[b]
1986	27.5	123	1	3	1	2	6	11			
1987	17.3	77	1	0	1	2	3	7			
1988	21.2	95	0	1	0	1	2	9	9	OK	0.003
1989	17.5	78	0	0	0	1	1	7	8	OK	0.003
1990	25.0	112	1	2	3	7	10	10	9	exceeded	0.484
1991	37.8	169	0	0	0	1	1	15	11	OK	0.000
1992	40.5	181	0	1	0	1	2	16	14	OK	0.000
1993	21.1	94	0	1	2	5	6	9	13	OK	0.031
1994	22.5	101	0	2	1	2	4	9	11	OK	0.014
1995	43.0	192	3	0	3	7	10	17	12	OK	0.235
1996	37.5	168	1	3	2	5	9	15	14	OK	0.059
1997	38.8	173	0	0	3	7	7	16	16	OK	0.036
1998	36.9	165	0	0	1	2	2	15	15	OK	0.002
1999	36.0	161	0	0	1	2	2	14	15	OK	0.002
2000	51.0	228	1	1	3	7	9	21	17	OK	0.047
2001	48.2	216	5	3	1	2	10	19	18	OK	0.010
2002	58.1	260	2	2	4	10	14	23	21	OK	0.079
2003	46.4	208	1	0	5	13	14	19	20	OK	0.115
2004	57.5	257	4	0	5	13	17	23	22	OK	0.142

[a]Data in this column are estimates of unknown and unreported mortality plus mortalities reported by the public. The method of Cherry et al. (2002) estimates the number of times an event occurred given an observed outcome and the probability of that outcome. For example, the method would estimate the number of times a coin was flipped given that 3 heads were observed and the probability of a heads was 0.5. In our case here, it estimates the number of dead bears (both reported and unreported) given the number reported by the public. So in 2004,

given that 5 bears were reported dead, the method estimated that 13 actually died

[b]The probability of exceeding was based on the method of Cherry et al. (2002). The probability values represent the likelihood of exceeding the 3-year running limit minus the known deaths (MGMT and TELE), given a public reporting (PUBL) rate for that year. For example in 2004, the 3-year limit was 22. The probability is therefore the likelihood of exceeding 19 deaths (22 – 4 - 0 +1 = 19) given that 5 were reported.

Independent Males ≥2 Years Old

We used empirical data to establish a male mortality limit based on estimates from 1983–2001 (Haroldson et al. 2005). Estimated survival of independent male bears in the GYE equaled either 0.874 or 0.823 for the censored and assumed dead data sets. We split the difference and established the limit of mortality equal to 0.15. Results of calculations and thresholds are reported in Table 15. Male limits are based on the status quo and the past 20 years, when the GYE grizzly bear population increased in size and expanded in range.

UNKNOWN AND UNREPORTED MORTALITY

To address objective 3, we considered the current method and evaluated and discussed other options.

Current Method

- Harris (1986) suggested that grizzly bear populations could sustain approximately 6% human-caused mortality without population decline. To facilitate recovery and to account for unknown, unreported, human-caused mortality, known human-caused mortality was set by the USFWS Grizzly Bear Recovery Plan at 4% of the minimum population estimate (USFWS 1993). The reduction from 6% to 4% was justified because an assumption was made that for 2 reported mortalities, an additional one was unreported.

However, Knight and Eberhardt (1985:330) stated that actual mortality in the GYE "appears to be approximately double that recorded."

Benefits

- Simple.
- Can be applied to any of the proposed population methods above.
- Has worked in the past.

Limitations

- Does not include estimates of uncertainty.
- This ratio may have changed.

Discussion

We all agreed that there was better information and that we should explore new methods to account for unknown and unreported mortality.

Table 15. Estimated number of females with cubs-of-the-year ($\hat{N}_{Chao2}$) and independent males (≥2 years old) in the Greater Yellowstone Ecosystem, 1986–2004. Mortalities were listed by cause (management removal [MGMT], known because of telemetry [TELE], reported by the public [PUBL], estimates of known, unknown, and unreported [KNO:UNR], and total. The annual mortality limit from all causes for males ≥2 years old was set at 15% of the male population estimate. The 3-year running average of mortality smoothed the limit and was used as a threshold. Status indicates if threshold was exceeded, and the probability of exceeding it was provided based on the credible interval used to calculate unknown and unreported mortality.

Year	$\hat{N}_{Chao2}$	Males ≥2 years	Male mortality					15% mortality limit	3-year running average limit	Status	$\hat{P}$ of exceeding
			MGMT	TELE	PUBL	UNK:UNR	Total				
1986	27.5	74	1	1	0	1	3	11			
1987	17.3	47	2	1	0	1	4	7			
1988	21.2	57	1	1	1	2	4	9	9	OK	0.031
1989	17.5	47	1	1	1	2	4	7	8	OK	0.046
1990	25.0	68	1	1	2	5	7	10	9	OK	0.154
1991	37.8	102	0	0	0	1	1	15	11	OK	0.000
1992	40.5	110	2	5	1	2	9	16	14	OK	0.031
1993	21.1	57	0	2	0	1	3	9	13	OK	0.000
1994	22.5	61	0	1	1	2	3	9	11	OK	0.010
1995	43.0	116	2	4	4	10	16	17	12	exceeded	0.750
1996	37.5	102	2	2	3	7	11	15	14	OK	0.182
1997	38.8	105	1	1	2	5	7	16	16	OK	0.016
1998	36.9	100	2	2	0	1	5	15	15	OK	0.000
1999	36.0	97	2	2	3	7	11	15	15	OK	0.140
2000	51.0	138	2	4	11	29	35	21	17	exceeded	1.000
2001	48.2	131	7	2	1	2	11	20	18	OK	0.014
2002	58.1	157	4	1	3	7	12	24	21	OK	0.036
2003	46.4	126	2	3	3	7	12	19	21	OK	0.036
2004	57.5	156	3	2	7	18	23	23	22	exceeded	0.476

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Alternative Method
Cherry et al. (2002) provided an alternative method that used a hierarchical Bayesian model, with an assumed noninformative prior distribution for the number of deaths. Information from reporting rates of deaths in radiocollared bears was used to develop a beta prior distribution on the probability that a death would be reported by the public. Data were reassessed and those results are provided in Appendix B.

Benefits

- Based on empirical data.
- Deals with uncertainty.
- Can be updated with new information.

Limitations

- The method assumes that deaths occur independently of one another.
- Deaths of instrumented and noninstrumented bears have the same probability of being reported.
- The probability of a death being reported is independent of the cause of death.
- The probability a death is reported is constant over the period on which the prior distribution is based.
- In general the estimate is sensitive to the prior distribution.
- Bayesian credible intervals are wide.
- Estimate sensitive to prior.

Discussion
We all agreed that this approach was superior to the original method. Recent information (Appendix C) suggested the at ratio of known:unknown deaths was closer to 1:2 as opposed to the 2:1 ratio used in the original method. Items that we felt needed additional investigation and tasks we assigned to Dr. Cherry included:

- Is the median the best statistic to establish the prior?
- Cherry et al. (2002) used a 3-year running average of mortalities to illustrate how to calculate the credible interval. Can we use an annual estimate?

It was recommended we use the median because it is a reasonable summary measure that works well for all posterior distributions we have seen in our data (Appendix D).

It was also recommended that the credible interval be based on the annual estimate to avoid issues with running averages.

POPULATION MONITORING

Our objectives in this report addressed establishing methods to index bear numbers, establishing of mortality thresholds for independent females, independent males, and dependent young, and accounting for unknown and unreported mortality in tallies of dead bears. The group felt that to successfully monitor the GYE bear population and ensure that mortality thresholds are in line with demographics, additional monitoring was important. We therefore endorsed recommendations made by Schwartz et al. (2005*c*). Those recommendations are repeated here.

Simulations conducted by Harris et al. (2005) quantified and confirmed conventional wisdom that changes in λ are largely influenced by changes in survival of independent females (73% elasticity), which is principally driven by human-caused mortality. Managing human-caused female mortality was a major goal established by Interagency Grizzly Bear Committee (IGBC) in 1983, and results of our spatial analysis suggest success in this management effort.

We recommend the following to improve our abilities to understand the GYE population:

1. Identify additional areas outside the Recovery Zone (RZ) that will be designated as biologically suitable and socially acceptable habitats for grizzly bears in the GYE. The states of Idaho, Montana, and Wyoming have agreed to this in their management plans. These lands should be managed as biologically secure habitat. Biologically secure habitat in aggregate would be defined as lands where on average reproduction and survival rates result in $\lambda = 1$.
2. Maintain a representative sample of radiomarked individuals residing in biologically secure habitat for monitoring purposes. As indicated by Harris et al. (2005) results should be robust to geographic heterogeneity as long as survival rates of dependent and independent females are unbiased estimates of the entire GYE grizzly population.
3. Estimate trajectory for biologically secure habitat in aggregate at approximately 10-year intervals. Harris et al. (2005:Tables 20–22) showed that when survival of independent female bears was ≥0.91 with $m_x = 0.318$, then $\lambda \geq 1$ about 95% of the time. Assuming that survival of independent females remains at or near our current estimate of ≥0.92, survival can be estimated with SE ≤ 0.02 from a telemetry sample ≥185 bear-years. Assuming we continue to meet the IGBC mandate of maintaining a sample of at least 25 adult females/year, we can estimate a population trajectory in biologically secure habitat approximately every 8 years.
4. Continue counts of unduplicated females with cubs in all occupied habitats.
5. Conduct a demographic review to consider alternate mortality limits based on findings in Schwartz et al. (2005*d*) and those of Cherry et al. (2002). This review must recognize that habitat carrying capacity may change, and may ultimately be reached; if this occurs, an annual management goal of $\lambda \geq 1$ is unrealistic. We recommend exploring alternative mortality limits that consider counting all forms of mortality — not just human-caused — in any revised demographic management system, setting different mortality limits for independent females and males, and exploring mechanisms for more liberal mortality limits outside areas designated as biologically secure habitat.
6. Develop more sophisticated models of the current source–sink dynamic using covariates that might explain observed differences in mortality rates among the 3 politically defined residency zones (see Schwartz et al. 2005*e*). We recognize that our 3 zones are a rather simplistic approach to any spatial analysis.
7. Explore habitat use and home-range sizes of historically collared bears to better understand potential edge effects (White et al. 1982) associated with home range size and the geographic extent of the existing RZ.

8. Explore dispersal rates and distances within GYE to better understand where bears killed in insecure habitats originate.
9. Explore the influence of type of conflict on subsequent survival of individuals. Our a posteriori models demonstrated that survival of individuals improved with years post conflict. We suspect that conflict type (i.e., livestock, human dwellings, etc.) also could influence the rate of survival.

DEMOGRAPHIC OBJECTIVES

Under the Conservation Strategy, the IGBST is responsible for carrying out a biology and monitoring review. Such reviews are triggered by negative deviations from the desired conditions established in the Conservation Strategy for population, mortality reduction, and habitat parameters. The Conservation Strategy (USFWS 2003:6) states that "it is the goal of the agencies implementing this Conservation Strategy to manage the Yellowstone grizzly population in the entire GYA at or above 500 grizzly bears." Because of the increased level of uncertainty in estimating total population size using the methods we propose here, and because long-term survival of the GYA grizzly bear is most closely linked to survival of adult females (Eberhardt 1977, 1990, 2002; Knight and Eberhardt 1987; Harris et al. 2005), we recommend a demographic target ≥48 adult females (age ≥4 years) be maintained annually. This target of 48 females, when extrapolated, is equivalent to a population of approximately 500 individuals. We derived this figure by starting with a population of 500 bears. On average, the number of dependent young in the population based on our methods of calculation (Table 7) is approximately 31% (range 29–33 for years 1999–2004). Consequently, 69% of the population of bears is ≥2 years old which equates to 500 x 0.69 = 345 adult bears. Assuming a sex ratio of 62 females:38 males, this equates to a population of ≥2-year-old females of 215 (345 x 0.62). Females ≥4 years old constitute approximately 0.773 of the ≥2-year-old females or 215 x 0.773 = 166. Our transition probabilities suggest that approximately 28.9% of females ≥4 years old have cubs in any given year, which equates to 48 females (166 x 0.289 = 48). Using the old method (Equation 1), we would sum 3 years of counts and divide by 0.274. This equates to a population estimate of ([48 + 48 + 48]/0.274 = 526. If we replace the value 0.274 with the updated estimate from Harris (Appendix A, Table 1 of this report) of 0.289, 48 females returns a population of 498 bears. These different methods yield approximately the same number of bears.

This target of 48 will be derived from the point estimate of the $Chao_2$ estimator using frequency counts of unduplicated females with cubs. We recommend the point estimate because: (1) the $Chao_2$ estimator is either accurate relative to actual bear numbers or biased low, and (2) statistically, the point estimate is the best unbiased estimate of the mean. Because we observe normal variation about counts of females related to reproductive performance and foods (Schwartz et al. 2005*b*), we anticipate some natural variation to occur. Short-term fluctuation in counts is therefore expected. We are most concerned with long-term chronic declines in counts which might reflect a declining population. We recommend a biology and monitoring review should the estimate decline below this threshold of 48 for any 2 consecutive years. We make no effort to define all possible management scenarios that might need review. We likewise make no effort to outline in detail recommendations that might come from a biology and monitoring review because each would have its own unique combination of circumstances and data that must be evaluated in light of other information.

Management agencies lack complete control over female mortality. Hence, if the lower one-tailed 80% bound of the $Chao_2$ estimate is <48 in any given year, agencies should attempt to limit female mortality the following year as a proactive measure to help minimize exceeding the point estimate recommendation above.

Although male mortality has no impact on population trajectory over the long run (Harris et al. 2005), we feel that some limits are necessary. We therefore recommend that managers try not to exceed established mortality limits for males as set forth in this document. We recommend that a management review be considered should male limits be exceeded in any 3 consecutive years. We further recommend that mortality limits of dependent young not be exceeded in any 3 consecutive years.

ADAPTIVE MANAGEMENT

Dale Strickland provides a brief summary of adaptive management (West, Inc. 2005), which he gleaned from Holling (1978), McLain and Lee (1996), Walters (1997), and Holling and Allen (2002). Adaptive management (AM) is characterized as a 6-step feedback loop:

1. Assessment — the point where current understanding of the system leads to development of strategies to meet management goals, prediction of outcomes of management, and the identification of key questions in the form of testable hypothesis.
2. Design — management actions and associated monitoring and research evaluate how well management meets specific management targets and address the hypothesis being tested.
3. Implementation — management is implemented according to the design.
4. Monitor — completed according to the design with data collected on specific performance measures.
5. Evaluation — outcome is evaluated against predictions about effects of management; progress toward goals is assessed.
6. Adjust — management adjusted based on evaluation of initial management actions. This adjustment can range from slight modification of the management action to a complete change in management direction, and possibly a change in the overall focus of the management program.

An AM plan includes 3 critical elements:

1. Conceptual and quantitative models that make explicit the current understanding of the system, the underlying hypotheses driving management, and key uncertainties;
2. Rigorous monitoring plans focused on reducing the most critical uncertainties and clearly evaluating progress toward management goals; and
3. A scientifically defensible plan for monitoring and research and rapid feedback from management outcomes to revised management decisions.

AM usually sets limits on goals, objectives, and management flexibility. These limits are usually based on logistical and technological feasibility, costs, and laws and regulations.

A major implication of adaptive management is that acquisition of useful data is one of the more important goals of management; therefore, the need for useful data should be considered when making management decisions. Monitoring and research should consider sources of uncertainty and attempt to reduce or eliminate them. However, the expected likelihood and costs of reducing uncertainty and the expected benefit in terms of improved management decisions will be primary considerations when prioritizing monitoring and research projects. This requires that setting of monitoring and research priorities is directly tied to the management framework.

The Conservation Strategy (USFWS 2003) recommends using AM when possible. Our approach here follows those recommendations. Much of the original demographics work (Eberhardt et al. 1994, Eberhardt 1995, Boyce et al. 2001, Haroldson et al. 2005, Harris et al. 2005, Schwartz et al. 2005*a, b, c*) has been completed and meets the assessment set of the 6-step process. Development of strategies to meet management goals (in this case a sustainable population) is the objective of this document. We have formally developed testable hypotheses. Based upon recommendations here, our scientific hypothesis would be that recommended mortality limits based on methods to estimate population size and unknown and unreported mortality will result in a stable or slightly increasing population of grizzly bears in the GYE.

Design elements for monitoring and continued research are contained within this document, as management recommendations to the demographics monograph (Schwartz et al. 2005*c*, and as part of the population monitoring recommendations of the Conservation Strategy (USFWS 2003). Annual reviews of results from all monitoring are recommended as per the Conservation Strategy.

The implementation phase is recommended to begin in 2005. Monitoring is ongoing and will continue. Counts of females with cubs and mortality documentation will be assessed annually for changes. Formal evaluation is recommended approximately every 8–10 years. Evaluation research will focus on updating demographic parameters used to estimate reproduction and survival, λ, and to reassess the stable age distribution, and transition probabilities used to estimate the number of females with cubs in any year. Should age structure, survival, or reproduction change due to density dependent relationships previously identified (Boyce et al. 2001, Schwartz et al. 2005*a*, *b*), or due to changes in food abundance or other natural processes adjustments to parameters used to estimate bear numbers, sustainable mortality, or unknown and unreported mortality will occur. Adjustments to this recommended protocol can occur after annual evaluations or following the more rigorous one that occurs every 8–10 years.

REPORT PREPARATION

We prepared this report to detail what we reviewed and our recommendations. We further recommend that results contained here be presented to state and federal managers for discussion, modification, and acceptance. Once this task is complete, we also recommend that these methods be presented to the Yellowstone Ecosystem Subcommittee for endorsement and application.

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Appendix A

Age-structures of modeled Greater Yellowstone Ecosystem grizzly bear populations

Appendix to
Final Report

16 April 2003

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The bulk of work completing this contract is contained in the report "Trajectory of the Yellowstone grizzly bear population under alternative survival rates," which is also being submitted for publication. This Appendix deals, separately, with the work pursuant to the last named deliverable: "Estimates and confidence limits around the proportion of the Greater Yellowstone Ecosystem (GYE) grizzly bear population consisting of adult females will also be produced as part of this work. Such estimates and confidence limits are a necessary component of estimates of total grizzly bear population size."

Objective
Size of the GYE grizzly bear population is currently estimated by dividing the estimate of "adult females" by the constant 0.284 (USFWS 1993:42). It is desirable to evaluate whether this constant is appropriate, and whether it should be updated. As well, use of a constant ignores the fact that this proportion may vary among years, and thus total population size should be estimated with appropriate error terms.

Here, I employed simulation techniques used in Harris et al. (2005) to update estimates that may be useful should managers desire to estimate total population size from some index of females with cubs or females of a minimum age.

Methods
Analyses of population parameters and development of a simulation model are both described in Harris et al. (2005), Schwartz et al. (2005*a*, *b*), and Haroldson et al. (2005). To generate statistics for this report, I used 2 parameterizations of the full simulation: (1) mean adult female (age >2) survival at 0.949, adult male (age >2) survival at 0.874, and

yearly process variation of survival rates approximating the shrunk estimates of process variation for the data set in which bears with unresolved fates were censored at last contact (Haroldson et al. 2005:Table 13); and (2) mean adult female (age >2) survival at 0.922, adult male (age >2) survival at 0.823, and yearly process variation of survival rates approximating the shrunk estimates of process variation from the data set in which animals with unresolved fates were assumed to have died (Haroldson et al. 2005). For each parameter set, I used a model run of 10 years (paralleling the larger analysis) and performed 3,000 iterations. The resulting proportions come from a sample of 30,000 years (there is some dependence of proportions within each 10-year series). Results are summarized via 5 statistics, determined yearly: (1) proportion of females in the population with cubs-of-the-year (cubs, hereafter); (2) proportion of all females aged >2 with cubs; (3) proportion of females aged >4 with cubs; (4) proportion of females aged >5 with cubs; and (5) proportion of the total population consisting of females aged >5.

Results

Proportions of females with cubs in any given year, and by females in the presumptive "adult" ages of 5 and older are shown in Tables 1 and 2 for the 2 alternative parameter sets. Values were very similar for both simulations. The mean proportion of the total population consisting of adult females varied from 0.29 to 0.30, which are both similar to the earlier assumed value of 0.284. Without simulations, values of the proportion of the female segment made up by females with cubs in any year were not previously available.

Table 1. Proportions generated from age-structures of simulated populations with high survival and low process variance.

	Mean	CV[a]	Lower 95% CL	Upper 95% CL
Proportion of all females that are with cubs	0.176	0.097	0.145	0.212
Proportion of female 2+ that are with cubs	0.247	0.110	0.199	0.307
Proportion of female 4+ that are with cubs	0.315	0.096	0.259	0.378
Proportion of female 5+ that are with cubs	0.356	0.090	0.294	0.421
Proportion of total population that are females age ≥5	0.289	0.047	0.266	0.319

[a] Standard deviation/mean.

Table 2. Proportions generated from age-structures of simulated populations with low survival and high process variance.

	Mean	CV[a]	Lower 95% CL	Upper 95% CL
Proportion of all females that are with cubs	0.176	0.094	0.143	0.209
Proportion of female 2+ that are with cubs	0.248	0.105	0.197	0.300
Proportion of female 4+ that are with cubs	0.314	0.103	0.251	0.378
Proportion of female 5+ that are with cubs	0.353	0.101	0.284	0.424
Proportion of total population that are females age ≥5	0.299	0.036	0.278	0.320

[a] Standard deviation/mean.

Discussion
Variability of the figures provided in Tables 1 and 2 may be slightly lower than reality, because cub production varied independently each year, and variance was modeled as coming from a single distribution that was normal on the logit scale. In reality, we suspect that some very poor food years are characterized by near complete failure to breed of all available females (i.e., those of sufficient maturity who do not have cubs or yearlings from previous years at their sides). The year following such a failure, there is probably a bumper crop of cubs, because those females failing to breed during the poor year are added to those who would have been available in any case. Thus, there is probably more variability in the true ratio of females with cubs to all females than represented in these simulations.

Even were that variation to be included, coefficients of variation and confidence limits (Table 1, 2) depict variation of the entire population (i.e., reflect process variation). They do not reflect the variability that will characterize samples of the population, the magnitude of which will depend on sample size.

It would seem more straight forward to estimate the number of females from females with cubs, than the current alternative (estimating total population size from adult females). This is because the yearly estimates of the number of females with cubs do not correspond exactly to females of any particular age. Age at first reproduction is not a step function, but rather a gradually increasing function (Schwartz et al. 2005*a*). As well, breeding interval, although close to 3 years, is itself variable. Thus, additional assumptions and approximation are necessary to convert females with cubs into "adult" females. In contrast, the ratio of females with cubs:all females does not require additional assumptions or approximations (beyond those included in the simulation model). In addition, estimating the size and trend of the female segment of the population is probably more informative for conservation and management purposes than is estimating total population size.

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Appendix B

Counts and estimates of mortality for independent-aged grizzly bears in the Greater Yellowstone Ecosystem

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Grizzly bears (*Ursus arctos horribilis*) in the Greater Yellowstone Ecosystem (GYE) are currently listed as threatened under the Endangered Species Act. Tracking mortality in the population is an essential component of the recovery process. Grizzly bear deaths caused by agency removals or those of instrumented bears are known or can be inferred. Additionally, the public reports an unknown portion of mortalities of uncollared bears. Cherry et al. (2002) described methodology to estimate the number of nonagency human-caused deaths of uncollared bears using a hierarchical Bayesian model with a noninformative prior distribution for the number of deaths. Critical assumptions relative to the method were identified in Cherry et al. (2002).

We applied methodology developed in Cherry et al. (2002) to estimate annual unreported mortality, from all causes, for independent aged female and male bears. We excluded possible mortalities (Craighead et al. 1988) from consideration because by definition the chance is small that these instances resulted in dead bears. Also, since we estimated for all mortalities regardless of cause, known deaths from undetermined causes are included.

Cherry et al. (2002) alternately included or excluded unexplained and unresolved losses of radiomarked bears to estimate reporting rates. We used a Delphi procedure to identify which unexplained and unresolved losses were likely mortalities. Nine experts who manage or research grizzly bears in the GYE ranked each unexplained and unresolved loss as whether it was, in their opinion, a human-caused mortality. Results of this Delphi procedure suggested that 41% (9/22) of these unexplained and unresolved losses were likely human-caused mortalities and are included as such in subsequent analyses.

We combined sexes to estimate reporting rate because there was no evidence that rates were different between sexes (Table 1). We used estimates of reporting rates developed from deaths of radiomarked bears from 1983–2004 to develop prior probability distributions that the public reported bear mortalities regardless of cause.

Table 1. Method of discovery for deaths of independent (ages ≥2 years) radiomarked grizzly bears during 1983-2004, regardless of cause. Estimated reporting rate is 37%, conversely 63% of mortalities of radiomarked bears go unreported.

Method of discovery	Frequency	%
Unreported (discovery due to telemetry)	36	63.2
Reported (discovery not due to telemetry)	21	36.8
Total	57	100

The number of publicly reported deaths of uncollared bears, together with the beta distribution estimated from the observed reporting rate, are used to estimate a posterior distribution for total annual reported and unreported mortality (Cherry et al. 2002). We used the median of the posterior distribution (Appendix D) as our best estimate of unreported mortality (Table 2, 3). Number of management removals and losses of radiomarked bears documented annually are added to the median estimate of reported and unreported mortality to estimate total annual mortality from all causes.

Table 2. Mortality counts and estimates for independent female deaths, 1986–2004.

Year	Sanctioned[a] removals	Radiomarked[b] loss	Reported[c] loss	Reported and[d] unreported loss (median)	Total[e] mortality
1986	1	3	1	2	6
1987	1	0	1	2	3
1988	0	1	0	1	2
1989	0	0	0	1	1
1990	1	2	3	7	10
1991	0	0	0	1	1
1992	0	1	0	1	2
1993	0	1	2	5	6
1994	0	2	1	2	4
1995	3	0	3	7	10
1996	1	3	2	5	9
1997	0	0	3	7	7
1998	0	0	1	2	2
1999	0	0	1	2	2
2000	1	1	3	7	9
2001	5	3	1	2	10
2002	2	2	4	10	14
2003	1	0	5	13	14
2004	4	0	5	13	17

[a] Includes removals of radiomarked bears.
[b] Losses of radiomarked bears from all causes except sanctioned management removals.
[c] Reported losses from all causes excluding sanctioned management removals and radiomarked bears.
[d] Median of creditable interval for reported and unreported loss estimates using methodology described in Cherry et al. (2002).
[e] Total mortality is the sum of sanctioned removal plus radiomarked loss plus the median for reported and unreported loss.

Table 3. Mortality counts and estimates for independent male deaths, 1986–2004.

Year	Sanctioned[a] removals	Radiomarked[b] loss	Reported[c] loss	Reported and[d] unreported loss (median)	Total[e] mortality
1986	1	1	0	1	3
1987	2	1	0	1	4
1988	1	1	1	2	4
1989	1	1	1	2	4
1990	1	1	2	5	7
1991	0	0	0	1	1
1992	2	5	1	2	9
1993	0	2	0	1	3
1994	0	1	1	2	3
1995	2	4	4	10	16
1996	2	2	3	7	11
1997	1	1	2	5	7
1998	2	2	0	1	5
1999	2	2	3	7	11
2000	2	4	11	29	35
2001	7	2	1	2	11
2002	4	1	3	7	12
2003	2	3	3	7	12
2004	3	2	7	18	23

[a] Includes removals of radiomarked bears.
[b] Losses of radiomarked bears from all causes except sanctioned management removals.
[c] Reported losses from all causes excluding sanctioned management removals and radiomarked bears.
[d] Median of creditable interval for reported and unreported loss estimates using methodology described in Cherry et al. (2002).
[e] Total mortality is the sum of sanctioned removal plus radiomarked loss plus the median for reported and unreported loss.

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Appendix C

Estimation of Proportion of FCOY

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The purpose of this analysis was to estimate the proportion of females ≥3 years old that had cubs-of-the-year (FCOY).

Data

Data were from the reproductive database from 1983 through 2003. This database was filtered for bears ≥3 years old and research trapped, and had a good count of litter size. Not all individuals are in a continuous time series. In some cases their time series was interrupted and started again >1 year later because the individual lost its collar (or the collar went dead) and the individual was recaptured and recollared. Only 2 consecutive years of observations could be used to estimate transition rates. A total of 204 transitions were available for analysis: 54 from females with COY, 26 from females with yearling offspring, 13 with 2-year old offspring, and 111 with no offspring.

Methods

A multi-state model (Brownie et al. 1993) was used to estimate transition rates. Four states were assumed (Table 1), generating 16 possible transition probabilities (Table 2). However, 6 of these transitions are not biologically possible and are thus assumed to be zero: N to Y, N to T, C to T, Y to Y, T to Y, and T to T. Further, the sum of transitions for each state must equal 1, so only 6 transitions were estimated, with the remaining 4 obtained by subtraction. The estimated transition probabilities were N to C, C to C, C to Y, Y to C, Y to T, and T to C. All transitions to N were obtained by subtraction: N to N, C to N, Y to N, and T to N.

Table 1. The 4 states used with a multi-state model to estimate transition probabilities.

State	Code
No offspring present	N
Cubs-of-the-year present	C
Yearlings present	Y
Two-year olds present	T

Table 2. Transition probabilities estimated with the multi-state model.

	Transfer to state			
Current State	N	C	Y	T
N	Subtraction	Estimated	Zero	Zero
C	Subtraction	Estimated	Estimated	Zero
Y	Subtraction	Estimated	Zero	Estimated
T	Subtraction	Estimated	Zero	Zero

Estimation was performed with Program MARK (White and Burnham 1999) using the Brownie et al. (1993) multi-state model with maximum likelihood estimation and information-theoretic procedures for model selection (Burnham and Anderson 2002). Because only consecutive observations were analyzed, survival and capture probability parameters in the model were set to 1 and not estimated. Animals were removed from analysis after their last observation. A time-varying covariate of age of the female was included in 2 multi-state models to evaluate the effect of age on transition probabilities using a logit link. A model with each transition modeled with its own intercept and linear age effect on a logit scale was considered, followed by a model with each transition modeled with its own intercept, age and age-squared effects on a logit scale. Based on results from these models, additional post hoc, reduced models were considered where the results from the age and age-squared models suggested terms to remove that did not contribute to the fit of the model to the data. Time-specific models of the transition probabilities were not considered because of limited data available across the 21 years of observations. For the model with transition probabilities constant across time and no age covariate, the transition probabilities can be estimated directly from multinomial distributions, with this approach used to verify the estimates from Program MARK.

To estimate the proportion of the population in each state if the transition probabilities are assumed to be constant across time, the matrix of transition probabilities was raised to the 50^{th} power and multiplied by the vector [1, 0, 0, 0]. The variance–covariance of the resulting vector was obtained numerically with the delta method.

Results

The models estimated and the model selection results (Table 3) suggest that age was an important predictor of transition probabilities. Estimates of the 6 transition probabilities for the intercept only model (no age effects) are provided in Table 4.

Table 3. Results of model selection conducted in Program MARK for the 3 models considered a priori (bottom 3 models) and the 3 additional models (top 3 models) considered post priori to estimate 6 transition probabilities.

Model	AICc	Delta AICc	AICc weights	Model likelihood	Num. par	Deviance
{psi(Age(Y to C, Y to T) *Transition*Age^2(N to C))}	303.384	0	0.63188	1	10	282.341
{psi(Age*Transition*Age^2 for N to C, Y to C, and Y to T)}	305.605	2.2207	0.20817	0.3294	12	280.112
{psi(Age*Transition +N to C Age^2)}	306.213	2.8293	0.15355	0.243	13	278.463
{psi(Age*Transition*Age^2)}	314.222	10.8376	0.0028	0.0044	18	274.852
{psi(Constant)}	314.487	11.1034	0.00245	0.0039	6	302.097
{psi(Age*Transition)}	315.998	12.6137	0.00115	0.0018	12	290.505

Table 4. Estimates of the 6 transition probabilities from the likelihood analysis of the constant model in Table 3.

Transition probability	Estimate	SE	LCI	UCI
N to C	0.475	0.045586	0.387371	0.564196
C to C	0.033898	0.02356	0.008493	0.125662
C to Y	0.79661	0.052404	0.675093	0.88071
Y to C	0.103448	0.056552	0.033745	0.276003
Y to T	0.689655	0.085909	0.502948	0.829943
T to C	0.642857	0.12806	0.376261	0.84304

The matrix of transition probabilities, including estimates obtained by subtraction, are shown in Table 5. In Table 6 are the estimates of the proportion of the population that would exist in each state assuming that transition probabilities are constant across time and age.

Table 5. Matrix of transition probability estimates.

	Transfer to state			
Current state	N	C	Y	T
N	0.525	0.475	0	0
C	0.169492	0.033898	0.79661	
Y	0.206897	0.103448	0	0.689655
T	0.357143	0.642857	0	0

Table 6. Asymptotic proportion of females in each state, with associated SE and 95% confidence intervals.

State	Estimate	SE	LCI	UCI
N	0.322529	0.056233	0.212313	0.432745
C	0.288777	0.022984	0.243728	0.333827
Y	0.230043	0.02362	0.183748	0.276338
T	0.158650	0.025705	0.108269	0.209032

Discussion

From Table 6, I conclude that 28.9% of the female population ≥4 years of age (recall I measured transitions, so bears starting at age 3 transitioned to age 4) will have cubs-of-the-year. This estimate is not affected by bias in the initial captures of the radiomarked sample. Suppose that the state of newly radiocollared animals is not in proportion to what exists in the population because some states are more likely to be trapped than others. For example, suppose that females in the N state are most likely to be collared, whereas females with offspring present are less likely. The sample used in the analysis will be weighted heavily toward the trappable state. However, estimates of the transitions are conditional on the current state. So although sample sizes will not be proportional to the actual frequencies of the states in the population, the estimates are not biased by this discrepancy in the frequency of states in the sample compared to the population. The precision of the estimates in Table 4 reflects the sample sizes available to estimate each transition.

If the frequency of the class transitioned from in the 204 transitions used in the analysis had been used to estimate the proportion of the population in each state, the estimates would have been N 0.544, C 0.265, Y 0.128, and T 0.064. These estimates differ substantially from the values in Table 6, and bias in capture frequencies. For the 74 captures of females where a radiocollar was attached, the proportions were N 0.663, C 0.229, Y 0.084, and T 0.024. These estimates of the proportion of each class captured to be radiocollared suggest that the most likely state to be captured in the sample is N, where the female is not encumbered by offspring.

However, a potential source of bias exists if radiocollared animals slip or otherwise lose their collars (possibly from death) at different rates. In particular, if females about to make a particular transition, say Y to T, are more likely to lose their radiocollars than females in other states, biased estimates of the transition probabilities will result because of this disproportional censoring, and hence biased estimates of the proportion of females in each state will result. Of the 80 losses (i.e., loss of collar or death of the female), 0.263 occurred for N, 0.400 for C, 0.250 for Y, and 0.088 for T. These values are intermediate between the estimated asymptotic distribution (Table 6) and the frequency of females collared (Fig. 1). The proportion of collars lost seems to be the highest for females with offspring, particularly cubs-of-the-year. Possibly the loss of collars for FCOY is higher because of weight loss from the energetic costs of suckling cubs.

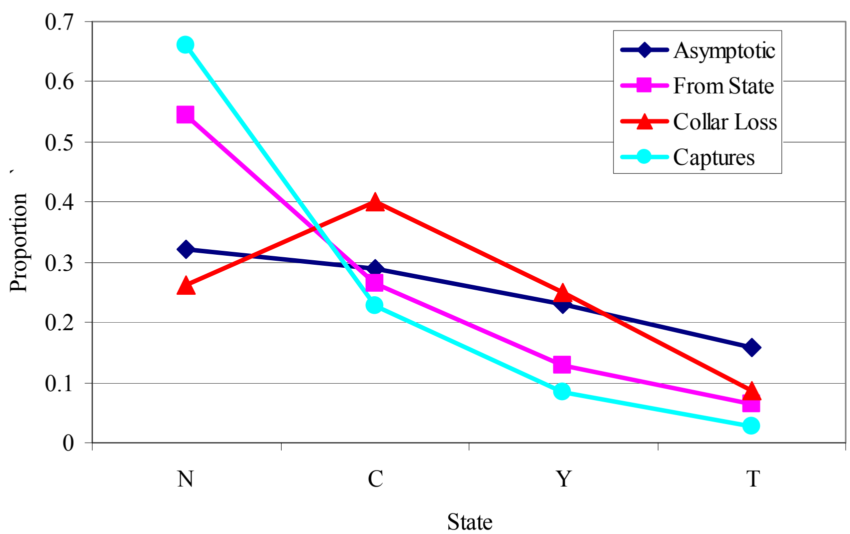

Figure 1. Proportion of females in each state for 4 estimates: "asymptotic values" are proportion of females estimated from the multi-state analysis, "from state" is the proportion of the 4 states from which the transitions were estimated, "collar loss" is the proporiton of each state losing collars, and "captures" is the proportion of each state in the sample when the animals were captured and radiocollared.

Age was important in model selection results (Table 3), particularly for the N to C transition when modeled as a quadratic. Graphs of the transition functions (Fig. 2) suggest evidence that older animals became better mothers, more capable of raising cubs to independent offspring. The transition rates of both C to Y and Y to T are increasing early with age, and then declining at older ages. If older, more mature females become better mothers, I expect that both these transitions should increase with experience. Both C to C and Y to C transitions decrease with age, which is expected under the hypothesis of older females being better mothers. The graph for N to C (Fig. 2) also suggests that the most fertile females are of medium age, as suggested by the C to Y and Y to T curves.

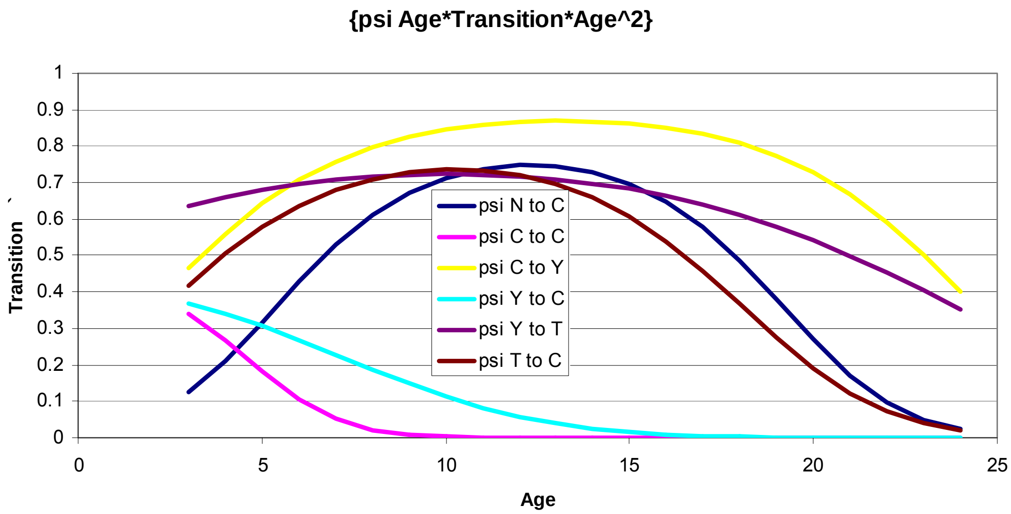

Figure 2. Age-specific transition probabilities from the quadratic model {psi(Age*Transition*Age^2)}.

Because the {psi(age x transition x age^2)} model has 18 parameters, a more parsimonious model was sought to use in modeling age effects in a population model. The top AICc model obtained post posteriori was {psi(age(Y to C, Y to T) x transition x age^2(N to C))}, where the Y to C and Y to T transitions were modeled as a linear function of age, N to C was a quadratic function of age, and the remaining transition probabilities were assumed constant (Fig. 3). This is the model that will be used to develop an age-structured model for evaluating the consistency of various estimates of survival, population size, and recruitment.

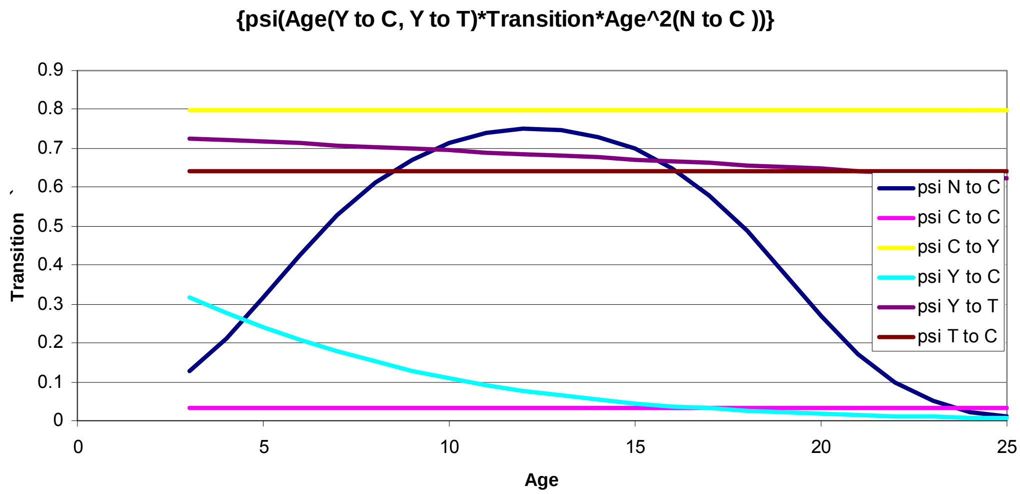

Figure 3. Transition probabilities as a function of age from the model {psi(age(Y to C, Y to T) x transition x age^2(N to C))}.

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Appendix D
Point Estimation using the Total Mortality Estimator

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The proposed method of estimating total mortality given a number of known and probable reported mortalities leads to a posterior distribution of total mortality. There are a number of ways of summarizing the information in this distribution to arrive at a point estimate of total mortality. Three common summaries are the mean, median, and mode of the distribution. These estimators are derived assuming different costs of being wrong. The cost of being wrong is quantified in a loss function, and an estimator is derived for each loss function by finding the one which minimizes average loss. Each estimator is briefly discussed below.

Mean

The loss function is referred to as squared error loss and the goal is to find an estimator $\hat{N}$ which minimizes $E\left(N-\hat{N}\right)^2$ where the *E* refers to a probabilistic averaging operation. The best estimator is the mean of the posterior distribution,

$$\hat{N} = \sum_{n=0}^{\infty} nP\left(N = n\right).$$

Median

The loss function is referred to as absolute error loss and the goal is to find an estimator $\hat{N}$ which minimizes $E\left|N-\hat{N}\right|$. The best estimator is the median of the posterior distribution. We actually chose $\hat{N}$ to be the value of the posterior distribution that is smallest value of *n* such that $P\left(N \le n\right) \ge 0.5$.

Mode

The loss function (*L*) is a 0/1 loss function, where $L = 1$ if $N = \hat{N}$ and $L = 0$ if $N \ne \hat{N}$. The mean of this loss function is the mode of the posterior distribution. The mode is the value of *N* that has the highest probability associated with it.

There are other possible loss functions, but these 3 are the most commonly used. If the number of reported losses is small, the posterior is skewed to the right and the median is a better summary measure of center than the mean. As the number of reported losses increases, the posterior distribution becomes more symmetric and the median and mean give essentially the same result. Using the mode is analogous to finding a maximum likelihood estimator of *N*; however, the posterior distribution for many of the examples we have looked at is very flat. Thus, one value of *N* may be the mode but neighboring values are not very different. Further, there is little difference in the estimates generated by these 3 estimators. Therefore, we chose to use the median because it is a reasonable summary measure that works well for all posterior distributions we have seen in our data.

Appendix L. Supplement to Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear

Reassessing methods to estimate population size and sustainable mortality limits for the Yellowstone Grizzly Bear Workshop Document Supplement[1] 19–21 June 2006

This supplement is the result of a Workshop held at the AMK Ranch in Grand Teton National Park, 19–21 June 2006. The purpose of this workshop was to establish the scientific rationale and conduct additional analyses needed to adequately address concerns and issues raised by professional peer reviews and by the general public during the public comment period of the original document *Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear* (Interagency Grizzly Bear Study Team [IGBST] 2005). We do not address all comments expressed during the public review period explicitly in this document because those have been addressed in a separate document titled *Responses to Public Comments on the Reassessing Methods Document* and are available online at http://mountain-prairie.fws.gov/species/mammals/grizzly/yellowstone.htm.

Items addressed here focus on 2 issues: (1) the wide variation about the original method proposed to index population size using annual estimates of females with cubs of the year as derived from the Chao2 estimator ($FCOY_{Chao2}$), and (2) the uncertainty about the estimate of independent females, independent males, and dependent young in the population.

Professional peer reviewers expressed concern about the wide swings in the index of population size using annual counts derived from estimates of FCOY and the use of a constant in the denominator when extrapolating $FCOY_{Chao2}$ to an index of independent females, independent males, and dependent young. In the original *Reassessing Methods* document, the group rejected using a running average over multiple years to address the variability about the annual population indices because of "possible unknown statistical biases" (IGBST 2005:25). Instead, we chose to smooth the mortality limit provided to managers "to dampen variability and provide managers with inter-annual stability in the threshold." Consequently, we recommended that allowable mortality limits be based on a 3-year running average derived from the annual index of population size (IGBST 2005:7–8).

We anticipated that the normal process (biological) variation associated with grizzly bear reproduction in the Greater Yellowstone Ecosystem (GYE) would result in wide swings in counts of FCOY and the resultant $FCOY_{Chao2}$ estimate (see Schwartz et al. 2006*a*:20, Figure 6). Female bears tend to produce litters in the year following an autumn with highly abundant naturally occurring autumn foods. Hence, using a constant

[1] This document is the product of team work. Participants from the original workshops contributed to its production. Please cite as follows: 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.

in the denominator to extrapolate $FCOY_{Chao2}$ to index independent females, independent males, and dependent young failed to remove this process variation.

After considerable discussion, the group concluded that it was more appropriate to use $FCOY_{Chao2}$ as an initial estimate of FCOY. This was used along with all the data and information-theoretic model selection methods (Burnham and Anderson 2002) to select the best model for estimation of FCOY. We considered both linear and quadratic models and model averaging of the $FCOY_{Chao2}$. Model averaging has the effect of putting the numerator (model averaged estimates of number of FCOY) on the same temporal scale as the denominator (mean transition probability derived from 1983–2003) based on previous work (IGBST 2005:60–65) and thus addresses concerns about process variation causing wide swings in population estimates. The model averaging method and its application are presented in the following sections.

Estimation of number and trend for females with cubs of the year

The Chao2 estimator (Chao 1989, Keating et al. 2002, Cherry et al. 2007) is used annually to estimate the number of females with cubs of the year ($FCOY_{Chao2}$) for year *i*. For convenience, we will change notation and define $\hat{N}_i$ to be the value of $FCOY_{Chao2}$ in year *i*. The trend in this segment of the population and its rate of change (λ) can also be estimated from these annual estimates. Although the Chao2 estimator accounts for sampling heterogeneity, annual estimates of FCOY can vary because of sampling error (sampling variance) associated with the annual estimates, and because of pulsed or synchronized reproductive output by a segment of the female population (process variance). Consequently, using each annual estimate independently each year can result in wide swings in the estimate of total population size, producing results that may be inconsistent with expected changes in true population size, which complicates management. This annual variability was criticized during professional peer review. Therefore, we investigated methods to smooth these potential swings.

Methods

Monitoring numbers and λ using females with cubs. We fit the natural logarithm of the number of females with cubs [$\log(\hat{N}_i)$] with a linear model of year (y_i):

$$\log(\hat{N}_i) = \beta_0 + \beta_1 y_i + \varepsilon_i$$

so that the population size at time zero is estimated as $\hat{N}_0 = \exp(\hat{\beta}_0)$. An additional benefit of this model is that it allows (under reasonable assumptions) estimation of the rate of population change (λ) as $\hat{\lambda} = \exp(\hat{\beta}_1)$, giving $\hat{N}_i = \hat{N}_0 \hat{\lambda}^{y_i}$. Confidence intervals on λ can be estimated as the exponential of the confidence bounds on β_1, providing an asymmetric confidence bound. Standard errors and confidence intervals for $\log(N_i)$ can be computed with the usual linear model methods, and confidence intervals for N_i can be estimated as the exponential of the confidence bounds on $\log(N_i)$.

Changes in the numbers of FCOY are representative of the rate of change of the entire population, but with additional process variation coming from the proportion of the female population that has cubs of the year (COY). Thus, random noise of $\hat{N}_i$ is coming from both sampling variation from the Chao2 estimator and the proportion of the population with COY. When we assume a reasonably stable age and sex structure for the total population, the model provides an estimate of λ, which represents the rate of change of the entire population and a modeled estimate of FCOY for the current year. Fitting a linear relationship makes the standard assumptions of least squares regression.

Quadratic regression can be used to detect a change in $\hat{\lambda}$ (i.e., the slope of the log-linear model) through time. We fit the model

$$\log(\hat{N}_i) = \beta_0 + \beta_1 y_i + \beta_2 y_i^2 + \varepsilon_i ,$$

and the estimate of β_2 provides a metric for assessing whether λ has changed through time. We expect that the estimate of β_2 will become negative as the population reaches carrying capacity and λ approaches 1. Information-theoretic model selection methods (Burnham and Anderson 2002) can be used to select between the linear and quadratic models, and hence to detect changes in $\hat{\lambda}$ and $\hat{N}_i$ as additional data are collected. We used model averaging with the linear and quadratic models of the predicted population sizes of females with cubs to estimate population sizes through time (i.e., $\hat{N}_i$), and thus smooth the variation of the Chao2 estimates. We used Akaike's information criterion weights corrected for small sample size (AIC_c; Burnham and Anderson 2002) to weight the estimates from the linear and quadratic models to produce our best estimate of the current number of females with cubs and λ.

Power analysis of using $\hat{N}$ to estimate λ. To assess the behavior of our proposed model selection procedure, we (i) added 2 hypothetical years of data for 2006 and 2007, assuming λ = 0.9 for both additional years, and (ii) added 4 hypothetical years of data, assuming λ = 1.0 for all additional years. In other words, we assumed that λ was equal to 0.9 for 2006 and 2007, or λ was 1.0 for 4 consecutive years.

Simply adding hypothetical years with altered λ, as above, would not constitute a power analysis of the proposed trend monitoring method, because future years' data will also contain process and sampling variation. To estimate the power of these data to detect a true reduction in λ (i.e., correctly choose the quadratic model), we estimated variance components of the Chao2 estimates from 1983–2005 and applied these in Monte Carlo projections for 10 additional years under assumed values of λ.

To separate sampling variance associated with each population estimate, ($\mathrm{var}(\hat{N}_i)$) from process variance, we fit the linear model (above), assuming that the error term ε_i was the sum of the sampling variance and process variances (earlier analyses provided no evidence for significant serial correlation; unpublished data). For the Chao2 estimator, $\mathrm{var}(\hat{N}_i)$ was estimated with bootstrap resampling of the data, and the variance of the resampling distribution was the estimate of $\mathrm{var}(\hat{N}_i)$. Note that the variance of $\log(\hat{N}_i)$ is estimated, using the delta method, as $\mathrm{var}\left(\log(\hat{N}_i)\right) = \mathrm{var}(\hat{N}_i) / \hat{N}_i^2$.

To estimate the process standard deviation from the 1983–2006 Chao2 estimates, we used PROC NLMIXED in SAS. This procedure maximizes the likelihood of $\log(\hat{N}_i)$ for β_0, β_1, and the process SD, with the likelihood specified as a normal distribution with mean predicted by $\log(\hat{N}_i) = \beta_0 + \beta_1 y_i$ and variance

$\text{var}\left(\log(\hat{N}_i)\right) + (\text{Process SD})^2$. This model thus explicitly includes the sampling variance of $\log(\hat{N}_i)$ plus the process variance that is estimated by the procedure. Process SD was estimated to be 0.176 with SE 0.0461 and 95% confidence interval 0.0808–0.271

To estimate the expected sampling variance of future Chao2 estimates (which assumes that future sampling effort will remain approximately the same as used to collect the 1983–2006 data), the mean of the sampling variances of the log population estimates for the 1983–2006 data was computed. The sampling variance of future Chao2 estimates was sampled from a normally distributed population with mean zero and standard deviation equal to the square root of mean sampling variance. From this procedure, the estimated sampling standard deviation was 0.34.

To evaluate sensitivity of the linear and quadratic models to changes in $\hat{N}$ over 1 to 10-year intervals, we projected forward the 2006 population estimate of N_{2006} = 52.356 (obtained by model averaging the linear and quadratic model estimates from the 1983–2006 data), assuming alternative λ values of 0.95, 0.975, 1, 1.025, and 1.05, and using our estimates of process and sampling variation (above). Population size for each succeeding year was generated with the recursive relation $\log(N_{i+1}) = \log(N_i) + \log(\lambda) + \delta_i$, where the process variation was added as δ_i, a normally distributed random variable with mean zero and standard deviation of 0.176. The estimated population size (corresponding to the Chao2 estimates) was taken as $\log(N_{i+1}) + \varepsilon_{i+1}$, where the sampling variation ε_{i+1} was added as a normally distributed random variable with mean zero and standard deviation of 0.34. Each replicate was simulated independently (i.e., new data were added to the 1983–2006 data for each simulation).

One thousand replicates of each of the 50 scenarios (5 alternative λ x 10 alternative time-frames) were generated, from which we estimated the mean AIC_c weight of the quadratic model, the proportion of iterations in which the quadratic term was selected (weight > 0.5), and the power of the *t*-test to reject the null hypothesis that the quadratic term was equal to zero. This realistically simulated the data and analyses managers would have available to them to make decisions about whether the true population had changed its trajectory.

Results

Monitoring numbers and λ using females with cubs. Data for 1983–2005 (Table 1) were used to estimate the rate of population change (Figure 1). The parameter estimates and AIC_c weights for the linear and quadratic models (Table 2) suggest that only the linear model was needed to model changes in the $FCOY_{Chao2}$ population during this period. The estimate of λ using the linear model was 1.0479 with 95% confidence interval of 1.031 to 1.065 and was quite close to the independent estimates of Harris et al. (2006:48) using data from radiocollared bears (mean estimates of 1.04 or 1.07 under slightly different assumptions). The estimated quadratic effect (–0.00071104, SE = 0.00133) was not significant (P = 0.6), with 79% of the AIC_c weight associated with the linear model. Thus, the linear model was the best approximating model for 1983–2005, but we also provide the model averaged estimates (Figure 1).

Table 1. Observations of females with cubs of the year (FCOY) in the Greater Yellowstone Ecosystem, 1983–2005, where *m* is the number of unique individuals observed after *n* samples and f_j is the number of individuals observed 1 or 2 times. The annual and modeled estimates (1983–2005) of $FCOY_{Chao2}$ are also provided.

			Sighting frequency		Chao2 estimate	
Year	***n*[a]**	***m*[a]**	**f_1**	**f_2**	**Annual**	**Modeled**
1983	12	10	8	2	19.33	18.46238
1984	40	17	7	3	22.25	19.40793
1985	17	8	5	0	18.00	20.39578
1986	82	24	7	5	27.50	21.42746
1987	20	12	7	3	17.25	22.50457
1988	36	17	7	4	21.20	23.62873
1989	28	14	7	5	17.50	24.80158
1990	49	22	7	6	25.00	26.02483
1991	62	24	11	3	37.75	27.30021
1992	37	23	15	5	40.50	28.62948
1993	30	18	8	8	21.11	30.01446
1994	29	18	9	7	22.50	31.45699
1995	25	17	13	2	43.00	32.95893
1996	45	28	15	10	37.55	34.52222
1997	65	29	13	7	38.75	36.14879
1998	75	33	11	13	36.93	37.84063
1999	96	30	9	5	36.00	39.59974
2000	76	34	18	8	51.00	41.42819
2001	84	39	16	12	48.23	43.32803
2002	145	49	17	14	58.07	45.30139
2003	54	35	19	14	46.40	47.35039
2004	202	48	15	10	57.55	49.47720
2005	86	29	6	8	30.67	51.68401

[a]Values differ from Keating et al. (2002) because we included females throughout the Greater Yellowstone Ecosystem. Only observations made without the benefit of radiotelemetry are included.

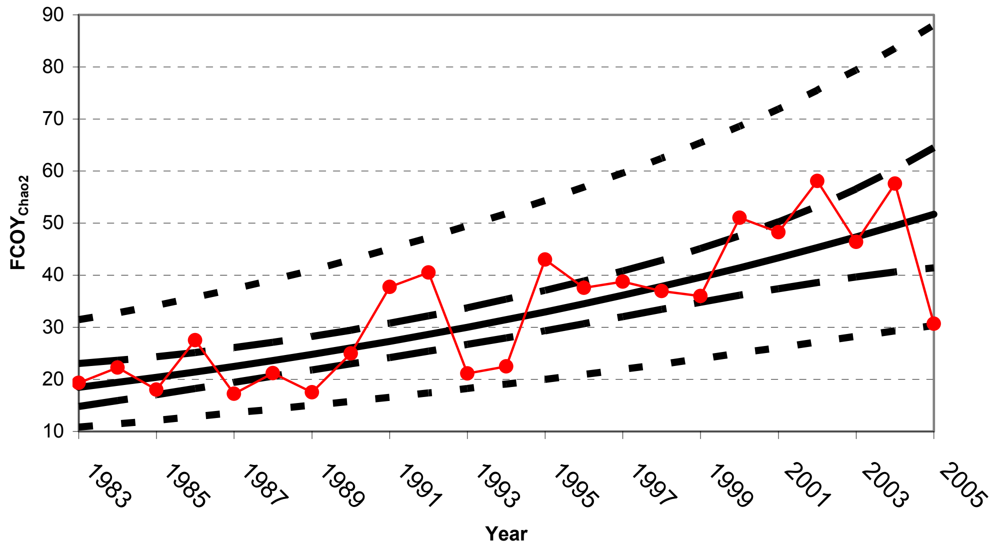

Figure 1. Model-averaged estimates of $FCOY_{Chao2}$ for 1983–2005, where the linear and quadratic models of log($FCOY_{Chao2}$) were fitted. The inner dashed lines represent a 95% confidence interval on the predicted population size, whereas the outer dashed lines represent a 95% confidence interval for individual population estimates. The red dotted line represents number of unique FCOY observed.

Table 2. Estimates and model selection results from fitting the $FCOY_{Chao2}$ population estimates from the Chao2 model, 1983–2005.

Model	Parameter	Estimate	Standard error	t	Pr(>t)
Linear					
	β_0	2.88051	0.10628	27.10	<0.0001
	β_1	0.04679	0.00775	6.04	<0.0001
	SSE[a]	1.27685			
	AIC_c	-59.2320			
	AIC_c weight	0.78870			
Quadratic					
	β_0	2.80941	0.17165	16.37	<0.0001
	β_1	0.06386	0.03295	1.94	0.0669
	β_2	-0.00071104	0.00133	-0.53	0.5997
	SSE	1.25895			
	AIC_c	-56.5978			
	AIC_c weight	0.21130			

[a]Sum of squared errors.

Power analysis of using $\hat{N}$ to estimate λ. When 2 years with λ = 0.9 were added to these data, the resulting quadratic model had an AIC_c weight of 0.67847 and an estimated quadratic effect of −0.0028 (SE = 0.0012) that differed from zero (P = 0.03). Thus, had the Chao2 counts declined by 10% each year, our model selection would have detected this fundamental change within 2 years. Two years would not have been sufficient to detect a change to stationary Chao2 counts (Table 3), but by the third year, model weights would have shifted to favor the quadratic model, suggesting that population growth had stopped.

Table 3. Behavior of linear and quadratic models of population growth assuming identical Chao2 estimates following 2005, showing AIC_c weights (w_i) for the linear and quadratic models and P values for the quadratic term in the quadratic model.

Years of Chao2 estimates identical to 2005 values	**Linear model w_i**	**Quadratic model w_i**	**Quadratic term P**
2	0.73241	0.26759	0.1902
3	0.46623	0.53377	0.0561
4	0.20702	0.79298	0.0168
5	0.07439	0.92561	0.0053

When our best estimates of process and sampling variation were added to hypothetical years 1 through 10, approximately 5 years were required of the population decreasing 5% yearly (i.e., λ = 0.95) before the preponderance of evidence (AIC_c weight > 0.5) favored the quadratic model (i.e., fundamental change in state from linear increase, Figure 2). Under the scenario in which population size stabilized after year 2006 (i.e., λ = 1.0), 7 or 8 years were required for the preponderance of evidence to favor the quadratic model (depending on the criterion used, Figure 3). Power to detect a yearly decline of 2.5% was intermediate between these 2 examples. Power was lower to detect changes in λ to 1.025 or 1.05 (unpublished data), but this was neither unexpected nor worrisome under the baseline linear estimate of λ of 1.0479.

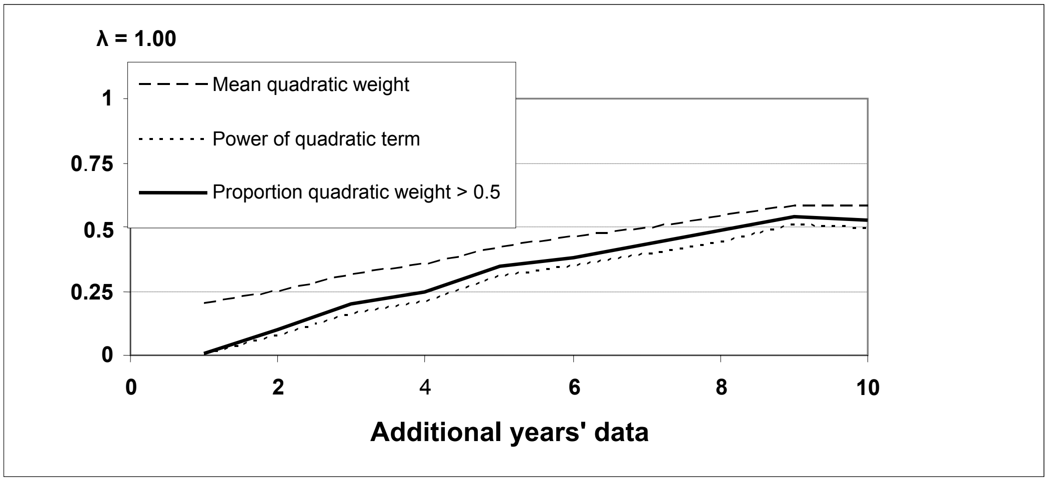

Figure 3. Mean AIC_c weight of the (negative) quadratic term, proportion of simulations in which the quadratic model had greater AIC_c weight than the linear model, and power of the quadratic term (i.e., probability of rejecting the linear model) when expected λ changed to 1.0 following the 1983–2006 series of estimates of females with cubs, for additional years 1 to 10 and using estimates of process and sampling variation from the data.

Discussion

FCOY are the critical segment of the population driving reproduction. Thus, we appropriately use all the data to estimate the number of FCOY each year and the rate of change of this segment as a measure of the rate of change of the entire population. Both reproductive effort and mortality of the entire population are driven by the performance of the FCOY segment.

According to the 1993 Recovery Plan (U.S. Fish and Wildlife Service 1993:20) "[a]ny attempt to use this parameter [FCOY] to indicate trends or precise population size would be an invalid use of these data." However, subsequent to the drafting of the 1993 Recovery Plan, several researchers developed methods to address varying effort and heterogeneity in sightings of females with cubs of the year, the underpinnings for the above quote. When Knight et al. (1995) published the methods used to distinguish unique females from replicate sighting of the same female and presented a method to estimate trend, there were no methods available to correct for problems of observer effort and sighting heterogeneity. Subsequent to that publication, a number of researchers provided improved methods that address varying effort and heterogeneity of sighting probabilities and use the FCOY index to estimate trend (Eberhardt et al. 1999, Boyce et al. 2001, Keating et al. 2002). The method we recommended is an extension of that research.

Summary of workshop recommendations for grizzly bear monitoring

We propose using the linear and quadratic models as described above to estimate changes in λ over time and the predicted numbers of FCOY as the best estimate of the number of FCOY annually. The results will then be used to estimate the number of independent females, independent males, and dependent young following procedures outlined in the original *Reassessing Methods Document* (Interagency Grizzly Bear Study Team 2005). We recommend this new weighted model method replace the older method proposed in the *Reassessing Methods Document* that used the annual estimate $FCOY_{Chao2.}$ The new method addresses normal process variation and associated swings in annual counts of FCOY and dampens fluctuations arising from sampling variation because it uses the entire string of data. Details on how the methods will be applied to calculate the index of independent females, independent males, and dependent young are below.

The estimated λ and associated confidence interval demonstrate an increase in the FCOY numbers, and hence the total population. The proposed set of models will also allow managers to detect a decline in λ, and thus recognize when the population is approaching carrying capacity or decreasing. We recommend this method of estimating λ be used as an independent measure of population trajectory that can be compared to estimates derived from data using radiocollared bears as recommended in the *Reassessing Methods Document* (IGBST 2005:42–44).

For future monitoring, we recommend continued monitoring of females with cubs, fitting both linear and quadratic models to the data set, and using AIC_c to evaluate the strength of these competing models. Weight favoring the quadratic term is evidence that population growth has slowed or reversed, but lack of such evidence is not necessarily proof that change has not occurred. Under the best of circumstances, this monitoring protocol leaves uncertainty about the system state during the most recent years. Gradually increasing evidence for the quadratic model over a few years (assuming a negative quadratic slope) should keep biologists and managers alert to a possible change in system state. We recommend continued monitoring of demographic rates from a sample of radiomarked females and their offspring. Although also characterized by variability and time-lags, such monitoring provides an independent measure of population vigor and is likely to be helpful in explaining hypothesized changes in numbers of females with cubs. We recommend that if the AIC_c weight favors the quadratic term (i.e., >0.5) in modeling the rate of change of females with cubs in any year, a full review of the population's demographics be undertaken to better understand its status.

Because we are refitting the model with new data each year, estimates from previous years will change slightly after each iteration. We recognize that this will occur, but do not recommend retrospectively adjusting previous population estimates and accompanying mortality limits. The purpose of the model is to get the best possible 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.

Occasionally, a dead bear is reported in a year(s) subsequent to the actual year of mortality. We recommend that the IGBST, to the best of their ability, attempt to estimate actual year of death and sex and age of the individual. These mortalities would then be added into the mortality tally for year of death, and mortality totals recomputed (including estimates of unknown and unreported deaths). If adding extra bear(s) retrospectively results in exceeding the threshold in that year, the excess (tallied mortality minus threshold) would be deducted from the current years threshold (i.e., the threshold would be reduced by the difference). For example if a dead bear reported in 2006 died in 2005, that bear (and the estimated unknown and unreported mortality) would be counted in 2005 and the updated mortality total compared to the 2005 threshold. If the 2005 threshold is exceeded, the difference would be deducted from the current years' threshold.

Establishing confidence intervals around estimates of independent females, independent males, and dependent young

The second issue raised during public and professional peer review of the *Reassessing Methods Document* (Interagency Grizzly Bear Study Team 2005) was the need to display uncertainty around the estimates of independent females, independent males, dependent young, and total population size. Here we detail methods used and present confidence intervals around those estimates.

Methods

We estimated the uncertainty associated with an estimate $\hat{\theta}$ of a parameter θ using a formula derived from the delta method (Seber 1982:7). For estimates of the form

$$\hat{\theta} = \frac{\hat{\beta}_1 \hat{\beta}_2 \ldots \hat{\beta}_k}{\hat{\beta}_{k+1} \hat{\beta}_{k+2} \ldots \hat{\beta}_n}$$

the variance of $\hat{\theta}$ was approximated by

$$\hat{\mathrm{var}}(\hat{\theta}) = \hat{\theta}^2 \sum_{i=1}^{n} \mathrm{CV}(\hat{\beta}_i)^2$$

where $\hat{\mathrm{var}}(\hat{\theta})$ is the estimated variance of the index $\hat{\theta}$ (independent females, independent males, cubs, or yearlings). For estimates of the form

$$\hat{\theta} = \hat{\beta}_1 + \hat{\beta}_2 \ldots + \hat{\beta}_k$$

the variance of $\hat{\theta}$ was approximated by

$$\hat{\mathrm{var}}(\hat{\theta}) = \sum_{i=1}^{n} \mathrm{var}(\hat{\beta}_i)$$

where $\hat{\mathrm{var}}(\hat{\theta})$ is the estimated variance of the index $\hat{\theta}$ (dependent young or population size). For both methods used to estimate variance, we assumed that covariances (correlations) of the various inputs were zero because we lacked the ability to determine their structure.

The coefficient of variation for the ratio of females 4 years and older in the population of females 2 years and older (4+ females:2+ females), and the ratio of males 2 years and older in the population of females 2 years and older (2+ males:2+ females) were derived using back-transformed logit normal distributions to model the survival parameters: cub survival, yearling survival, and adult (age 2+) survival. The variable m_x was modeled with a beta distribution so as to reproduce, as nearly as possible, the mean and 95% confidence limits about the mean, as reported in the monograph (Schwartz et al. 2006*c*). We used the PopTools extension on Excel to run Monte Carlo iterations from all distributions simultaneously, each time. We ran 10,000 iterations for each of the 2 possible mean independent female survival rates (0.922 and 0.950) and 2 possible mean independent male survival rates (0.874 and 0.823) to generate the expected relationship between the number of 4+ and 2+ females (4+ females:2+ females) and 2+ males and 2+ females (2+ males:2+ females) when stable age distribution was achieved. We used PopTools to convert the life-table formats in the Leslie matrix formats and took age ratios from the eigenvector (i.e., stable age distribution) associated with each iteration. Variation about the ratio of adult females (age 4+) to independent females (age 2+) was derived from these simulations (Table 4). Variation about the ratio of independent males (age 2+) to independent females (age 2+) was derived from a second series of simulations (Table 5). These estimates did not include temporal variation in rates.

For estimating the number of 2+ females based on the estimated ratio of 4+ females:2+ females, and for the estimate of the proportion of 2+ males based on the ratio of 2+ males:2+ females, we used the mean and variance from the assumed dead (AD) estimate rather than the censored (C) estimate because the former included more uncertainty about estimates. Because of the random simulation process, values presented in Tables 4 and 5 differ slightly from the *Reassessing Methods Document* (0.773, 4+ females:2+ females, and 0.605, 2+ males:2+ females). We recommend using the new estimates.

Table 4. Mean, variance, and upper and lower 95% confidence limits around the ratio (4+ females:2+ females) when mean vital rates during 1983–2002 varied randomly. Line AD was when adult survival was estimated assuming all females with unresolved fates died at last contact, line C was when adult survival was estimated censoring unresolved females (as in Haroldson et al. 2006). This ratio provides a way to estimate the number of females older than yearling based on an estimate of the number of females ≥4 years old.

	Mean	Variance	Lower CL	Upper CL
AD	0.77699	0.00081	0.72459	0.83546
C	0.78446	0.00075	0.73504	0.84156

Table 5. Mean, variance, and upper and lower 95% confidence limits around the ratio (2+ males:2+ females) when mean vital rates during 1983–2002 varied randomly. Line AD was when adult survival was estimated assuming all adults with unresolved fates died at last contact, whereas line C was when adult survival was estimated censoring unresolved losses (as in Haroldson et al. 2006). This ratio provides a way to estimate the number of independent males older than yearling based on an estimate of the number of females ≥2 years old.

	Mean	Variance	Lower CL	Upper CL
AD	0.63513	0.002457	0.528489	0.720547
C	0.61093	0.001992	0.515741	0.691977

Estimates of variation for transition probabilities were presented in the *Reassessing Methods Document* (Interagency Grizzly Bear Study Team 2005:Appendix C, page 62, Table 6). Estimates of variation for litter size and cub survival can be found in Schwartz et al. (2006*a*:19) and Schwartz et al. (2006*b*:27), respectively.

Results

We used estimates of FCOY derived from model averaged estimates (Table 1). Data from counts of FCOY used to generate the annual Chao2 estimate are provided in Table 1.

Using this formula, we generated 95% confidence intervals around the estimate of independent females (Table 6), independent males (Table 7), dependent young (Table 8), and total population size (Table 9).

Table 6. Model average estimate of $FCOY_{Chao2}$, the derived estimate of independent females (age ≥2 year old), the estimated variance, and the 95% confidence interval about the estimate. Data are based on observations of females with cubs of the year in the Greater Yellowstone Ecosystem, 1983–2005.

Year	Model averaged	$\hat{N}_i$ 2+ females	Estimated variance	95% confidence interval Lower	Upper
1983	18.46	82	52.23	68	96
1984	19.41	86	57.63	72	101
1985	20.40	91	63.59	75	106
1986	21.43	95	70.14	79	112
1987	22.50	100	77.33	83	117
1988	23.63	105	85.23	87	123
1989	24.80	110	93.88	91	129
1990	26.02	116	103.35	96	136
1991	27.30	122	113.72	101	142
1992	28.63	127	125.05	106	149
1993	30.01	134	137.43	111	157
1994	31.46	140	150.95	116	164
1995	32.96	147	165.70	122	172
1996	34.52	154	181.79	127	180
1997	36.15	161	199.32	133	189
1998	37.84	169	218.41	140	197
1999	39.60	176	239.19	146	207
2000	41.43	184	261.79	153	216
2001	43.33	193	286.36	160	226
2002	45.30	202	313.05	167	236
2003	47.35	211	342.02	175	247
2004	49.48	220	373.46	182	258
2005	51.68	230	407.55	191	270

Table 7. Derived estimate of independent males (age ≥2 year old), the estimated variance, and the 95% confidence interval about the estimate. Data are based on observations of females with cubs of the year in the Greater Yellowstone Ecosystem, 1983–2005.

Year	$\hat{N}_i$ 2+ males	Estimated variance	95% confidence interval Lower	Upper
1983	52	37.70	40	64
1984	55	41.57	42	68
1985	58	45.88	44	71
1986	61	50.62	47	75
1987	64	55.82	49	78
1988	67	61.53	51	82

1989	70	67.78	54	86
1990	74	74.63	57	91
1991	77	82.12	59	95
1992	81	90.30	62	100
1993	85	99.25	65	104
1994	89	109.01	69	109
1995	93	119.67	72	115
1996	98	131.29	75	120
1997	102	143.95	79	126
1998	107	157.74	82	132
1999	112	172.74	86	138
2000	117	189.07	90	144
2001	123	206.81	94	151
2002	128	226.08	99	158
2003	134	247.00	103	165
2004	140	269.69	108	172
2005	146	294.30	113	180

Table 8. Derived estimate of dependent young (cubs and yearlings), the estimated variance, and the 95% confidence interval about the estimate. Data are based on observations of females with cubs of the year in the Greater Yellowstone Ecosystem, 1983–2005.

Year	$\hat{N}_i$ dependent young	Estimated variance	95% confidence interval Lower	Upper
1983[a]				
1984	64	12.59	57	71
1985	67	13.90	60	74
1986	70	15.33	63	78
1987	74	16.91	66	82
1988	78	18.64	69	86
1989	81	20.54	73	90
1990	85	22.63	76	95
1991	90	24.91	80	99
1992	94	27.40	84	104
1993	99	30.13	88	109
1994	103	33.12	92	115
1995	108	36.37	96	120
1996	113	39.92	101	126
1997	119	43.80	106	132
1998	124	48.02	111	138
1999	130	52.61	116	144
2000	136	57.61	121	151
2001	142	63.05	127	158
2002	149	68.97	133	165
2003	156	75.39	139	173
2004	163	82.37	145	181
2005	170	89.94	151	189

[a]Number of yearlings estimated from the previous years estimate of cubs. Data not available.

Table 9. Derived estimate of total population size, the estimated variance, and the 95% confidence interval about the estimate. Data are based on observations of females with cubs of the year in the Greater Yellowstone Ecosystem, 1983–2005.

Year	$\hat{N}_i$ All bears	Estimated variance	95% confidence interval Lower	Upper
1983				
1984	205	111.79	184	226
1984	215	123.37	194	237
1986	226	136.09	204	249
1987	238	150.07	214	262
1988	250	165.40	224	275
1989	262	182.20	236	289
1990	275	200.60	247	303
1991	288	220.74	259	318
1992	303	242.76	272	333
1993	317	266.81	285	349
1994	332	293.08	299	366
1995	348	321.74	313	383
1996	365	353.00	328	402
1997	382	387.06	343	421
1998	400	424.16	360	440
1999	419	464.54	376	461
2000	438	508.47	394	482
2001	458	556.22	412	504
2002	479	608.09	431	527
2003	501	664.41	450	551
2004	523	725.52	470	576
2005	546	791.79	491	602

Discussion

The confidence intervals we provide were derived with a Taylor series expansion (delta method) and may be only rough approximations. Because we lacked the ability to estimate the underlying covariance structure, intervals may be too narrow (or too broad). Uncertainty is a fact that we must deal with regarding data collected on the Yellowstone grizzly bear. However, as stated by Beissinger and Westphal (1998:836) "[u]ncertainty is inherent in decision-making but is not an excuse for not making decisions." We agree. In the *Reassessing Methods Document*, we elected not to generate confidence intervals around our estimates of independent females, independent males, dependent young, and population size because we lacked valid statistical methods to do so. Here we provide approximate estimates of uncertainty because many commenters requested them. It is important to recognize that in the *Reassessing Methods Document* and this supplement, we recommend methods to estimate bear numbers and sustainable mortality limits. However, we also recommended using the point estimate and not intervals of uncertainty. We focused on point estimates because statistically they represent the best approximation of reality. Some will argue that not knowing the uncertainty about our estimates could mislead us when making recommendations or when managers are forced to make decisions. This is a valid point in general; however, we feel that the monitoring protocols established for the Yellowstone grizzly bear are multifaceted and when considered as a whole, provide us with a reasonable understanding of the current health and status of the population. Further, when faced with making decisions, the group made recommendations that if wrong, err on the conservative side. In other words, if uncertainty leads us astray, we are more likely to underestimate bear numbers and sustainable mortality limits as opposed to overestimating them. We have made every attempt to build in conservative recommendations to cushion against uncertainty but in the real world, managers still must make decisions.

Summary of proposed methods

We recognize that the methods we originally proposed (IGBST 2005) and the newer methods proposed here might be difficult to assimilate. The Interagency Grizzly Bear Study Team will use the following procedures to establish and track sustainable mortality for grizzly bears in the Greater Yellowstone Ecosystem:

1. 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).
2. The Chao2 estimator will be applied to sighting frequencies of unique females to estimate the number of females with cubs of the year in the population.
3. The number of unique females obtained from the Chao2 estimator each year will be added to the dataset and the model averaging process described above repeated.
4. The predicted number of females with cubs obtained from the model fit 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.
5. The purpose of the model 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. We do not recommend retrospectively adjusting estimates from previous years.
6. The predicted number of females with cubs will be divided by the proportion of females ≥4 years old estimated to be accompanied by cubs of the year (transition probability = 0.289). The resulting value represents the best estimate of the total number of females in the population ≥4 years old.
7. 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 (0.77699). The resulting value is the best estimate of the number of independent females (≥2 years old) in the population that year.
8. The sustainable mortality limit for independent females will be set at 9% of the population estimate of independent females.
9. Unknown and unreported mortality will be estimated based on the methods of Cherry et al. (2002) as described in the *Reassessing Methods Document*.
10. The number of independent males in the population will be based on the estimated ratio of independent males:independent females (0.63513) derived via stochastic modeling described above. The number of independent females in the population will be multiplied by 0.63513 and the resulting value represents the best estimate of the number of independent males that year.

11. The sustainable mortality limit for independent males will be set at 15% of the population estimate of independent males.
12. The number of cubs in the annual population estimate will be calculated directly from the model-predicted estimate of females with cubs of the year. The number of cubs will be estimated by multiplying the modeled estimate by the mean litter size (2.04) observed from 1983–2002.
13. 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 (0.638) observed from 1983–2001.
14. The sustainable mortality limit for dependent young (cubs and yearlings) will be set at 9% of the annual estimate of dependent young. Only human-caused deaths (reported known and probable) will be tallied against the threshold.
15. Unknown and unreported mortality will not be estimated for dependent young.
16. Allowable mortality limits will be established annually following methods detailed here. Because we are using modeled predictions, annual variability among years has been addressed. Consequently, we do not recommend basing annual limits on a 3-year running average as proposed in the *Reassessing Methods Document*. Rather, we recommend annual mortality limits based on the current year.
17. Estimates of uncertainty about the number of independent females, independent males, dependent young, and total population size will be derived following methods detailed in this report.
18. We recommend the demographic objective originally proposed in the *Reassessing Methods Document* (Interagency Grizzly Bear Study Team 2005:44–45) of 48 $FCOY_{Chao2}$ remains the same; however, we recommend using the predicted number based on model averaging.
19. We recommend a biology and monitoring review should this predicted estimate decline below 48 for any 2 consecutive years.
20. We also recommend the management agencies attempt to limit female mortality if the model predicted estimate of Chao2 drops below 48 in any given year.
21. We recommend a biology and monitoring review if independent female mortality exceeds the 9% limit in any 2 consecutive years.
22. We recommend a biology and monitoring review if independent male mortality exceeds the 15% limit in any 3 consecutive years.
23. We recommend a biology and monitoring review if dependent young mortality exceeds the 9% limit in any 3 consecutive years.
24. We recommend that if the AIC_c weight favors the quadratic term (i.e., >0.5) in modeling the rate of change of females with cubs, a full review of the population's demographics be undertaken to better understand its status.
25. We recommend that dead bears reported in years subsequent to actual year of mortality be tallied against year of death and mortality total be recalculated. If mortality exceeds the threshold for that year, the difference (total mortality minus threshold) should be counted against the current years' threshold. If sex cannot be

determined, sex will be assigned randomly using ratio of 59:41 male:female as recommended in Appendix A (Schwartz and Haroldson 2001:120).

Supplemental data

Nearly all the information used in the *Reassessing Methods Document* (Interagency Grizzly Bear Study Team 2005) is in the public domain. Mortality information, including date of death, sex, age, certainty of death, if the bear was marked, and approximate location are published in the study team annual reports. The status of marked bears is also published in the annual reports. This information can be used to assess reporting rates. This information can be freely accessed via the internet [http://nrmsc.usgs.gov/research/igbst-home.htm]. Data to calculate population size using methods described in the workshop are available in the tables in Keating et al. (2002), and we have updated and included them here (Table 1). Estimates of sustainable mortality and limits recommended in the *Reassessing Methods Document* are in the Wildlife Monographs (Schwartz et al. 2006*c*). The data used to generate those estimates are in the monograph. All results of Harris et al. (2006), where estimates of population growth were derived, can be duplicated from data in the other chapters of the Monograph. Raw data to calculate the transition probabilities are in Table 10.

Table 10. Data used to calculate transition probabilities (Appendix C of the original Workshop Document). Data are presented as an inp file format compatible with Program MARK.

```
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Appendix M. Updating and Evaluating Approaches to Estimate Population Size and Sustainable Mortality Limits for Grizzly Bears in the Greater Yellowstone Ecosystem

Updating and Evaluating Approaches to Estimate Population Size and Sustainable Mortality Limits for Grizzly Bears in the Greater Yellowstone Ecosystem

10 September 2012

Interagency Grizzly Bear Study Team (IGBST)

Updating and Evaluating Approaches to Estimate Population Size and Sustainable Mortality Limits for Grizzly Bears in the Greater Yellowstone Ecosystem

10 September 2012

Report summarizing discussion of issues and analyses during workshops at Bozeman, Montana, February 3–4, 2011; July 11–12, 2011; and February 1–2, 2012

Report prepared by
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Cover photo: Female grizzly bear with cub-of-the-year near the Madison River, Montana, May 2012. Photo by John Way.

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6.3. Alternatives considered but not recommended

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Report Preparation

Literature Cited

Appendix A: Summary of 'rule-set' for identifying unique individual females with cubs-of-the-year (Knight et al. 1995)

Appendix B: The ADR approach presented by Dr. Megan Higgs, Montana State University

Appendices C through F: GYE grizzly bear data relevant to report recommendations

Executive Summary and Management Recommendations

1. Workshop objectives: Our objectives were to 1) revise current protocols for estimating population size of the Greater Yellowstone Ecosystem (GYE) grizzly bear population, 2) reevaluate current mortality limits as necessary based on this revised estimate of population size and updated demographic analyses, and 3) discuss possibility of zoning the ecosystem for mortality limits given the expanding population.

2. Background: To aid the reader in understanding the context of this workshop and the differences between management recommendations contained herein and those arising from previous workshops (see Interagency Grizzly Bear Study Team 2005, 2006), a summary of analyses and protocols underlying previous population estimates and management recommendations is provided. We include schematic diagrams of the processes involved in population estimation and derivation of mortality limits, and graphs indicating how uncertainty is accounted for.

3. Improving estimation of population abundance: Following up on the results of Schwartz et al. (2008), which demonstrated biases inherent in the existing method of indexing population size using unduplicated counts of females with cubs-of-the-year (F_{COY}) and the associated rule set of Knight et al. (1995), the group made efforts to consider alternative approaches. We considered, but ultimately abandoned, a clustering algorithm combined with Bayesian methods and ancillary data resampling to estimate the number of true F_{COY} using existing data on bear movements. We found that, although the method had considerable promise, it was quite complex, and depended on assumptions of the true spatial juxtaposition of female bears on the landscape, for which information is currently lacking. Instead, the group recommends transitioning from the current protocol for indexing abundance to a mark-resight estimator using systematic flight observation data collection since 1997. The mark-resight estimator yields an estimate of the number of F_{COY} present based on 1) the presence of a radio-marked sample, and 2) two systematic observation flights/year, during which all F_{COY} observed are recorded and, following observation, checked for marks (i.e., radio collar). This mark-resight estimator solves many of the problems inherent in the Knight et al. (1995) approach, but suffers from 1) low precision, because of small numbers of F_{COY} marked and observed, and 2) biases from geographic heterogeneity in the availability and detection probabilities of marked bears relative to unmarked bears. Ways to substantially reduce bias associated with the second disadvantage is the subject of ongoing research and analysis.

4. Preliminary analyses to update our understanding of grizzly bear vital rates from telemetry data: Mortality limits currently in place are based on demographic analyses using data from 1983 through 2001. Monitoring results from 2011 triggered a demographic review under existing protocols. Therefore, the team re-evaluated survival and fecundity of GYE grizzly bears for the time period 2002–2011, independent of previous analyses (but using consistent analytical approaches). These analyses are currently being refined, finalized, and prepared for a peer-reviewed publication. Preliminary data suggest, however, that the rate of growth seen during the 1983–2001 period has slowed. The proximate cause of this slower growth was lower survival rates among the yearling, and possibly, cub age-classes. Survival of adult females did not change between the two time-periods. Data indicate survival of adult males increased from the earlier to the later time period. Fecundity (female cubs produced/adult female/year) declined slightly. Based on these vital rates, asymptotic population growth of the GYE grizzly bear population during 2002–2011 ranged from 0% (using a conservative assumption that unresolved fates of independent females represented mortality) to 2.2% (based on censoring data of independent females with unresolved fates). Similar to the 1983–2001 period, population growth based on grizzly bear vital rates suggested greatest vigor within the Recovery Zone but outside of Yellowstone National Park, followed by the area encompassed by Yellowstone National Park. Although population growth rates remained lowest in the area outside the Recovery Zone, this rate increased compared with the 1983–2001 period. Consequently, population growth rates are now more similar across these 3 zones of the ecosystem.

5. Preliminary analyses of intrinsic and extrinsic factors associated with grizzly bear vital rates: Preliminary analyses using Program MARK (White and Burnham 1999) and an information-theoretic framework indicated 1) density dependence and 2) resource effect hypotheses (i.e., losses of whitebark pine, WBP) are both supported by the data. WBP indices were prominent in top models estimating the transition probabilities for the proportion of females with cubs. However, indices of population density effects were better supported in models estimating juvenile survival. Thus, our conclusions regarding the primary drivers for the change in population trajectory were mixed, in part because the effects of density dependence on grizzly bear vital rates may be similar to those resulting from a reduction in food supply and may be temporally confounded as well. Analyses are ongoing and will be submitted to a peer-review journal for publication.

6. Recommended revisions to sustainable mortality limits: Based on the updated demographic rates and a deterministic analysis of population growth yielding stability, the team recommends that managers adopt a new threshold of 7.6% mortality (from all causes) for independent (2 years or older) female grizzly bears. This differs from the previously recommended threshold of 9% because 1) juvenile survival rates (and fecundity) seem to be lower during 2002–2011 than the 1983–2001 period, and 2) the team feels comfortable in recommending a strategy focused on a goal of stability rather than growth. Similar to existing protocols, the team recommends the mortality threshold of 7.6% also be adopted for dependent offspring, counting human causes only. We note that despite a reduction of the mortality threshold for independent females and dependent offspring to 7.6%, the corresponding mortality limit may represent a greater number of bears compared with previous years because of greater size of the GYE grizzly bear population and because new techniques, such as the mark-resight estimator, may reduce the low bias of current population estimates based on the Knight et al. (1995) rule set. The team recommends the existing mortality threshold for independent males (15% from all causes) be retained.

The team also recommends that a revision of the existing boundary defining Suitable Habitat be adopted as the area within which grizzly bear mortalities counting against the mortality threshold be tallied. Under this change, some grizzly bear mortalities in areas where long-term occupancy or expansion is likely unsustainable would not be counted against the mortality threshold. This change would also correct a currently existing inconsistency, under which bear mortalities are counted over a much larger area than where systematic data collection efforts occur.

1. Workshop Objectives

When initially organized in late 2010, this workshop had 3 major objectives:

1. Review and revise the rule set of Knight et al. (1995) used to determine the unique number of females with cubs-of-the-year, which has been the foundation for determining population size, with the goal of reducing bias in the estimate.
2. Evaluate current mortality limits as necessary based on an updated population estimate.
3. Discuss the possibility of zoning the ecosystem for mortality limits given the expanding population.

Subsequent to the first workshop in February 2011, population monitoring results collected during 2011 (Haroldson 2012) triggered a demographic review under existing protocols (U.S. Fish and Wildlife Service 2007*a*). This necessitated two additional tasks:

4. Evaluate current mortality limits as necessary in light of newly updated estimates of demographic (vital) rates for the GYE grizzly bear population for 2002–2011 (i.e., results of the demographic review). This time period was selected because it 1) represented an independent data set from the previous analyses based on data from 1983–2001 and 2) reflected the time period when whitebark pine began noticeably declining.

5. Produce an initial investigation of intrinsic and extrinsic factors potentially associated with changes in grizzly bear vital rates.

Results of this workshop will be used to re-evaluate the basis for, and application of, rules for sustainable mortality limits. As per the commitment of all involved management agencies, our goal is to ensure that mortality management of the Greater Yellowstone Ecosystem grizzly bear population is based on the best available science to maintain long-term population viability. We expect a number of peer-reviewed publications to result from investigations conducted as part of these workshops, and when published, they should supplant this document as an authoritative source. This report is provided now so that stakeholders can be informed of our deliberations and necessary decisions and actions can be taken using the best available science.

2. Background

The GYE grizzly bear population was listed as threatened under the Endangered Species Act in 1975. A concerted and coordinated effort by federal, state, tribal, and private land managers led to the development and implementation of conservation measures with the primary purpose to reduce grizzly bear mortality and manage for suitable and secure habitat. During the decades of the 1980s and 1990s, the Interagency Grizzly Bear Study Team documented an increase of the GYE grizzly bear population, growing from approximately 200–350 bears in the mid-1980s (Eberhardt and Knight 1996) to at least 600 in 2012.

The U.S. Fish and Wildlife Service submitted a final rule to delist the GYE grizzly bear population in March 2007. This delisting rule was challenged in court and the Federal District Court in Missoula, Montana ordered to reverse the delisting in September 2009; protections under the Endangered Species Act were reinstated in March 2010. The District Court decision was appealed on two primary issues: 1) adequacy of regulatory mechanisms after delisting (i.e., the Conservation Strategy) and 2) potential threat of whitebark pine decline on the GYE grizzly bear population. The 9th Circuit Court of Appeals rendered a decision in November 2011 and reversed the District Court decision regarding the adequacy of protections provided under the Conservation Strategy but upheld the District Court decision that the U.S. Fish and Wildlife Service had not sufficiently articulated that whitebark pine decline was not a threat to the GYE grizzly bear population.

We provide here a capsule summary of protocols in use from adoption of the 1993 Grizzly Bear Recovery Plan until 2007, when the Revised Demographic Recovery Criteria for the Yellowstone Ecosystem were implemented (U.S. Fish and Wildlife Service 2007*a*), and from 2007 through the present time. This background (Section 2) can be skipped, but may be useful for reference in understanding options for improving the protocols presented in this document. Readers wishing to examine only the considerations and results of the current (year 2011–2012) workshop should go to Section 3.

2.1. Protocol in place prior to 2007

Management guidelines were set to assure that:

- A minimum of 15 females accompanied by cubs-of-the-year (F_{COY}, hereafter) were documented over a running 6-year average, inside the Recovery Zone plus a 10-mile perimeter immediately surrounding the Recovery Zone.
- 16 of 18 Bear Management Units (BMUs) were to be occupied by females with young (cubs, yearlings, or 2-year-olds) for a running 6-year sum of observations, with no 2 adjacent BMUs unoccupied.
- Known human-caused mortality was not to exceed 4% of the conservative, minimum population size index based on the most recent 3-year sum of unduplicated F_{COY}.

  - This rule was amended in 2000 to include probable human-caused mortalities, and cubs accompanying known and probable human-caused female deaths.
- No more than 30% of the 4% mortality were to be females (i.e., 1.2% of the minimum population size index).
- These mortality limits were not to be exceeded during any 2 consecutive years for recovery to be achieved. The threshold was based on a 6-year running average of mortality contrasted with the annual limit established from the 3-year sum of F_{COY}.

The population size and allowable numbers of human-caused mortalities were calculated as a function of the number of unique F_{COY} observed. Identification and separation of F_{COY} followed methods reported by Knight et al. (1995; these protocols came to be known colloquially as the "Knight rule set"). We summarize the protocols suggested by Knight et al. (1995) to distinguish unique individual F_{COY} seen in any given year from duplicate observations of the same F_{COY} in Appendix A.

Following determination of the number of F_{COY} observed in any year, the next step was to produce a conservative index of the number of adult females present. This was achieved by summing the number of F_{COY} seen during a 3-year period and subtracting the number of adult female mortalities recorded during this time period (Equation 1):

$$\hat{N}_{\min,t} = \sum_{i=t-2}^{t} \frac{\hat{N}_{obs,\,i} - d_i}{0.274}, \qquad (1)$$

where

$\hat{N}_{\min,t}$ = a conservative index of total population size in year (*i*-2)

$\hat{N}_{obs,\,i}$ (following notation of Keating et al. 2002) = number of unique F_{COY} observed in year *i* (as per Knight et al. [1995]), and

d_i is the number of known and probable human-caused mortalities of adult females (age >4) in year *i*.

To extrapolate to the number of all bears present, this value was divided by the estimated proportion of adult females in the population (0.274), assuming a stable age distribution.

This extrapolation made no claims to being an unbiased estimate of actual population size. Because the 3-year sum of F_{COY} was based on an observed number of unduplicated individuals (as described by Knight et al. [1995]), it provided a very conservative index of population size (i.e., an extrapolation from bears actually seen), rather than a true estimate of population size. As such, it undoubtedly underestimated both total population size and sustainable mortality limits. Nor did it permit calculation of valid confidence bounds.

Mortality limits were set at 4% of $\hat{N}_{\min,t}$ with no more than 30% of this 4% (1.2% of the population) to be females. The 4% total mortality and 30% female values came from simulation work conducted by Harris (1986), suggesting that a population of grizzly bears similar to those in the U.S. Northern Rockies sustaining approximately 6% added human-caused mortality (to an assumed background level of natural mortality) would have a very low probability of decline (on average, 70% of simulated mortalities were of males). Further, to account for the likelihood that not all dead bears would be known and thus enter the calculations, it was assumed that 1 additional bear died for each 2 that were documented. This was accomplished by further reducing the mortality limit from 6% to 4% annually. These steps are summarized in Figure 1.1.

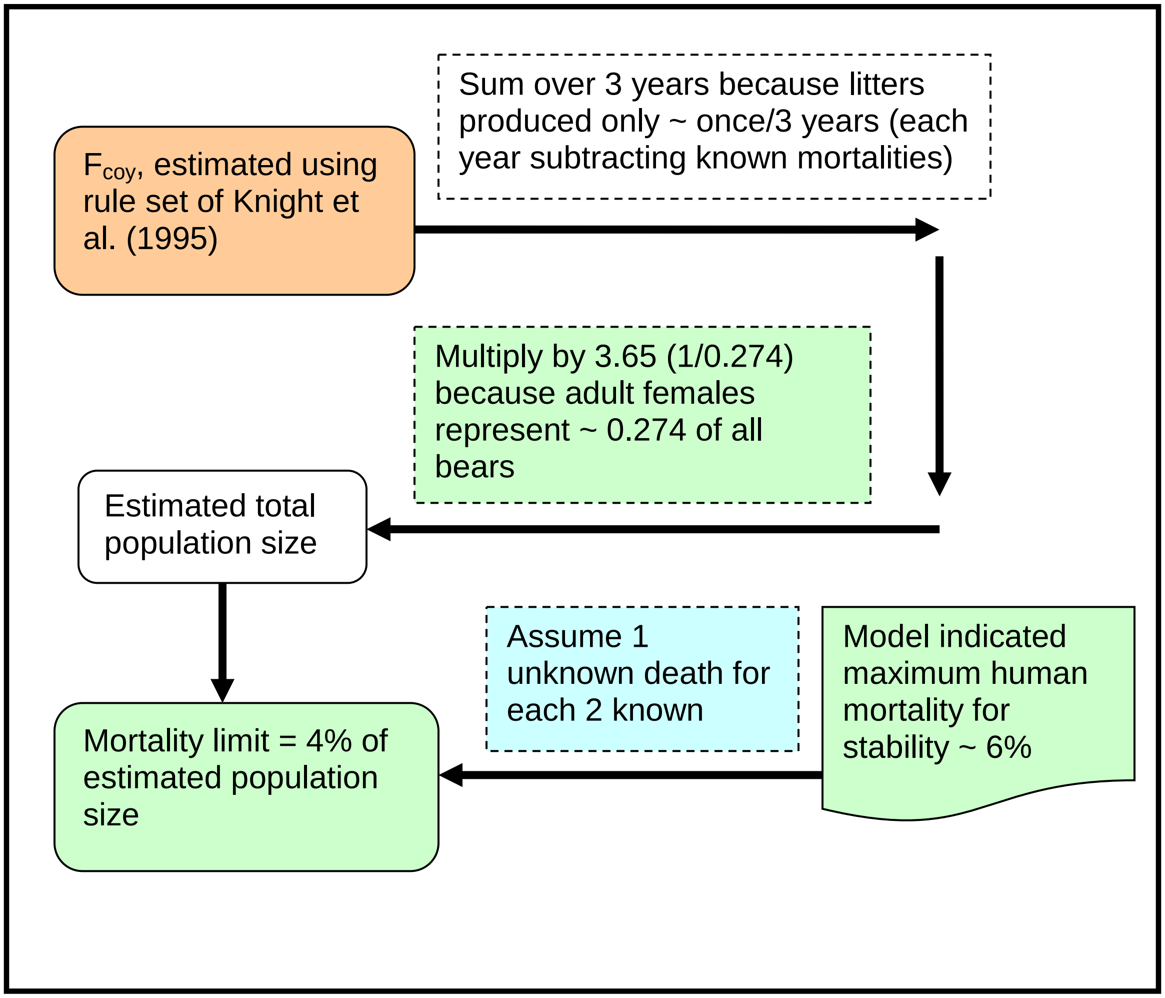

Figure 1.1. Flow chart of the protocol in place during 1993–2007 for estimating the number of grizzly bears in the Greater Yellowstone Ecosystem and limits to mortality.

This protocol had a number of characteristics, some of which could be seen as deficiencies, others as benefits:

- The 30-km rule set developed by Knight et al. (1995) to distinguish unique F_{COY} was designed to minimize Type I errors (i.e., reduce probability of mistakenly identifying sightings of the same F_{COY} as a different F_{COY}) and thus was designed to be conservative (i.e., some F_{COY} will not be identified as unique because they are too close to other F_{COY}).
- The protocol was conservative in that mortality limits were based on a conservative index of population size.
- The protocol was in place until 2007. During the 1983–2001 period, point estimates of the rate of increase of the GYE grizzly bear population ranged between 4% and 7% per year (4% if survival of independent females was calculated based on the assumption that unresolved fates represented mortalities and 7% if records of independent females with unresolved fates were censored; Harris et al. 2006: Table 18; Harris et al 2007:172). During this same period, grizzly bear distribution expanded (Schwartz et al. 2002, 2006*c*, lending additional support to a growing population.
- The constant 0.274 (Eberhardt and Knight 1996:417) represented the proportion of adult females in the population, defined as bears $\geq$5 years of age (U.S. Fish and Wildlife Service 1993: Appendix C:156; Eberhardt et al. 1994: Table 2:362). Because some 4-year-old females produce cubs (Eberhardt and Knight 1996, Schwartz et al. 2006*b*), their inclusion into the above equation could result in an overestimation of total population size because the constant 0.274 represents only females $\geq$5 years of age. Additionally, not all females of age class 5 produce first litters, as some delay reproduction until ages 6–8 (Eberhardt and Knight 1996: Table 1:361; Schwartz et al. 2006*b*). Consequently, the proportion used to extrapolate F_{COY} to total population size contained an unknown amount of error. Also, this proportion was based on the assumption of a stable age distribution, which may not be the case.
- The protocol assumed that on average, adult female grizzly bears produced a litter once every 3 years. Deviations from this assumption could overestimate (interval <3 years) or underestimate (interval >3 years) population size. The estimated proportion of F_{COY} in any given year based on a sample of radio-collared bears (age >3) ranges from 0.05 to 0.60. During this period (1983–2001), the Study Team monitored 352 females and documented 110 cub litters. This equated to 0.315 litters/female/year or 3.2 years between litters (1/0.315), suggesting that summing over 3 years generates a downward bias in estimating population size.
- Mortality limits were based on original work by Harris (1984), which was developed using input from a generic grizzly bear population for the continental U.S. These values were not specific to the GYE population. More recent ecosystem-specific data are now available.

During 2004–2006, scientists and managers involved with the GYE grizzly bear population had arrived at a consensus that newer, peer-reviewed scientific information (Cherry et al. 2002; Keating et al. 2002; Haroldson et al. 2006; Harris et al. 2006; Schwartz et al. 2006*a, b, d*) existed that should be used to improve these methods, develop new methods for these management approaches, or both.

2.2 Protocol adopted in 2007 and currently in place ("Knight-Chao2" protocol)

Following considerable analyses during the years 2000–2005, consideration of options, and input and review from both scientists and general public, a new protocol for estimating population size and mortality limits was proposed in 2005 (see Interagency Grizzly Bear Study Team 2005, 2006), and incorporated into the final Conservation Strategy for Grizzly Bears in the Greater Yellowstone Ecosystem published in 2007 (Interagency Conservation Strategy Team 2007) and the Revised Demographic Recovery Criteria for the Yellowstone Ecosystem (U.S. Fish and Wildlife Service 2007*a*). This remains the protocol in use as of the writing of this document.

2.2.1. Independent females

2.2.1.1. Estimating population size of females.**—**The earlier conservative index of population size has been replaced by a population estimate, albeit one that still has its roots in the method of delineating unique F_{COY} using the Knight et al. (1995) rule set. Counts of unduplicated F_{COY} and sighting frequencies continue to follow methods outlined by Knight et al. (1995). However, unlike prior to 2007, an attempt is made to estimate the total number of F_{COY} present from the distribution of the frequencies of sighting of individual F_{COY}. As implemented by Cherry et al. (2007), observed count frequencies are used to estimate a preliminary, year-specific total number of F_{COY} using the Chao2 estimator (Chao 1989) (hereafter $\hat{N}_{\text{FCOY-Chao2}}$).

F_{COY} are assumed to be ≥4 years of age because female grizzly bears in the GYE almost never produce cubs prior to this age. The total number of females ≥4 years of age in the entire population (i.e., with and without cubs-of-the-year) is estimated by dividing $\hat{N}_{\text{FCOY-Chao2}}$ by 0.289; this number is the estimated proportion of F_{COY} in the entire population of females ≥4 years of age and is based on transition probabilities calculated from the telemetry sample (see Appendix C of Interagency Grizzly Bear Study Team [2005] and for details see Schwartz and White [2008]). Thus, the resulting estimate represents, on average, the total number of females ≥4 years of age in the GYE population.

In turn, this number is divided by 0.77699, the estimated proportion of female bears ≥4 years of age in the population of females that are ≥2 years of age. The resulting value represents an estimate of total independent female bears (age ≥2 years) in the GYE. It is this, the number of females aged 2 and above that serves as the reference for mortality limits, as estimated by Harris et al. (2006).

2.2.1.2. Derivation of sustainable mortality limit.**—**The mortality limit for independent female bears is set at 9% of the population estimate for females ≥2 years old based on Harris et al. (2006; equivalent to a survival rate of 91% for these age classes). All mortalities are counted including: (1) agency-sanctioned management removals, (2) loss of radio-marked bears, (3) reported deaths from all causes (i.e., human, natural, and undetermined causes), and (4) an estimate of unknown and unreported losses. The 9% mortality threshold was chosen because simulations suggested that given fecundity and survivorship for dependent offspring estimated for 1983–2001, when survival of independent-aged females was ≥0.91, the annual growth rate (λ) of the population would be ≥1.0 in 95% of simulations (Harris et al. 2006, Schwartz et al. 2006*a*).

***2.2.1.3. Application of allowable mortality limits*.**—To dampen variability and provide managers with inter-annual stability in the threshold, allowable mortality limits are based on a smoothed estimate of the number of F_{COY} present in the population in each year, using past years' data and estimates. Linear and quadratic regression models of the natural log of $\hat{N}_{FCOY\text{-}Chao2}$ with year are fitted as an initial estimate of trend for $\hat{N}_{FCOY\text{-}Chao2}$. Support for linear versus quadratic models is assessed using an information-theoretic analysis approach based on Akaike's Information Criterion (AIC_c; Burnham and Anderson 2002). Respective AIC_c weights of the linear and quadratic models are then used to obtain model-averaged estimates of $\hat{N}_{FCOY\text{-}Chao2}$. The model-averaged endpoint in the time series is used as the most appropriated estimate for number of F_{COY} in the population. The method described in 2.2.1.1 is applied to the model-averaged estimate of F_{COY}, and it is this estimate from which sustainability of annual mortality is assessed.

***2.2.1.4. Unknown and unreported mortality*.**—Unknown and unreported mortality are estimated based on the method of Cherry et al. (2002). This method assumes that all deaths associated with management removals (sanctioned agency euthanasia or removal to zoos) and deaths of radio-marked bears are known. It estimates the number of reported and unreported mortalities based on counts of reported deaths from all other causes.

2.2.2. Dependent offspring

***2.2.2.1. Estimating the number of dependent offspring*.**—The number of cubs in the annual population estimate is based on estimates of the model-averaged number of F_{COY} ($\hat{N}_{FCOY\text{-}Chao2}$, see section 2.2.1.1.). We use an average litter size of 2.04 cubs (Schwartz et al. 2006*b*). The number of yearlings in the population is estimated from the number of cubs the previous year that survived. We assume cub survival to be 0.638 (Schwartz et al. 2006*d*). Thus, we estimate the number of yearlings in the population in any given year by multiplying the estimated number of cubs the previous year by 0.638.

***2.2.2.2. Sustainable mortality limit of dependent offspring*.**—Just as for independent females, the mortality limit for dependent bears of both sexes be set at no more than 9% of the total estimate of dependent offspring in the population. The rationale for using the same mortality limit as for independent females is explained in IGBST (2005:36). However, unlike for independent females, only human-caused deaths (both reported known and probable) are tallied against the threshold (Interagency Grizzly Bear Study Team 2006).

***2.2.2.3. Application of allowable mortality limit*.**—To dampen variability and provide managers with inter-annual stability, estimates for numbers of dependent offspring are derived from the model-averaged estimate of F_{COY} based on Chao2 and allowable mortality limits are a 9% annual limit from human causes only.

***2.2.2.4. Unknown and unreported mortality*.**—We lack empirical data to estimate unknown and unreported mortality for dependent offspring (Interagency Grizzly Bear Study Team 2006).

2.2.3. Independent males

***2.2.3.1. Population estimate for males*.**—An estimate of independent males (age ≥2 years old) depends on the estimate of independent females and modeled sex ratio of the population (Harris et al. 2006, Interagency Grizzly Bear Study Team 2006). Based on estimates of reproduction and survival, the sex ratio based on projections from the stable age distribution is 0.388:0.611 M:F. Therefore the male segment represents 63.5% (0.388/0.611 = 0.635) of the female population (i.e., there are 0.635 male bears for every female bear).

***2.2.3.2. Sustainable mortality limit*.**—Based on Harris et al. (2006), the mortality limit for independent male bears is set at 15% of the population estimate for males ≥2 years old. Similar to mortality limits for independent female bears, all mortalities are counted, including: (1) agency-sanctioned management removals; (2) loss of radio-marked bears; (3) reported deaths from all causes (i.e., human, natural, and undetermined causes); and (4) an estimate of unknown and unreported losses. The 15% mortality threshold was chosen because it approximates what occurred in the GYE from 1983–2001 (Haroldson et al. 2006), a period when population was estimated to have increased around 4–7% per year (Harris et al. 2006).

***2.2.3.3. Application of allowable mortality limits*.**—To dampen variability and provide managers with inter-annual stability in the mortality threshold, the allowable annual mortality limit is 15% of the estimate of males ≥2 years old as derived from the estimate of females ≥2 years old (see section 2.2.1.1.). For example, the 2004 estimate of females ≥2 years old was 214 bears. The number of independent males (age ≥2 years) is estimated at 136 (214 x 0.635 = 136). The 15% limit based on this estimate = 20 (136 x 0.15 = 20) male bears. Therefore, estimated total mortality for independent-aged males in 2004 (23 mortalities; Cherry et al. 2002) was 3 bears above the allowable mortality limit of 20.

***2.2.3.4. Unknown and unreported mortality*.**—Estimates of unknown and unreported mortality for independent males are based on the method of Cherry et al. (2002), as for females.

All steps are summarized in Fig. 2.1.

2.2.4. Total population size
Total population size is estimated annually based on the sum of estimates for independent female, independent male, and dependent bears.

2.2.5. Uncertainty
Unlike the protocol in place prior to 2007, most (but not all) steps involved in this protocol contain statistically valid measures of sampling error, and thus confidence limits can be calculated for individual steps. At the least, these provide information on how certain we are of any given step along the way. In some cases, they provide explicit bases for calibrating risk, by allowing for more or less conservative management guidelines based on a range of plausible outcomes rather than a single point estimate. However, uncertainty in each step is not incorporated into subsequent steps, making it difficult to understand the degree of certainty in final estimates.

Table 2.1 summarizes the steps illustrated in Fig. 2 that begin with counting the number of F_{COY} seen yearly to estimates of mortality limits, indicating the function of each, whether the expectation of the calculation is unbiased or not, whether uncertainty of the estimator is explicitly estimated, and, if so, whether it is carried through to the next step in the process and in what way. Most steps leading up to this estimate of population size are biased towards underestimating the population. Accordingly, use of these population estimates to obtain sustainable mortality rates likely result in conservative mortality thresholds.

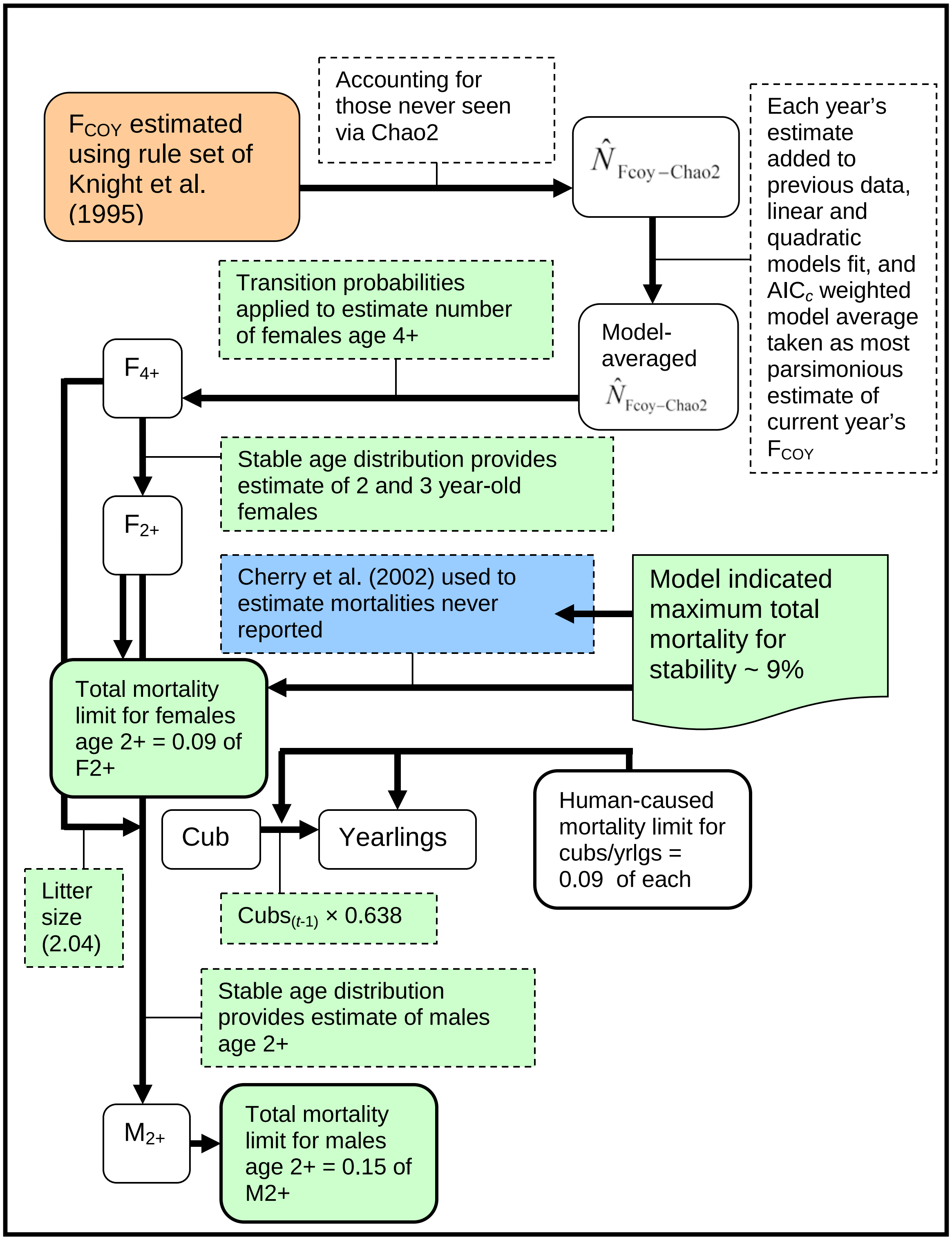

Figure 2.1. Flow chart of the protocols in place since 2007 for estimating the number of grizzly bears in the Greater Yellowstone Ecosystem and assessing sustainable mortality limits.

Table 2.1. Current protocol (in place since 2007), showing expected biases at each step, whether or not uncertainty (from sampling error) can be estimated, and whether (or how) this uncertainty is carried through to final estimates of population size and sustainable mortality of grizzly bears in the Greater Yellowstone Ecosystem.

Step in process	Function	Is expectation of result unbiased (U) , biased low (L), or biased high (H) and implications of this	Is uncertainty available from estimation procedure? (Y or N)	Is uncertainty carried through to the final management indicator? (Y or N)
1. Knight et al. rule set	Provide an index of the number of unique F_{COY} seen from observations	L (increasing negative bias with increasing population size)	N	N
2. Chao2	Estimate number of F_{COY} ($\hat{N}_{F_{COY-Chao2}}$) in the GYE from observed number	L (slight negative bias depending on assumptions and sampling frequency, bias decreases as effort increases)	Y	N
3. Estimate taken from model-averaged regression (linear and quadratic)	Smoothen annual fluctuations in estimates of total number of F_{COY}	Expectation is U, but in any given year could be L or H; consequence of smoothing is delay in response to true process change	Y	N
4. Transition probability calculation	Estimate number of females 4+ from estimate of total number of F_{COY}	U	Y	N
5. Stable age distribution	Estimate number of females 2+ from estimate of females 4+	U	Y	N
6.Model sustainable mortality rate for females 2+ using stochastic simulation	Use 'assumed dead' survival rates	Slightly L (sustainable rates conservative)	Y	Y[a] (use survival rate associated with 5% probability of 10-yr decline)
	m_x unadjusted for den emergence time	Slightly L (more cubs probably produced than suggested by this approach)		
	All unaccompanied yearlings assumed dead	Slightly L (more yearlings may have survived than estimated)		
	Use mean λ over 10-yr interval	Slightly L (declines more likely in 10 years than during shorter time span)		
7. Use Cherry et al. (2002)	Estimate total number of deaths from documented deaths	Slightly L (slightly more deaths may have occurred than estimated because heterogeneity in data greater than accounted for in estimator; effect would lead to underestimating total mortality)	Y	N

[a] Uncertainty because of deviation from stable age distribution is not accounted for.

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3. Improving the current approach to population estimation

The group spent considerable time discussing two alternatives to estimate size and trend of the GYE grizzly bear population. The first alternative estimates the number of F_{COY} from unduplicated sightings in the ecosystem yearly (i.e., the same raw data set currently used in the Knight et al. [1995] approach) using a sequential clustering algorithm and simultaneously estimates the F_{COY} population size using an approach called ancillary data resampling (ADR). The simultaneous estimation of the minimum number of F_{COY} sighted and population size carries uncertainty in assigning unduplicated sightings through to the population estimate. The second alternative uses more traditional mark-resight methods to estimate population size of F_{COY}, bypassing the estimate of the number sighted each year used in all previous methods. The mark-resight approach uses only data from systematic aerial surveys conducted twice yearly and radio-marked animals known to be alive and in the population, as opposed to all sightings of F_{COY} used in previous methods. The consensus of the group is that the second of these two alternatives is preferred, for reasons explained below. Methods for both alternatives are described in this section, following a review of why current methods based on the Knight et al. (1995) rule set are problematic and a better approach is desirable.

3.1. Assessing the Knight et al. (1995) rule set

It has long been recognized that the rule set established by Knight et al. (1995) to distinguish unique F_{COY} from a set of yearly observations of unmarked F_{COY}, while useful for the purposes it had initially been designed for, suffers from two flaws that permeated the entire protocol: 1) there is no way to quantify uncertainty, and 2) it is known to produce population estimates that are biased low and the magnitude of this bias increases with true population size. Thus, if measuring an increasing population, it would underestimate the rate of increase. Similarly, it would also underestimate the magnitude of the reduction in a population that was truly declining.

Schwartz et al. (2008) wrote a computer program to automate application of the Knight et al. (1995) rule set by developing algorithms that accurately replicated manual application of the rule set. They then used data from radio-marked F_{COY} to simulate performance of the rule set under various hypothetical but realistic levels of known population abundance. To accomplish the latter, radio-locations of bears from multiple years were overlaid on a map of the ecosystem as if they had all been produced in a single year, and bears were then randomly sampled from this "superpopulation" of observable bears. Sets of known (radio-marked) F_{COY} locations were placed on the map in ways that would populate areas in which few, if any, radio-marked females had been located (livetrapping bears is difficult in some geographic regions) but were known to be occupied by adult female bears. The result was a rather uniform distribution of bear locations for the simulations to evaluate the Knight et al (1995) rule set, with the goal of producing realistic inter-sighting distances and times, which are crucial components of the rule set. Repeated samples (n = 500 simulations) of 10, 20, 40, 80, and 100 true F_{COY} were taken from this superpopulation to represent variability in samples obtained by chance through the sampling protocol.

The result of most relevance from Schwartz et al. (2008) was that the rule set returned increasingly negatively biased results as simulated number of unique F_{COY} (and thus density) increased. With 10 true F_{COY}, the rule set was negatively biased by 12%; this bias increased to 48% for a true population of 100 F_{COY} (Fig. 3.1). Stochastic simulations of any populations with true F_{COY} of 20 or greater failed to produce a single estimate that exceeded the hypothesized population size.

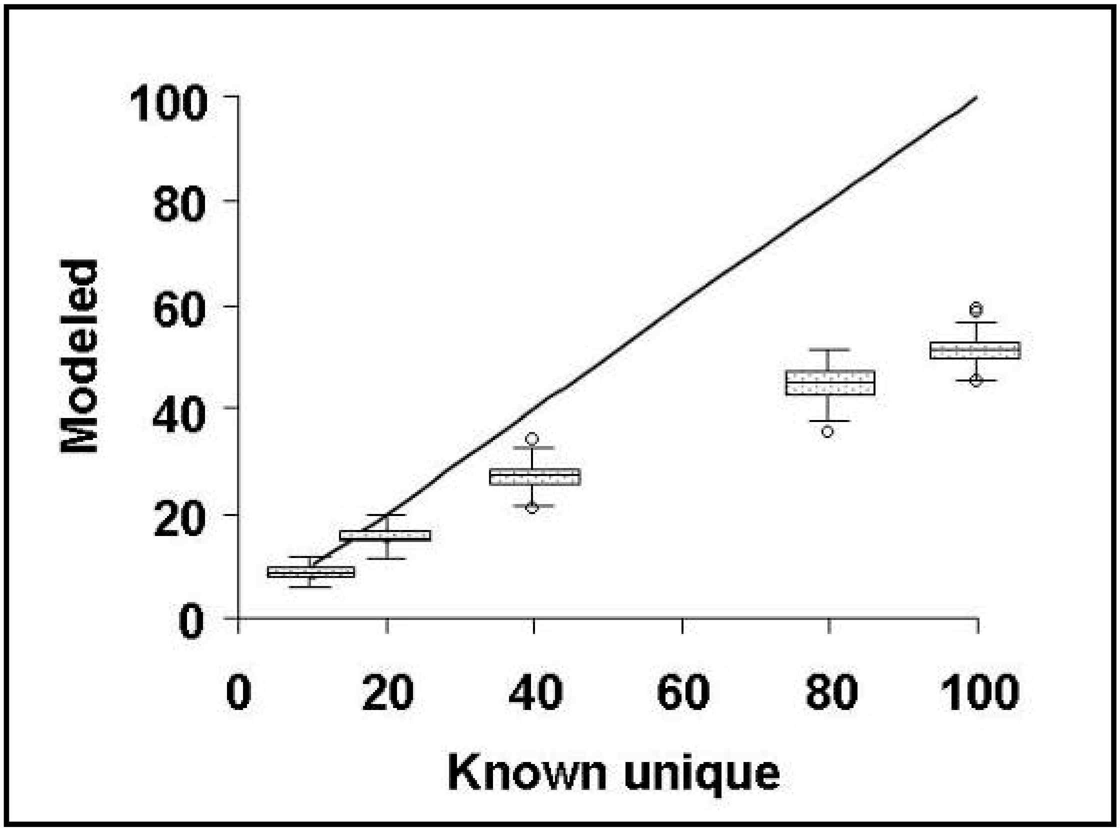

Figure 3.1. Side-by-side box plots of the simulated number of unique female grizzly bears with cubs-of-the-year (F_{COY}) in the Greater Yellowstone Ecosystem using the Knight et al. (1995) rule set to distinguish among telemetry locations for radio-collared F_{COY} sampled over a superpopulation of 10 to 100 unique sighted. In each case, n = 500 simulations. Adapted from Schwartz et al. (2008), except that reference F_{COY} line (solid line) has been corrected from that published in their paper.

One might ask if these biases resulted from errors in the way the Knight et al. (1995) rule set was conceived or executed, or alternatively, whether they are inherent in any similar attempt to distinguish unique animals from a set of unknown animals. We believe that obtaining an unbiased estimate of the true number of animals from unduplicated counts is difficult because it becomes increasingly challenging to distinguish unique animals from duplicates as density increases. Under the current methods for obtaining sightings of F_{COY}, there are few ways in which 2 sightings can be judged as representing distinct individuals, and they generally depend on such factors as number of cubs (1, 2, or 3) and the interaction of distance and time interval between sightings (summarized in Appendix A). The rule set was designed to reduce the probability of erroneously categorizing 2 sightings of a single animal as being from multiple animals but Schwartz et al. (2008) clearly showed there is a trade-off as population density increases (Fig. 3.1).

In light of these known biases, a group met in October 2007 to devise a research direction with the goal of producing a method to address these problems (Interagency Grizzly Bear Study Team 2008) and that would explicitly account for the uncertainty in estimating the number of unique F_{COY} sighted. The proposed strategy at the time was to develop a probabilistic model using a hierarchical Bayesian framework that would distinguish unique F_{COY} based on data from known (i.e., radio-marked) animals, while simultaneously estimating F_{COY} population size using methods similar to those in Wright et al. (2009). It was recognized at the outset that developing a model of true F_{COY} spatial distribution in the GYE would be required, and that this represented a substantial challenge.

3.2. Alternative #1: Sequential clustering algorithm combined with ancillary data resampling (ADR) to simultaneously estimate number sighted and F_{COY} population size

Dr. Megan Higgs, Department of Mathematical Sciences at Montana State University in Bozeman was contracted to pursue this modeling effort. She presented her preliminary results to the group on February 2 and 3, 2011, and further simulation results on July 11 and 12, 2011. Although the group ultimately concluded that they would not recommend using this approach as part of a revised management protocol, considerable time and effort was spent examining and assessing it. The following section provides a brief overview of the method Dr. Higgs developed and presented. A more detailed description is provided in Appendix B. Dr. Higgs plans to submit this work for publication in peer-reviewed literature at a later date.

The method has several steps and relies heavily on historic radio-telemetry and GPS data of F_{COY} in the study area. The method simultaneously estimates the minimum number of F_{COY} sighted (in place of the Knight et al. [1995] rule set) and the F_{COY} population size (in place of the Chao2 method) using a Bayesian model.

Stage 1: Estimate the minimum number of F_{COY} sighted (n) from all sightings within a year

Part 1: A logistic regression model fit to historic data is used to predict the probability that two sightings are from the same bear and this is used as the basis for a sequential clustering algorithm resulting in an estimated number of unique F_{COY} sighted.

Part 2: A cut-off value is obtained through an iterative process to remove most of the bias displayed in Fig. 3.1. Uncertainty in the estimate is quantified by repeatedly applying a sequential clustering algorithm to simulated data obtained by re-sampling from a superpopulation created from historic radio-telemetry and GPS data, similar to the strategy Schwartz et al. (2008) used to quantify uncertainty in the rule set

Stage 2: Estimate the number of F_{COY} in the population given the results from Stage 1

Part 1: This again relies on resampling from a superpopulation created from historic radio-telemetry and GPS data. Repeated sampling from the superpopulation consistent with the actual sampling protocol provides the method by which uncertainty is quantified.

Part 2: The superpopulation can be created based on combining historic data with hypotheses about the spatial distribution of F_{COY} on the landscape. We created three such superpopulations representing different assumptions about the distribution of F_{COY} within the GYE.

Part 3: Repeated sampling from each superpopulation scenario (i.e., ancillary data re-sampling) using the steps described in Appendix B resulted in quantification of the relative likelihood of different values of population size given the total number of observed sightings and the results for the minimum number of F_{COY} sighted obtained in Stage 1.

Model assessment: A simulation study was conducted to assess the performance of the models under violations of the spatial distribution assumptions. This allowed quantification of the magnitude of possible mistakes that could be made if we, for example, assume F_{COY} are preferentially distributed in high sightability areas when really they are distributed more uniformly across the region.

3.2.1 Benefits

1. The method uses all data (ground and flight data).
2. The method provides an estimate of the number of unique F_{COY} sighted.
3. Assumptions regarding the spatial distribution are based on real data from the study area and are readily visualized through plots of the superpopulations.

3.2.2. Limitations

1. The method is computationally intensive
2. The method involves many steps, which make it difficult to explain and understand.
3. The study team deemed the choice of a particular superpopulation to represent the spatial distribution assumption to be subjective.

3.2.3. Discussion

Because of the level of complexity involved in the entire method and computational time, the group decided against using this method. Also, lack of knowledge about the spatial distribution of F_{COY} across the region caused concerns regarding the choice of a particular superpopulation.

3.3. Alternative #2: Mark-resight to estimate number of F_{COY} from standardized aerial surveys

This approach takes advantage of the fact that, beginning in 1997, standardized aerial surveys have been flown twice per summer by experienced pilots and observers, whose tasks have been to 1) count all bears observed without the aid of telemetry, taking special care to ensure the presence of cubs-of-the-year and number of cubs-of-the-year were correctly documented, and 2) when a F_{COY} is observed, use telemetry receivers to determine whether or not that particular female is wearing a radio collar. These data naturally form the basis for mark-resight estimation of population size, pioneered by Rice and Harder (1977; see White 1996), and subsequently elaborated and extended by other investigators (Miller et al. 1997). In short, the total number of animals of interest (population size) is estimated by considering their detection probability. In this case detection probability is estimated by the distribution of number of re-sightings of the marked (radio-collared) F_{COY} (whose number is known exactly). The maximum number of re-sightings per year in this case is two (i.e., one during each set of observation flights).

Normally, an estimate would be produced for each sampling period (for large mammals, sampling typically occurs once per year) during which the number of marks is known and a set number of resighting surveys occurs. However, in the case of GYE grizzly bears, both the number of marked F_{COY} and the number subsequently observed during the observation flights are smaller than needed for standard yearly application of mark-resight methods (in 6 of the 15 years, no marked F_{COY} were re-sighted, which would make estimates in those years impossible; Table 3.1). Indeed, the Interagency Grizzly Bear Study Team previously studied the feasibility of this technique using all radio-marked bears with 1998–1999 data and concluded that resighting probabilities were too low, and uncertainty of population estimates too great, to apply the technique (Schwartz 1998, 1999).

However, if the assumption can be made that the probability a marked F_{COY} will be seen 0, 1, or 2 times during the 2 observation flights is generally similar from year to year (i.e., the yearly frequencies are manifestations of a single, underlying multinomial distribution), then the entire 15-year data set can be used to generate the probability of detection. Under this assumption, the number of marked F_{COY} in the population and the number of unmarked F_{COY} seen during observation flights varies yearly, but rather than using that individual year's distribution to model resighting probability, the overall resighting probability based on the 15-year aggregated sightings of F_{COY} is applied to each individual year.

Any approach using these data also assumes that the population of F_{COY} is closed within each sampling period (i.e., no deaths of F_{COY} between the first and second flights). Given the high survival rate of adult females (see later sections), this assumption seems biologically acceptable.

One additional assumption underlying use of this method is that the probability of observing a radio-marked F_{COY}, without using telemetry, does not differ from the probability of observing an unmarked F_{COY}. This assumption could be violated if marked F_{COY} differ from unmarked F_{COY} in behavior, habitat preference, pilot knowledge of their whereabouts, or geographic distribution. Study team members were unable to imagine any reasonable situation that would lead to either behavioral or habitat differences between collared and uncollared F_{COY}. Bears are not collared from aircraft, and thus recently collared bears are unlikely to react to them differently than uncollared bears. Further, F_{COY} are rarely captured and radio-marked in the year they have cubs; most collared F_{COY} wear collars that were attached in earlier years. The study team also indicated it is very unlikely that pilots and observers more readily find marked (radio-collared) F_{COY} than unmarked F_{COY} because they so rarely observed them visually (~10% of the time), even during telemetry flights. Pilots are under strict protocol not to locate F_{COY} using telemetry during observation flights.

With the exception of one characteristic of the data, study team scientists felt that the geographic distribution of collared female bears is generally representative of the geographic distribution and relative density of female bears in the population. The exception was that uncollared F_{COY} are more likely to use army cutworm moth sites for feeding in late summer than collared F_{COY}. Previous work has shown that a subset of bears in the GYE population typically spends 6 to 10 weeks in late summer (mid-July to late September) of most years feeding in alpine scree slopes on these moths (Mattson et al. 1991, Bjornlie and Haroldson 2011). These bears are thus highly visible and have constituted a substantial proportion of bears seen during observation flights. However, capturing and marking bears has been particularly difficult in these portions of the GYE. Early in the season, these remote and high-elevation areas are typically snow-covered, access is difficult, and ground-trapping has rarely occurred. Later in the season, when access improves, most of the bears that would be the subject of capture efforts have already begun feeding on army cutworm moths and are difficult to attract to capture sites. Thus, the proportion of radio-marked F_{COY} among those feeding on these high-visibility sites is lower than in the remainder of the ecosystem because of sampling limitations.

Table 3.1. Number of marked female grizzly bears with cubs-of-the-year (F_{COY}) known to be in the Greater Yellowstone Ecosystem population, number observed once or twice during twice-yearly observation flights, and total number of unmarked F_{COY} (i.e., not wearing operating radio collars) observed each year, 1997–2011.

Year	Marked F_{COY} available	Marked F_{COY} observed once	Marked F_{COY} observed twice	Unmarked F_{COY} observed
1997	6	2	0	16
1998	4	2	0	26
1999	6	1	0	7
2000	7	0	0	16
2001	9	5	0	32
2002	5	0	0	65
2003	4	1	0	25
2004	4	2	0	35
2005	3	0	0	22
2006	8	0	1	43
2007	6	3	0	45
2008	5	1	1	42
2009	6	0	0	28
2010	3	0	0	38
2011	3	1	0	28

Were mark-resight estimates to be applied ecosystem-wide without considering moth sites, the results would be positively biased (the probability of observing uncollared bears in this area is actually much greater than suggested by the proportion of marked bears that are re-sighted). However, the study team was able to identify moth sites and animals observed on them during each year. Thus, the study team proceeded with a preliminary mark-resight estimator that omitted any bears (marked or unmarked) observed at moth sites. In the remainder of the ecosystem, the assumptions of equal observability among marked and unmarked bears seems reasonable, thus the group viewed this approach as providing an unbiased estimator of the yearly number of F_{COY} within the GYE, excluding areas where bears feed on moths.

There are several alternative estimators for use with mark-resight data that differ in their generality (e.g., how well they handle heterogeneity of individual resighting probabilities) and assumptions. Megan Higgs and Gary White presented the group with the results of 3 different estimators:

1) a Bayesian approach, in which uncertainty in the probabilities of re-sightings obtained from data on marked animals is incorporated to obtain the posterior distribution for F_{COY} population size for areas of the GYE covered by observation flights, excluding the moth sites. Higgs et al. (in review) present several methods, exact and approximate, to obtain the appropriate posterior distribution for this problem.

2) the Poisson-log normal approach of McClintock et al. (2009), which has recently been incorporated into Program MARK, provides similar results to those obtained by Higgs et al. (in review); and

3) the generalized binomial model of Bowden and Kufeld (1995), which is available in Program NOREMARK.

Although the latter two are considered approximations, it is noteworthy that both accommodate heterogeneity in resighting probabilities (although the Bowden estimator is designed for situations in which resighting is without replacement within each occasion).

All estimators returned point estimates and confidence (or credible) intervals that did not differ practically, reducing the team’s concern regarding the choice of modeling approach.

Preliminary estimates of the number of F_{COY} based on this method suggest they will generally be greater than the numbers returned by the “Knight-Chao2” approach. Because of small sample sizes, confidence intervals surrounding each point estimate are wide. A formal manuscript was submitted in March 2012 to a peer-reviewed journal by Megan Higgs, Gary White, Mark Haroldson, and Dan Bjornlie, which is currently in review.

3.3.1. Benefits

If an unbiased correction factor can be developed for the problem of observations at moth sites, this approach can provide an unbiased estimate of the number of F_{COY} within the GYE, from which population estimates can be projected based on proportions of animals in each age-class (as in the current protocol). Unlike the current procedure, trends reflected in this estimate should reflect true trends, because there is no known density-associated bias. As currently implemented, it requires no additional research effort, because it uses animals that would be captured and collared in any case (for marked animals) and observation flights that have been consistently conducted since 1997 (for resightings).

3.3.2. Limitations

As currently implemented, the approach yields imprecise estimates (i.e., confidence intervals are large). In particular, the estimator produced with currently available data is somewhat sensitive to the small number of marked F_{COY} observed during both flights (most marked F_{COY} were never observed during flights, Table 3.1.). It also produces annual estimates of F_{COY} that vary considerably. Thus, a smoothing technique, such as regression on time, would be useful to better discern trends, rather than management responding to annual variation of estimates. To be used indefinitely in the future, a well-distributed sample of adult females must be radio-marked and, importantly, the larger this sample is, the more precise the estimator will be. Annual observation flights, similar to those conducted beginning in 1997, must be continued.

3.3.3 Work still to be done

3.3.3.1. Refine and update the geographic area to be excluded because of moth sites.—During the workshop, study team members provided an initial analysis that excluded marked F_{COY} resightings and sightings of unmarked F_{COY} within areas designated as moth feeding sites. A formal and objective procedure for defining areas inhabited by bears that use the moth sites during the period of observation flights is being developed. The downward bias resulting from excluding the moth sites entirely may be alleviated should it be possible to devise an additional estimate for moth sites only. To accomplish this, counts of F_{COY} during observation flights of confirmed moth sites will be conducted and evaluated for an annual moth-only addition to the mark-resight estimate. The accuracy of aerial observations of F_{COY} at moth sites will be evaluated based on simultaneous aerial and ground observations.

3.3.3.2. Work on an appropriate smoothing function.—The current protocol calls for fitting both linear and quadratic terms to series of F_{COY} estimates returned by the "Knight-Chao2" approach, with the single-best estimate in each year taken as the model-averaged mean using AIC_c weights. A similar approach could be applied to the series of estimates from the mark-resight approach. However, this approach may yet be improved by considering additional plausible models beyond the linear and quadratic. The quadratic model imposes a declining trend during later years of a series, thus not allowing for the possibility of population size becoming stable. Functions that include an asymptote would impose stability, thus not allowing for the possibility of a true decline. Because an a priori way to select among these possibilities does not exist, a larger array of candidate models of trend on time, weighted using AIC_c or similar information-theoretic methods, would offer the most objective assessment of recent population trends. We note that fitting smoothing functions will require several years as counts of F_{COY} based on moth-only observation flights could not be backcast but will only accumulate with additional years of data.

3.3.3.3. Power analysis.—Power analysis would estimate the ability of this monitoring protocol to correctly detect a specified change in state (e.g., increase to decline), given existing estimates of process and sampling variation and specified time frames. A similar analysis was already published for the "Knight-Chao2" approach (Harris et al 2007:174). The anticipated time frame to complete these power analyses is the end of 2012.

3.3.3.4. Improve the precision of mark-resight estimates by expanding it to all females with dependent offspring.—Protocols for aerial observation flights require pilots, upon finding a $F_{COY,}$ to determine whether bears are radio-marked. However, unlike in the "Knight-Chao2" protocol, which depends on the unique nature of F_{COY} to discriminate one individual from another, it may be possible to expand the subset of the population estimated beyond F_{COY}. For the GYE, sample size of marked and unmarked animals would approximately double (assuming a roughly 3-year reproductive cycle) if all observations of adult females with any offspring were considered. This would require little or no additional investment of time on the part of pilots and observers, or reconsideration of the areas to exclude from moth sites (see 3.3.3.1, above). In extrapolating to the total number of females (and from there, to total population size), transition probabilities would still be used, but the ratio to use would be all females except those in the "no offspring" state. However, this approach could fail if the detection probability of females with yearlings or 2-year-olds differs from that of females with cubs-of-the-year. Additionally, aerial observations of females with unrelated, young males could potentially be misclassified as females with offspring or vice versa. Because of these 2 limitations, the study team will first conduct analyses to examine the feasibility of improving precision based on increasing the sample size of marked females. Completion of these analyses is anticipated by the end of 2012.

3.4. Other alternative approaches to population estimation

Both the core study team members and larger group represented at the workshops were mindful of alternative approaches that exist to estimate the population size and trend of bears. Retrospective analyses using statistical population reconstruction (e.g., Gove et al. 2002) may be a potential avenue worth exploring and some simpler population reconstructions have already been completed. These would primarily be useful in either supporting or casting doubt on estimates obtained yearly because inference would lag behind management needs by a few years.

The group was also aware of, and had direct research experience, with mark-recapture estimators using either ingested marks (e.g., tetracycline, Garshelis and Visser 1997, Garshelis and Noyce 2006) or DNA from hairs (Woods et al. 1999, Kendall et al. 2009, Clark et al. 2010). These approaches had previously been considered by GYE managers and deemed currently impractical for budgetary reasons.

3.5. Discussion

The primary motivation for exploring alternative estimation techniques was the desire to obtain unbiased estimates of population size. The group clearly sees the mark-resight approach as the single best available alternative from which to estimate the number of adult females in the GYE (and thus total population size). As preliminary results have shown (Higgs et al., in review), there is an expectation that this technique will produce population estimates that are ≥ than those produced by the Knight-Chao2 approach. The mark-resight technique, unlike the Knight-Chao2 approach, is not increasingly biased low as population size increases (Higgs et al., in review). Although evaluations sofar indicate precision of the mark-resight estimator is low, we note that uncertainty associated with the Knight-Chao2 estimates likely is understated (Higgs et al., in review). We take the view of Paulik (1963) and other population biologists that an approximately unbiased estimate with low precision is always better than a highly precise but biased estimate. We thus conclude the mark-resight technique meets the first workshop objective (see Section 1). However, the group also discussed that 3 issues be further evaluated: (1) low precision, (2) correction factor for F_{COY} observed at moth sites, and (3) trend estimation.

3.5.1 Low precision

Precision of mark-resight estimates of F_{COY} would increase if additional females could be radiomarked. Field sampling constraints limit opportunities to increase sample size of marked females so it is important to determine trade-offs between sample size and precision. Analyses will be conducted to examine the effect of increased sample size on precision, with final evaluations expected by the end of 2012

3.5.2 Correction for F_{COY} observed at moth sites

The current estimate of the zone of influence around army cutworm moth sites for F_{COY} (5,000 m from moth site boundary, based on telemetry data of independent females that used moth sites) is being evaluated by the study team. Evaluation of the effectiveness of this correction is based on comparison of F_{COY} from simultaneous ground and aerial observations (8 flights at 5 different sites) during 2012. Congruence of >95% between ground and aerial estimates would indicate a separate census of F_{COY} at moth sites is feasible, and would serve to adjust the mark-resight estimate. This issue should be addressed by the end of 2012.

3.5.3 Trend estimation

Power analyses are planned to determine the effectiveness to track changes in population trends under different scenarios of population size and change. Final evaluations are expected by the end of 2012. Application of this technique to develop and evaluate trend data, however, will take several years; whereas mark-resight estimates excluding moth feeding sites will be backcast to 1997, estimates that are corrected for F_{COY} using moth sites started in 2012. Therefore, trend data of F_{COY} estimates including moth sites require accumulation of additional years of data.

Because final evaluation of the mark-resight estimator is pending, there was consensus that data required for the “Knight-Chao2” estimator continue to be collected, and these estimates be updated and reported annually.

4. Preliminary analyses to update our understanding of grizzly bear vital rates from telemetry data

The study team has completed preliminary demographic analyses of the GYE grizzly bear population that update those published by Schwartz et al. (2006*e*). That publication examined the population during the years 1983–2001 (with an additional year for reproduction only). New analyses covered the period 2002–2011. Most of these new analyses use Program MARK to estimate rates of survival (cubs, yearlings, subadults, adult females, and adult males) and transition rates among reproductive classes of females (which, in combination with litter sizes, yield fecundity).

With two exceptions, analytical approaches and assumptions followed closely those of Schwartz et al. (2006*e*). The two exceptions were:

1) Whereas the data set of 1983–2001 provided no basis for recognizing a distinct category of subadult females (aged 2–4) whose survival differed from adult females (aged ≥5 years), model selection procedures applied to the 2002–2011 data in which animals with unresolved fates were assumed to have died supported such a classification (although model selection for 2002–2011 data in which animals with unresolved fates were censored at last contact did not). Thus, subsequent models under the former assumption incorporated 4 age-classes for females: cubs, yearlings, 2–4 years-olds (subadults), and 5+ years old (adults).

2) Schwartz et al (2006*b*) made no adjustment for the raw reproductive rate (m_x) estimated from multiplying litter size by probability of an adult female being in the "with cubs" state. The updated analyses for 2002–2011 adjusted m_x to account for the discrepancy between the dates on which litter sizes were first documented and the date on which cub survival was modeled as beginning. Schwartz et al. (2006*b*:20) pointed out that the reproductive rate (at cub emergence) later used in population projections (m_x = 0.318) was likely biased low by approximately 13% because the mean date of first litter size documentation was 65 days later than the date on which cub survival was estimated. The study team's new analysis adopted the alternative procedure of Mace et al. (2012:122), which is more appropriate when combining m_x with cub survival rates as part of a life-table or matrix-based estimation of a rate of increase.

Results of these preliminary analyses are summarized in Table 4.1., which are provided here as a work in progress. Readers are cautioned that these analyses are ongoing, have not yet been thoroughly vetted or peer-reviewed, and that further work could result in revisions. Nonetheless, the broad outlines of changes in the demographic characteristics of the GYE grizzly bear population during the 2 periods (1983–2001 vs. 2002–2011; see Fig. 4.2) appear robust and are of sufficient importance to management that we believe these tentative results should be shared and considered at this time.

Table 4.1. Demographic rates of the Greater Yellowstone Ecosystem grizzly bear population, 2002–2011, as estimated from preliminary (as yet unpublished) analyses, compared with analogous results from 1983–2001 (Schwartz et al. 2006e). For each vital rate, the point estimate is provided above, and 95% confidence limits are provided below.

	2002–2011		**1983–2001[a]**	
Vital rate	**Point Estimate**	**95% CI**	**Point Estimate**	**95% CI**
Cub survival	0.553	0.421-0.667	0.640	0.443-0.783
Yearling survival	0.539	0.346-0.698	0.817	0.489-0.944
Subadult (age 2-4) survival[b]	0.948	0.917-0.968	0.950	0.926-0.965
Subadult (age 2-4) survival[c]	0.887	0.803-0.937	0.922	0.857-0.959
Adult (5+) female survival[b]	0.948	0.917-0.968	0.950	0.926-0.965
Adult (5+) female survival[c]	0.943	0.910-0.964	0.922	0.857-0.959
Adult (5+) male survival[b]	0.948	0.917-0.968	0.874	0.810-0.920
Adult (5+) male survival[c]	0.943	0.910-0.964	0.881	-
Fecundity (adjusted)	0.336	0.264-0.409	0.362	-
Fecundity (unadjusted)[d]	0.286	0.227-0.345	0.318	0.277-0.359

[a] Rates were estimated using a combined subadult and adult age class.

[b] Animals with unresolved fates were censored at last contact; no sex or age-class effect was observed.

[c] Animals with unresolved fates were assumed dead for this analysis; an age-class effect was observed.

[d] These reproductive rates are considered to be biased low for the 1983–2001 period (thus biasing λ low); adjusted fecundity was used in analogous estimations done by the study team for the 2002–2011 period (Table 4.2.)

Table 4.2. Point estimates (and, where calculated, 95% confidence intervals) of the rate of growth of the Greater Yellowstone Ecosystem grizzly bear population, λ (and bears within spatial subsets of it, weighted by the proportion of time spent in each), during the current period of analysis (2002–2011) and the previous period of analysis (1983–2001). A. Survival rates of independent females estimated with unresolved fate animals censored at last contact. B. Survival rates of independent females estimated with unresolved fate animals assumed dead (entire GYE only).

Geographic area	2002–2011	95% CI	1983–2001	95% CI
A.				
Entire GYE	1.022	0.966–1.060[a]	1.076	1.008–1.115[b]
YNP [c]	1.022	-	1.054	-
Beyond YNP but within recovery zone [c]	1.041	-	1.121	-
Beyond recovery zone [c]	0.965	-	0.887	-
B.				
Entire GYE	1.003	- [d]	1.041	0.972–1.096[b]

[a] Confidence interval based on techniques presented in Harris et al. (2007).

[b] Harris et al. (2007:172).

[c] We provide these separate λ estimates for each zone because of their management implications, but note that evidence for differences among zones was weak: confidence intervals for the untransformed covariate "zones" overlapped zero.

[d] We did not calculate confidence interval for this scenario; based on scenario A., the 95% confidence interval would likely be similar in width and bound 1.0.

Final analyses have yet to be completed but a few notable points were stressed by the study team and are relevant to the group's deliberations regarding revision of mortality limits:

1) Although confidence intervals for the two time periods overlapped (thus a formal statistical test may fail to show strong evidence of difference), the consensus among the scientific group was that evident declines in cub and yearling survival rates were real.

2) Subadult survival also seems to have declined (although again, a rigorous statistical test might not support this) because AIC_c supported a model for the 2002–2011 data in which age class was included as a covariate, which was not the case for the 1983–2001 period. However, this was only evident when independent survival was based on the scenario in which bears with unresolved fates were assumed dead; no difference was detected for survival of subadult and adult bears when bear with unresolved fates were censored.

3) The point estimate for fecundity was only slightly lower for the later period compared with the earlier period. Mean observed litter size during 2002–2011 was 2.12 cubs, similar to the mean observed during 1983–2002 of 2.04 cubs. Therefore, The

asymptotic proportion of a 4+ female having cubs-of-the-year was 0.269 during the latter period, compared with 0.289 during the earlier period.

4) Survival of adult males appeared to have increased between the 2 time periods.

5) Taken together, these vital rates yielded an estimated asymptotic λ very close to 1.0 during the 2002–2011 period (treating bears with unresolved fates as having died at last contact, estimated λ was 1.003; treating bears with unresolved fates as censored at last contact, estimated λ was 1.022; Table 4.2). Thus, the population increase that occurred during 1983–2002 had evidently slowed or stopped during 2002–2011. Because true vital rates during the 10-year period 2002–2011 may have changed, we cannot pinpoint when the change in trend occurred, or whether the population trajectory in future years will change from that estimated during this time period.

6) As during the earlier period, population growth rates during 2002–2011 were highest when modeled for the population living within the Recovery Zone but beyond the boundary of Yellowstone National Park, lowest beyond the Recovery Zone boundaries, and intermediate within Yellowstone National Park. However, divergence in these trends appeared to narrow during the latter period because there was little support for models with a zone covariate. The growth rate of bears as modeled within the Recovery Zone but outside of Yellowstone National Park declined markedly from the earlier to the later period; the growth rate within Yellowstone National Park declined slightly, and the (negative) rate of growth for bears outside the Recovery Zone actually increased from the earlier to the later period (Table 4.2).

5. Preliminary analyses of intrinsic and extrinsic factors associated with grizzly bear vital rates

The study team completed a number of preliminary analyses with the objective of improving our understanding of the reasons population growth has slowed in recent years. In particular, the team has employed linear models, both in Program MARK and other statistical software, to examine the strength of evidence for various hypotheses relating indices of population density and measure of whitebark pine abundance to vital rates in recent years. In recognition of the fact that vital rates (as well as measured physiological parameters) are likely also functions of sex, age, and other plausible environmental factors (e.g., proportion of time spent within the Recovery Zone boundary), these were also considered in models.

These analyses are currently being refined and re-checked; specific analyses are not yet available for publication in this report. However, the consensus among the assembled group, upon considering the preliminary analyses conducted thus far, is that these data are consistent with both the hypothesis of density-dependence (i.e., the population has grown with respect to a relatively stable carrying capacity, i.e., $N/K \approx 1$) and the hypothesis of adverse effects associated with resource changes, such as whitebark pine decline (i.e., K has declined). These two potential mechanisms are confounded to a large extent. The grizzly bear population has grown by 4% to 7% during the 1980s and 1990s up until ~2002, after which density-dependent effects would be expected to manifest themselves. However, the lower population growth of 0% to 2% during 2002–2011 also coincides with the period in which availability of whitebark pine seeds and other food resources (e.g., cutthroat trout in tributary streams of Yellowstone Lake) declined. Obtaining a better understanding if, and how, these two processes (density dependence and changing food resources) may have contributed to changes in population growth, and their relative contribution, is challenging and is currently the primary research focus for the Interagency Grizzly Bear Study Team. A synthesis report regarding whitebark pine decline, density dependence, and ecological plasticity of grizzly bears in the GYE will be finalized by October 2013. The consensus among the group is the GYE bear population remains healthy and stable at this time and there are no indications the grizzly bear population has entered a prolonged declining trend.

6. Recommended revisions to sustainable mortality limits

The existing protocol uses the results of modeling conducted by Harris et al. (2006) to estimate that, with the GYE exhibiting vital rates similar to those documented during 1983–2001, total mortality of adult females at 9% or below would have a very low probability of inducing a population decline. With the updated analysis of GYE grizzly bear vital rates during 2002–2011 (particularly those indicating possible reductions in cub and yearling survival in recent years), these limits require re-examination.

6.1. Revised limits

6.1.1. Independent females

As an initial approximation, we recommend that mortality limits applicable to independent females be 7.6% of the annual population estimate for independent-aged females. This is a revision of the currently-used 9% (Section 2.2.1.2.), and is based on 1) the revised estimates of vital rates for female grizzly bears during 2002–2011, and 2) a deterministic life-history projection that produces $\lambda \approx 1.0$ with these updated fecundity and survival rates for dependent offspring, and an independent female survival of 0.924. Thus, if survival rates for dependent offspring and fecundity remain similar to those estimated during 2002–2011, mortality (regardless of source) leading to annual survival of independent-aged females of $\geq$0.924 (i.e., annual mortality rate of 0.076 or 7.6%) would, on average, not produce a declining trend. We note that in addition to this mortality limit being based on updated vital rates from 2002–2011, it differs conceptually from the previously adopted one of 9% in being based on a deterministic model, rather than on the independent female survival rate yielding annual population growth rate of $\lambda \geq 1.0$ in 95% of simulations (Harris et al. 2006). The workshop attendees agreed that this conceptual shift was appropriate because wildlife populations in general, and grizzly bears in particular, cannot be managed for growth in perpetuity, especially when the boundary of suitable habitat is generally well defined because of limits on available habitat and incompatibility with human activities beyond this boundary (see Section 6.2). Thus, a change in management objective from one of population growth for recovery to maintenance of a stable grizzly bear population (i.e., $\lambda \approx 1.0$) is biologically logical and desirable, and compatible with management objectives of state and federal agencies charged with managing grizzly bears in the GYE. Secondly, we note that despite the lower mortality threshold of 7.6%, the number of female bears representing that mortality limit may be greater than previous years because population size has increased and because new techniques, such as the mark-resight estimator, may reduce the low bias of current population estimates based on the Knight et al. (1995) rule set.

As in the current protocol (Section 2.2.1.4.), as part of estimating the number of unmarked bears dying, we recommend that unknown and unreported mortality be estimated based on the method of Cherry et al. (2002). This method assumes that all deaths associated with management removals (sanctioned agency euthanasia or removal to zoos) and deaths of radio-marked bears are known. It estimates the number of unreported mortalities based on counts of reported deaths from all other causes.

6.1.2. Dependent offspring
Just as for independent females, we recommend the mortality limit for dependent bears be set at no more than 7.6% of the total estimate of dependent offspring in the population. The rationale here is similar to Section 2.2.2.2. (i.e., based on IGBST 2005:36), albeit using this revised number. As currently, and unlike for independent females, only human-caused deaths (both reported known and probable) would be tallied against the threshold.

6.1.3. Independent males
As in the previous protocol (Section 2.2.3.2.), no data exist that could be used to inform a sustainable mortality limit for males, because population trajectory is generally independent of male survival rates. Our recommendation therefore is that the current mortality limit of 15% of the annual population estimate of independent males be retained, which is a conservative criterion.

As in the current protocol (Section 2.2.3.4.), we recommend that estimates of unknown and unreported mortality for independent males be based on the method of Cherry et al. (2002).

The suggested protocol is illustrated in Fig 6.1., whereas Table 6.1. illustrates these steps with additional information on uncertainty and bias.

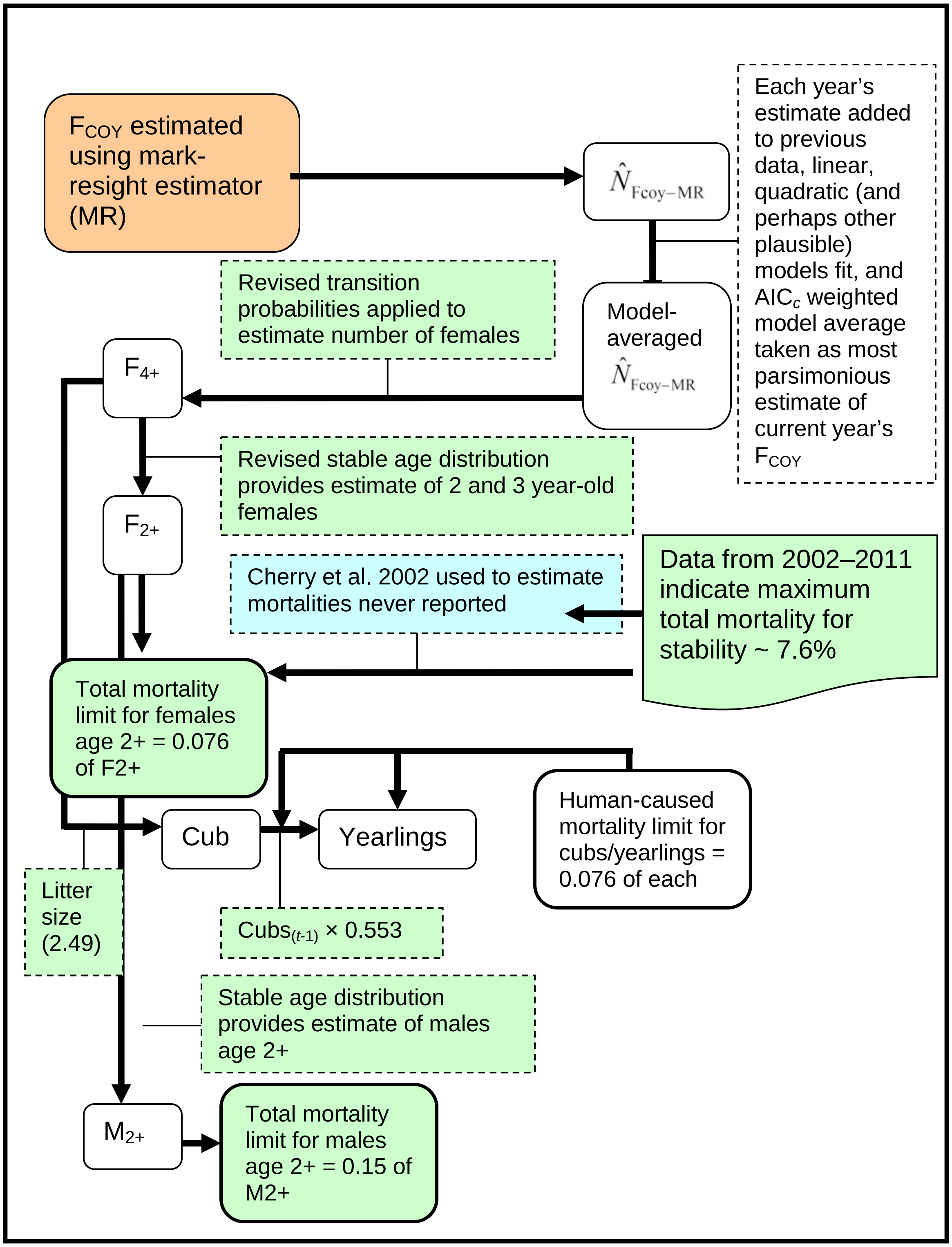

Figure 6.1. Recommended revised flow chart of protocols for estimating the number of grizzly bears in the Greater Yellowstone Ecosystem and limits to mortality.

Table 6.1. Recommended protocol (2012), showing expected biases at each step, whether or not uncertainty (from sampling error) can be estimated, and whether (or how) this uncertainty is carried through to final estimates of grizzly bear population size and sustainable mortality in the Greater Yellowstone Ecosystem.

Step in process	Function	Is expectation of result unbiased (U) , biased low (L), or biased high (H) and implications of this	Is uncertainty available from estimation procedure? Y or N)	Is uncertainty carried through to the final management indicator? (Y or N)
1. Mark-resight	Estimate total number of F_{COY} in the GYE from observation flights and marked F_{COY}	U (if satisfactory correction factor for moth site issue can be developed)	Y	N
2. Estimate taken from model-averaged regression (linear, quadratic, other plausible models)	Smoothen annual fluctuations in estimates of total number of F_{COY}	Expectation is U, but in any given year could be L or H; consequence of smoothing is delay in response to true process change	Y	N
3. Transition probability calculation	Estimate number of females 4+ from estimate of total number of F_{COY}	U	Y	N
4. Stable age distribution	Estimate number of females 2+ from estimate of females 4+	U	Y	N
5.Estimate sustainable mortality rate for females 2+ from new demographic analyses	Use survival rates where animals with unresolved fates are censored at last contact	U	Y	N (this differs from 2007 protocol, in which mortality limit had built-in conservative feature because was based on a model suggesting <10% probability of decline; under proposed rate, expected probability of decline = 50%)
	All unaccompanied yearlings assumed dead	Slightly L (slightly conservative because more yearlings may have survived than estimated)	N	
	Use fecundity (m_x) adjusted for date of emergence	U (Note change from previous protocol where this was labeled 'L', i.e., conservative)	Y	
6. Use Cherry et al. (2002)	Estimate true number of deaths from documented deaths	Slightly L (slightly more deaths may have occurred than estimated because heterogeneity in data greater than accounted for in estimator; effect would lead to underestimating total mortality)	Y	N

6.2. Revision of area within which mortality limits apply

Under the existing protocol, grizzly bear mortality limits apply to the entire Conservation Strategy Management Area (U.S. Fish and Wildlife Service 2007*a*). All mortalities occurring within this area are counted and total mortality is estimated (Cherry et al. 2002) to assess whether mortality limits have been exceeded or if a Biology and Monitoring Review is necessary under the Conservation Strategy implementation protocol. As the bear population in the GYE has increased in size and geographic extent, an increasing proportion of these mortalities have occurred outside the Recovery Zone boundary (Fig. 6.2); many of these have occurred in areas of private land ownership where the team consensus is that permanent occupation by grizzly bears is biologically and socially inappropriate or unlikely. Many mortalities are occurring in peripheral areas where the potential to support future maintenance or growth of the GYE grizzly bear population is limited.

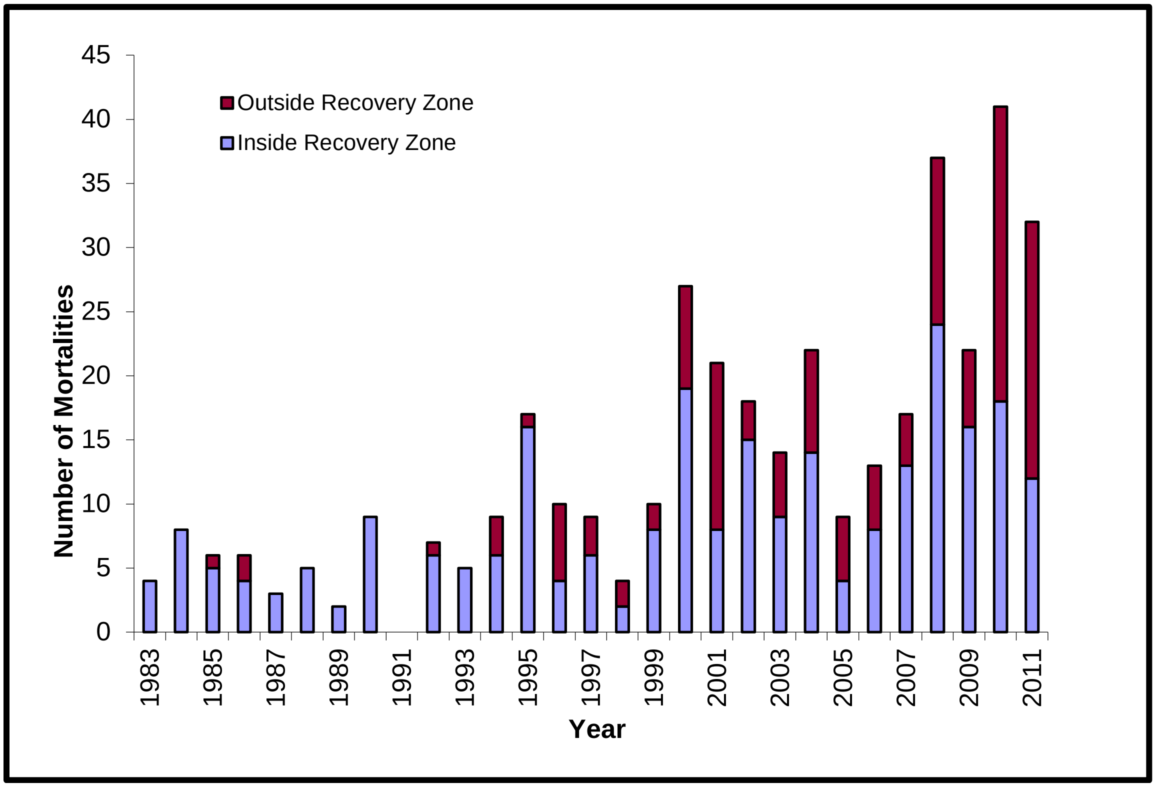

Figure 6.2. Number of mortalities of independent-aged grizzly bears inside and outside the Recovery Zone, Greater Yellowstone Ecosystem, 1983–2011.

In the grizzly bear recovery plan, the Recovery Zone (Fig. 6.3) is defined as the area "within which the population and habitat criteria for achievement of recovery will be measured" (U.S. Fish and Wildlife Service 1993:17). Whereas this may be true, maintenance of an increased bear population in numbers and distribution outside the Recovery Zone helps ensure long-term viability of this population. There is valuable habitat outside the Recovery Zone on public land, grizzly bears currently occur in many of these areas, and grizzly bears have a management future in these areas. Therefore, the group agreed that mortalities occurring beyond the Recovery Zone boundary on these public lands should be subject to mortality management.

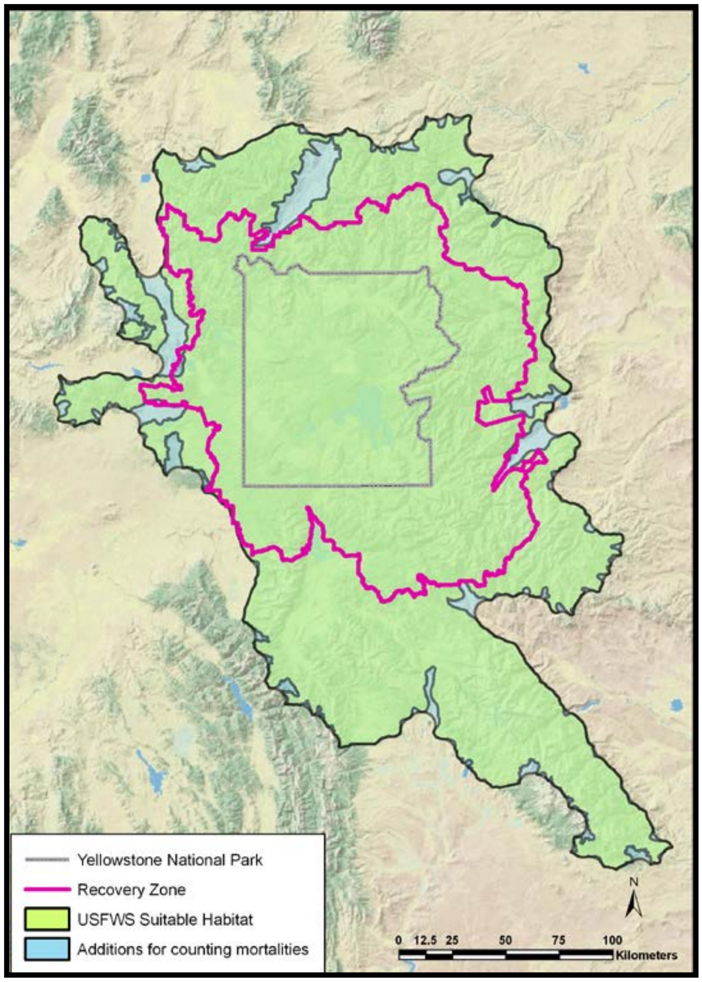

Figure 6.3. Greater Yellowstone Ecosystem, showing proposed boundary beyond which grizzly bear mortalities would not be counted against formalized mortality limits. This boundary is based on U.S. Fish and Wildlife Service Suitable Habitat designation (derived from ecoregions; U.S. Fish and Wildlife Service 2007b) and inclusion of narrow areas along valleys bounded mostly by suitable habitat that could act as potential mortality sinks (see text) for a total area of 49,928 km^2 . The purple line delimits the existing Recovery Zone (23,828 km^2) (termed the "Primary Conservation Area" in the conservation strategy), within which recovery criteria are required. Yellowstone National Park Boundary shown for reference only.

To achieve mortality management in the area appropriate to the long-term conservation of the Yellowstone population and to assure that the area of mortality management was the same as the area where the population estimates are made, the group considered using the boundary developed in 2007 by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 2007*b*) for what was termed "suitable habitat" as a reasonable way to define areas where mortality are managed (Fig. 6.3). There was general agreement that this suitable habitat boundary (enclosing a total area of 46,035 km^2) is sufficiently large to support a viable population in the long term, such that mortalities beyond it could be excluded from consideration. Importantly, this area closely resembles the area in which unique F_{COY} are surveyed and for which population size is estimated. This area is thus most appropriate for applying mortality limits. The study team noted, however, that because the suitable habitat boundary was drawn using mountainous ecoregions, there were narrow, linear areas along valley floors that did not meet the definition of suitable habitat and where population sinks may be created. This phenomenon, in which the quantity and quality of suitable habitat is diminished because of interactions with surrounding, less suitable habitat, is known as an "edge effect" (Lande 1988, Yahner

1988, Mills 1995). Edge effects are exacerbated in small habitat patches with high perimeter-to-area ratios (i.e., those that are long and narrow) and in wide-ranging species such as grizzly bears because they are more likely to encounter surrounding, unsuitable habitat (Woodroffe and Ginsberg 1998:2126). Mortalities in these areas would be outside suitable habitat but could have disproportionate effects on the population generally contained within the suitable habitat zone, potentially acting as mortality sinks. The study team recommends considering an alternative boundary that includes these narrow areas outside suitable habitat, but largely bounded by it (Fig. 6.3). During 2002–2011, 25 of 225 mortalities (11%) of independent-aged bears occurred outside the boundary of this composite area (Fig. 6.4). An additional issue with the U.S. Fish and Wildlife Service suitable habitat line was that the Recovery Zone occurs outside it in several small areas. This issue can be resolved by using suitable habitat plus the potential sink areas for a boundary that has the greater extent The so altered suitable habitat boundary plus potential sink areas would contain approximately 49,928 km^2 (see Fig. 6.4)

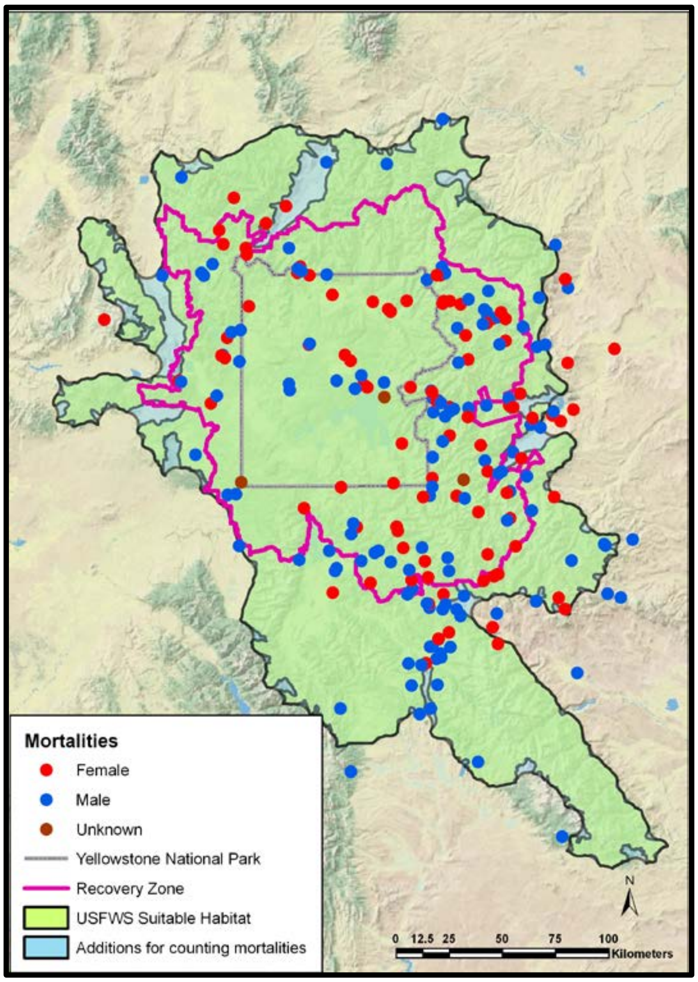

Figure 6.4. Known and probable mortalities of independent grizzly bears (2 years or older) during 2002–2011 (n = 225) and their occurrence relative to the U.S. Fish and Wildlife Service Suitable Habitat designation (U.S. Fish and Wildlife Service 2007b), Greater Yellowstone Ecosystem. Recommended alternative boundary includes narrow areas bordered mostly by suitable habitat that can potentially function as mortality sinks (blue polygons). Of 225 mortalities of independent-aged bears during this period, 25 occurred outside the modified suitable habitat line (9 females, 16 males). The Recovery Zone (termed the "Primary Conservation Area" in the conservation strategy) represents the area within which recovery criteria are required. Yellowstone National Park Boundary shown for reference only.

6.3. Alternatives considered but not recommended

6.3.1. Use rates leading to sustainability other than those suggested from demographic analyses

In response to several managers who expressed a desire for more flexibility in handling conflict bears, the group considered whether higher mortality limits (e.g., >9% for independent females) could be justified. Several members noted that, despite occasionally exceeding the mortality limits, the GYE population steadily increased from 1983 until the recent (2002–2011) stagnation of population growth. They also noted the 9% mortality limit incorporates a number of conservative decision points within the protocol (Table 1.1), and that even under the current situation of lower population growth, adult female survival remains high. Following presentation of the provisional demographic analyses from 2002–2011 (summarized in Section 4), this alternative was not pursued further.

6.3.2. Discount mortalities for individuals in some way that reflects their value to future population growth

Similarly (see section 6.3.1.), the group initially considered the suggestion that, because some sex-age classes of grizzly bears are known to exert much less influence on population trajectory than others, mortality quotas might reasonably be varied to reflect these. Analyses could potentially be pursued using either elasticities (from Leslie matrices) or reproductive values (from life-table analyses). The group elected not to pursue this possibility because of the complexity of implementing variable mortality limits based on age and sex.

Report Preparation

We prepared this report to document our review, discussions, and recommendations. We further recommend that results contained here be presented to state and federal managers for discussion, modification, and acceptance and to the general public for comment. Once this task is complete, we also recommend that these methods be presented to the Yellowstone Ecosystem Subcommittee of the Interagency Grizzly Bear Committee for endorsement.

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Appendix A

Summary of ‘rule set’ for identifying unique individual females with cubs-of-the-year (Knight et al. 1995)

Knight et al. (1995) developed a rule set used to distinguish sightings of unique females from repeated observations of the same female. Females were judged to be unique based on 3 criteria: (1) distance between sightings, (2) family group descriptions, and (3) dates of sightings. Minimum distance for 2 groups to be considered distinct was based on annual ranges, travel barriers, and typical movement patterns. A movement index was calculated using standard diameter of annual ranges (Harrison 1958) of all radiomarked F_{COY} were monitored 1 May–31 August (Blanchard and Knight 1991). The mean standard diameter for all annual ranges of F_{COY} was 15 km (SD = 6.7 km). They estimated the average maximum travel distance as twice the standard diameter, or 30 km, and used this distance to distinguish sightings of unique F_{COY} from repeat sightings of the same female.

Family groups within 30 km of each other were distinguished by other factors. The Grand Canyon of the Yellowstone, from the lower falls to the confluence of Deep Creek, was considered a natural barrier. Females on either side of this canyon were considered unique. Knight et al. (1995) also discussed paved highways as impediments to travel and cite data presented by Mattson et al. (1987), which showed that grizzlies tended to stay >500 m from roads during spring and >2 km during summer. They provided one example where 2 families considered unique were separated by 2 major highways and were <30 km apart (see Knight et al. 1995:Table 1). Family groups were also distinguished by size and number of cubs in the litter. Once a female with a specific number of cubs was sighted in an area, no other female with the same number of cubs in that same area was regarded as distinct unless (1) the 2 family groups were seen by the same observer on the same day, (2) the 2 family groups were seen by 2 observers at different locations but similar times on the same day, or (3) 1 or both of the females were radiomarked. Because of the possibility of cub mortality, no female with fewer cubs was considered distinct in an area unless (1) she was seen on the same day as the first female, (2) both were radiomarked, or (3) a subsequent observation of a female with a larger litter was made. Knight et al. (1995) assumed that all cubs in a litter were observed and correctly counted. This assumption was strengthened by only considering observations from qualified agency personnel. Observations from the air were only included if bears were in the open and easily observed. Ground observers watched family groups long enough to insure all cubs were seen; observers reported any doubt. Finally, Knight et al. (1995) reference a time-distance criteria but did not provide specific rules for its application. The only example they provided was the separation of 2 sightings of 2 family groups observed 1 day apart and 25 km apart.

This protocol was later criticized by Craighead et al. (1995) as unproven, and later by Mattson (1997), who pointed out ways in which the number of F_{COY} might be influenced by search effort or other annual factors unrelated to true abundance. Methods to identify unique F_{COY} that are similar in spirit to Knight et al. (1995), if necessarily slightly different in the particular rule set, have also been applied in the Banff ecosystem of Alberta, Canada (Brodie and Gibeau 2007), and the Cantabrian Mountains of Spain (Palomero et al. 1997). Brodie and Gibeau (2007) pointed out, however, that estimates of population trend based on this approach were quite imprecise. The application of the approach to the Cantabrian Mountain grizzly bear population in Spain was also criticized for reasons similar to those articulated by Mattson (1997) by Fernández-Gil et al (2010; see also Palomero et al. 2010; Ordiz et al. 2007).

Schwartz et al. (2008) provided a detailed analysis of the behavior of the Knight et al. (1995) rule set in the Greater Yellowstone Ecosystem. These findings are discussed in the main body of this report.

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Appendix B

The ADR approach presented by Dr. Megan Higgs, Montana State University[a]

1. Logistic regression for classification of sightings of individual bears to identify correlates of multiple sightings being of a single individual.

Ancillary data resampling (ADR) approaches the problem of distinguishing unique F_{COY} by relying strictly on empirical data from GYE grizzly bears (in contrast to Knight et al. 1995 which used rules of thumb coarsely derived from those data). Similarly to Schwartz et al. (2008), the ADR approach uses radio-telemetry data from previously marked F_{COY} (both conventional VHF radio-collars and GPS collars) as the basis for all inference. A map of the GYE is "populated" with a "superpopulation" of bear locations. Each location is from a real bear and retains its spatial and temporal orientation with regard to other locations from the same bear, as well as information on litter size. Simulations then proceed from randomly selecting from the desired number of bears from this superpopulation.

The first stage of the ADR approach begins by using logistic regression to quantify the probability that any given two observations of unknown F_{COY} were of the same bear. Logistic regression is a well-known statistical approach to using a series of explanatory variables to describe or predict a phenomenon that exists on a binary scale. In this case, the phenomenon of interest is whether two sightings of F_{COY} are of the same animal or not. Working with Interagency Grizzly Bear Study Team biologists, Dr. Higgs identified the following variables as useful in predicting the probability of two sighting being of the same bear:

1) distance between locations,
2) whether the number of cubs was the same,
3) if different, whether number of cubs and increased or decreased,
4) whether both observations occurred during March–April,
5) whether both observations occurred during May,
4) whether both observations occurred during June,
5) whether both observations occurred during July,
6) whether both observations occurred during August,
7) an interaction term between distance (variable 'a') and whether both observations were made during March–April (variable 'd'),
8) a similar interaction term between variable 'a' and variable 'e',
9) a similar interaction term between variable 'a' and variable 'f',
10) interaction between 'a' and 'g',
11) interaction between 'a' and 'h',
12) an interaction term involving the distance between locations ('a') and whether the time interval between the 2 observations was <3 days;

[a] A more technical and detailed description of this approach is available from Dr. Megan Higgs, Department of Mathematical Sciences, Montana State University, Bozeman, Montana.

13) an interaction term involving whether the number of cubs seen was the same ('b'), and whether the time interval between the 2 observations was < 3 days.

These predictor variables were all selected based on a prior knowledge of the data set consisting of many years of F_{COY} observations; all make intuitive sense and are similar conceptually to the variables used in the Knight et al. (1995) rule set. For example, it should be obvious that two observations from very distant locations are less likely to be of the same F_{COY} than of two different F_{COY}. Similarly, observations of F_{COY} with same number of cubs are more likely to be of a single bear than observations in which number of cubs differed (note, however, that cubs sometimes die, so an observation of a F_{COY} with *n* cubs could represent the same animal as a subsequent observation of a F_{COY} with *n*-1 or even *n*-2 cubs). Because F_{COY} move at different rates as the non-denning season progresses, the timing (i.e., month) of observations was also found to be a useful predictor. Exploratory data analyses also revealed that, whereas the time interval between observations was important, an important distinction could be made based on whether the intervals between observations was <3 days.

Various logistic regression models were developed based on a data set consisting of all pairwise comparisons of observations of known (e.g., radiomarked) F_{COY} during 1976–2003. The final model was that which minimized AIC. Coefficients for this predictive model are presented in Table 2. For example, the negative sign for distance (variable 'a') indicates that as distance between observation increased, probability of the F_{COY} being the same animal decreased; the positive sign for litter size being the same indicates that, when true, it was more likely that the observations were of a single animal than when false. The strongly negative coefficient for litter size increasing with time reflects the implausibility of litter size increasing with time. Some coefficients have signs (positive vs. negative) that are counter-intuitive because of the interactive effect of all when combined together (i.e., signs predicting the probability that 2 observations were of a single F_{COY} might have differed had they been entered into a single-variable model).

Using a logistic regression model to predict the probability that any 2 observations of unknown F_{COY} has the beneficial property of having been developed by objective, statistical methods, and being based on a large sample of known bears. It is useful in clarifying and quantifying relationships suspected to exist between correlates of observations and truth.

Table 2. Selected (best-fitting) logistic regression model of the probability that any 2 grizzly bear observations were from a single female with cubs-of-the-year (F_{COY}), based on radio-marked F_{COY} monitored in the Greater Yellowstone Ecosystem, 1976–2003. Standard errors of slopes are not shown because they were developed from non-independent data, and because they were not used in the resulting clustering algorithm.

Variable label and description		Parameter estimate
a	Distance between locations	−0.143
b	Whether number of cubs same	3.356
c	Whether number of cubs and increased	−4.514
d	Whether both observations occurred during March–April	0.744
e	Whether both observations occurred during May	0.921
f	Whether both observations occurred during June	0.786
g	Whether both observations occurred during July	0.001
h	Whether both observations occurred during August	−0.196
i	Interaction: a X d	−0.191
j	Interaction: a X e	−0.147
k	Interaction: a X f	−0.080
l	Interaction: a X g	−0.032
m	Interaction: a X h	−0.009
n	Interaction: a X time interval between observations <3 days	−0.163
o	Interaction: b X time interval between observations <3 days	2.218

2. Choosing optimal cut-off values for the probability of being same bear for that number of observations

Unfortunately, even the best-fitting logistic regression model only gets us part-way to the desired end-point. This is because it provides only a *probability* of two observations being of the same individual F_{COY}, whereas what we require is a *classification* algorithm; i.e., one that "decides", for each observation of a F_{COY}, whether it should be considered to represent a unique individual or not.

Thus, the next step in the ADR procedure is an algorithm that aggregates observations of F_{COY} into clusters representing sightings of the same animal, using the predicted probabilities generated from the logistic regression model (each pair of observations of F_{COY} is associated with the series of variables required by the logistic regression model and summarized in Table 2). The clustering itself is briefly described in the next section, and depends on selection of a cut-off value along the probability scale (0,1) to move from quantifying to categorizing. To retain constant bias (or lack thereof) across the range of number of Fcoy sighted, the cut-off value must change as the number of unique animals sighted changes. For example, the figure similar to Fig. 3.1 would require a different cut-off value for each value on the x-axis. Thus, through the cut-off specification determined through simulation, the method attempts to solve the bias problem of the rule set shown in Fig. 3.1.

The algorithm calls for finding cut-off values to minimize bias in identifying unique F_{COY} over the range of plausible values of the number of F_{COY} observations each year (which will be known) and the true number of F_{COY} present (which will be unknown). That is, cut-off values are selected so that the median of the distribution of the number of unique F_{COY} observed based on the sequential clustering algorithm is equal to the number known (from the telemetry data) to have been observed.

3. Clustering algorithm

Dr. Higgs concluded that a sequential clustering algorithm was both the simpler computationally and closer to the way data are actually accumulated than algorithms that attempt to find the most likely clusters from all possible groupings of that year's F_{COY} observations. Thus, the algorithm begins with the first observation of F_{COY} in that year, and considers this known. The 2nd observation is taken in chronological order, the coefficients from Table 2 applied to the pair of observations to calculate a probability of the 2nd observation being the same F_{COY} as the 1st observation; it is classified as either the same or a unique F_{COY}, based on a comparison of the cut-off value with this probability. This process continues chronologically, observation by observation. Where a cluster of >1 observations has been identified by the algorithm, probabilities of the new observation are calculated for each observation within the cluster, and the mean of those probabilities is taken as the value for that cluster. The cut-off value is then used to classify the new observation as either a unique bear, or, if not unique, as belonging to the cluster with the highest probability.

4. Quantifying uncertainty in the estimate of minimum number sighted using re-sampling from historic data.

To quantify uncertainty in the estimate (obtain a posterior distribution) of the minimum number sighted, Dr. Higgs used a Monte Carlo re-sampling approach modeled after the work in Schwartz et al. (2008) that initially demonstrated and quantified the low bias in the previously used methods. For many re-samples under a known true number of sighted animals, the sequential clustering algorithm is applied to obtain a distribution of estimates that can then be compared with the true value. Dr. Higgs presented the group with evidence that, based on simulations analogous to those conducted in Schwartz et al. (2008) showing the low bias of the previous method, this procedure is capable of predicting an unbiased distribution of F_{COY} present from sets of unidentified F_{COY} observations, over the true range of F_{COY} 10 to 100. Using the superpopulation of bears previously developed by Schwartz et al. (2008) from radio-marked bears as a reasonable approximation to the GYE situation and cut-off values optimized to reduce bias, the ADR procedure produced clusters that, on balance, replicated the number of F_{COY} known to be present.

5. Repeat for different maps (because true density or distribution are not known)

Had this had been all that was required, the group consensus might well have been that this approach provided a convincing and defendable alternative to estimating minimum number of F_{COY} sighted in a year as an alternative to the Knight et al. (1995) rule set. Unfortunately, all inference (i.e., moving from unknown F_{COY} observations to unbiased number of F_{COY} clusters representing the number of unique F_{COY} observed) depended on the particular "superpopulation" of bears that served as the basis for simulations. Although bear locations came from real bears and each retained known spatial and temporal associations with other locations from the same real bear, the group identified additional areas in which a single, GYE superpopulation, such as used by Schwartz et al. (2008) might fail to reflect reality:

1) F_{COY} captured and marked for radiotracking (or GPS tracking) likely did not reflect an unbiased geographic distribution of all F_{COY} available for observation. This was relevant because the spatial orientation of observations is a critical part of the clustering procedure;

2) The process of relocating a bear using radio-telemetry or GPS collars (i.e., data underlying the likelihood function used in the clustering) may not accurately reflect the process of observing a bear visually. Visibility varies within the GYE, as functions both of vegetation and access to human eyes (relatively few telemetry relocations were associated with a visual observation of the F_{COY}). Even if only the subset of radio-locations were used on which a visual observation was made, this process may also differ from how observations unaided by telemetry are made.

Without knowing the true distribution of F_{COY} in the ecosystem, or how visible any might be given where it lived, the decision was made to develop 3 alternative models of distribution. Each would form the basis for alternative "superpopulations" of bears, which, in turn, would be the basis for the re-sampling that provided the foundation for quantifying uncertainty (obtaining posterior distributions) for minimum number of individuals sighted *and* Fcoy population size using the ADR method (discussed in Section 5):

1) *Uniform scenario*.—A rather uniform spatial distribution scenario, in which the GYE was populated by F_{COY} locations without regard to geography or to the spatial juxtaposition of observations made during 1997–2010 (this latter was developed by Mark Haroldson by applying fixed kernel density methods to non-telemetry observations of F_{COY} from both ground and aerial observers; this was initially labeled "medium" during the workshop). The implicit assumption here was that F_{COY} are distributed and can be observed relatively uniformly within the GYE, and that the irregularities in spatial configuration seen among radio-marked bears resulted from inability to capture bears equally throughout the system, or to monitor them once marked;

2) *Proportional sighting scenario*.—A rather peaked spatial distribution scenario, in which the GYE was populated by F_{COY} locations in a way that followed the spatial distribution suggested by historic sightings of Fcoy without the aid of telemetry (this was initially labeled "high" during the workshop). In other words, this represents the situation where Fcoy have greater density in areas where they are most often sighted. This is thought to be plausible because of associations between habitat type and sightability;

3) *Inverse sighting scenario*.—An inversely concentrated spatial distribution scenario, in which F_{COY} locations were deliberately concentrated in areas where relatively few had actually been observed (this was initially labeled "low" during the workshop).

Note that each scenario was built relative to a spatial distribution of historic F_{COY} observations, but this distribution was itself an unknown mixture of true F_{COY} distribution and detection probability given true presence (which itself was likely a function of vegetation cover and human density in the area).

6. Estimate the number of F_{COY} actually present from those estimated to have been observed using ancillary data resampling (ADR).

As described in the section on the Knight et al. (1995) rule set, we need to be able to estimate the Fcoy population size in any year, not merely the number seen (to avoid yearly heterogeneity caused by variable sighting effort and conditions, i.e., Mattson 1997, others). The current algorithm does this by way of a frequency-of-capture approach (Chao2; see Keating et al. 2002, Cherry et al. 2007). The ADR approach avoids the 2-step nature of this process by directly estimating the number of F_{COY} actually present (i.e., accounting for those never seen in any given year) in a hierarchical Bayesian framework that simultaneously assesses the posterior distribution of F_{COY} observed and those truly present. In any case, these relationships will depend on the assumed spatial juxtaposition of F_{COY}, and thus will vary depending on which of the underlying scenarios is used to develop it. Because 3 different scenarios (i.e., superpopulations) were developed, 3 slightly different versions of the model are considered.

7. Preliminary tests of the ADR approach

It was deemed appropriate to test how the method would perform using data generated under a model different from the one being fit (i.e. supposing the assumed superpopulation describing the spatial distribution is incorrect). During the July 2011 meetings, Dr. Higgs presented the preliminary results of the method when applied to the 3 alternative “superpopulations” of bears from which samples were taken. Each superpopulation reflected an alternative hypothesis about the true spatial distribution of F_{COY} (not just those observed) within the GYE relative to distribution evident from only radio-marked bears.[a] Simulation provides an easy and intuitive way to evaluate the performance of the models under known data-generating models. With 3 models specifying the possible relationships among the known and unknown factors, and 3 sampling scenarios, we had 9 sets of simulation results to examine for any given postulated true number of F_{COY} in the population.

Results of these simulations yielded the following conclusions:

1) Bias in the predicted number of F_{COY} observed was negligible when sampling from the same scenario as the model used to develop it, except when the distribution was based on the high scenario, in which case it was always biased low, by about 8–10%.

[a] In all 3 scenarios, locations of F_{COY} marked using conventional VHF telemetry collars were retained in their original spatial positions. Because F_{COY} marked using GPS collars had many more locations from which to sample, these locations were the ones that were used to “fill-out” the superpopulations, and were placed on the landscape according to an algorithm that objectively reflected the assumptions of each scenario.

2) Widths of approximate 95% credibility intervals of the means of posterior distributions of observed F_{COY} were 11 to 13% of the mean when population size was small, and 7 to 11% of the mean when population size was large;

3) Bias in the predicted number of F_{COY} actually present was rather large and depended greatly on the data underlying the model generation and the scenario used for data sampling under the ADR. For example, when applying a model developed under the proportional sighting scenario to data sampled using the inverse sighting scenario (Table 6, first line), bias was about -23%; when applying a model developed under the inverse sighting scenario to data sampled using the uniform scenario, bias was +31%. We note that the inverse sighting scenario was chosen to assess the influence of an extreme superpopulation. Therefore, these estimates of bias are likely exaggerated.

4) Widths of approximate 95% credibility intervals of the means of posterior distributions of estimated F_{COY} actually present were large, often exceeding 100% of the true number. For example, when the true number of F_{COY} was 55, and the model using the uniform scenario was applied to samples selected from the inverse sighting scenario, the 95% credibility interval of the number of F_{COY} predicted, although almost unbiased, ranged from 38 to almost 78.

We have no way of knowing which of the scenarios used to develop the superpopulations was close to the true superpopulation and, in fact, do not know if a different scenario altogether may be more representative of the true superpopulation. Therefore, we have no way of choosing among the models or superpopulations for resampling. Although the method was shown to be potentially unbiased and to track population trends reliably when applied to a single hypothetical map (e.g., that produced by Schwartz et al. 2008), it was not consistently unbiased nor precise when applied to an array of data that represented hypotheses we felt must be considered given our uncertainty about the true spatial distribution of F_{COY} on the GYE landscape.

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Appendix C

Counts of known and probable mortalities by categories for independent aged female grizzly bears under alternative count lines, Greater Yellowstone Ecosystem, 1986–2010. Sustainability is set at 9% of the estimated population size for independent-aged females.

	Inside USFWS suitable habitat (proposed)				Inside USFWS conservation management area (current)				
Year	Sanctioned removal	Radioed	Reported	Total	Sanctioned removal	Radioed	Reported	Total	Difference (proposed - current)
1986	1	2	1	4	1	2	1	4	0
1987	1	0	1	2	1	0	1	2	0
1988	0	1	0	1	0	1	0	1	0
1989	0	0	0	0	0	0	0	0	0
1990	1	2	3	6	1	2	3	6	0
1991	0	0	0	0	0	0	0	0	0
1992	0	1	0	1	0	1	0	1	0
1993	0	1	2	3	0	1	2	3	0
1994	0	2	1	3	0	2	1	3	0
1995	3	0	5	8	3	0	5	8	0
1996	1	1	2	4	1	1	2	4	0
1997	0	0	3	3	0	0	3	3	0
1998	0	0	1	1	0	0	1	1	0
1999	0	0	1	1	0	0	1	1	0
2000	0	1	6	7	1	1	6	8	-1
2001	2	3	1	6	5	3	1	9	-3
2002	2	2	4	8	2	2	4	8	0
2003	0	0	5	5	0	0	5	5	0
2004	3	1	5	9	4	1	5	10	-1
2005	0	0	2	2	0	0	2	2	0
2006	0	1	1	2	1	1	1	3	-1
2007	3	2	6	11	3	2	6	11	0
2008	3	1	10	14	3	1	10	14	0
2009	0	3	6	9	0	2	7	9	0
2010	3	2	5	10	6	2	5	13	-3
Total	23	26	71	120	32	25	72	129	-9

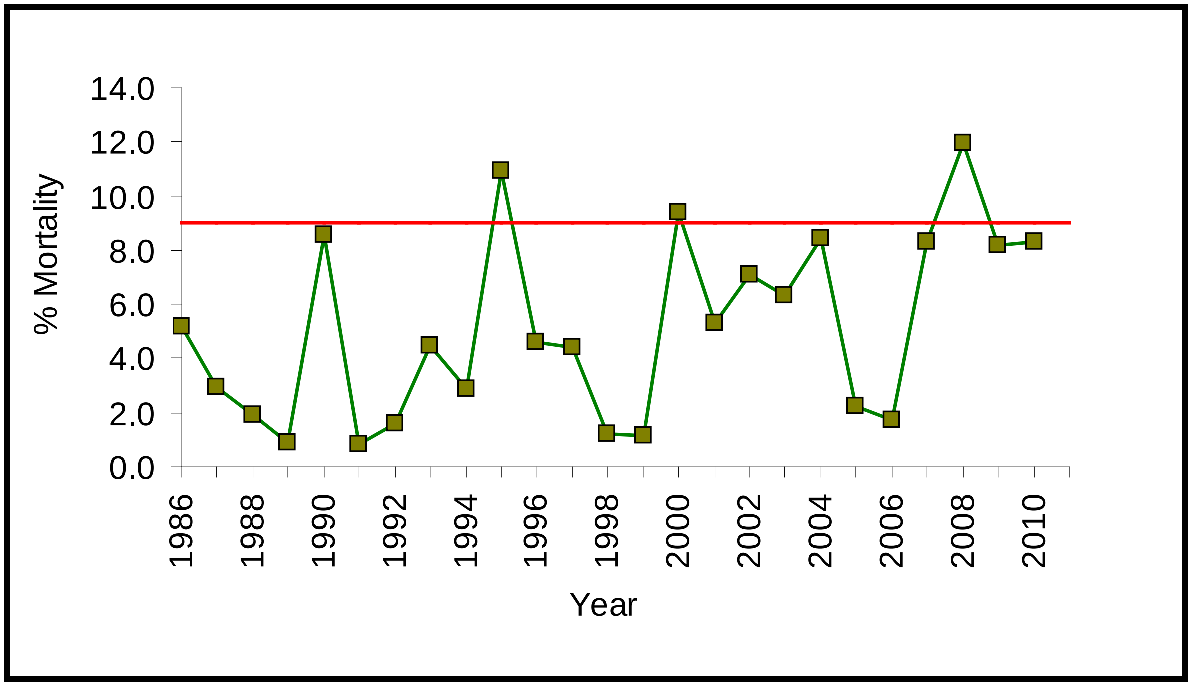
Appendix D

Counts of known and probable mortalities by categories for independent aged male grizzly bears under alternative count lines, Greater Yellowstone Ecosystem, 1986–2010. Sustainability is set at 15% of the estimated population size for independent-aged males.

	Inside USFWS suitable habitat (proposed)				Inside USFWS conservation management area (current)				
Year	Sanctioned removal	Radioed	Reported	Total	Sanctioned removal	Radioed	Reported	Total	Difference (proposed - current)
1986	0	0	1	1	1	0	1	2	-1
1987	1	0	0	1	1	0	0	1	0
1988	2	1	1	4	2	1	1	4	0
1989	0	1	1	2	0	1	1	2	0
1990	0	1	2	3	0	1	2	3	0
1991	0	0	0	0	0	0	0	0	0
1992	0	5	1	6	0	5	1	6	0
1993	0	2	0	2	0	2	0	2	0
1994	4	1	1	6	4	1	1	6	0
1995	2	3	4	9	2	3	4	9	0
1996	2	0	2	4	2	1	3	6	-2
1997	1	1	3	5	1	1	4	6	-1
1998	0	1	0	1	2	1	0	3	-2
1999	2	2	5	9	2	2	5	9	0
2000	1	2	14	17	2	3	14	19	-2
2001	4	2	3	9	7	2	3	12	-3
2002	3	1	5	9	4	1	5	10	-1
2003	1	3	3	7	2	3	4	9	-2
2004	2	2	5	9	3	2	7	12	-3
2005	1	1	2	4	4	1	2	7	-3
2006	1	3	3	7	1	3	3	7	0
2007	1	1	4	6	2	1	4	7	-1
2008	6	5	11	22	7	5	11	23	-1
2009	2	3	5	10	3	2	6	11	-1
2010	8	1	11	20	11	2	13	26	-6
Total	44	42	87	173	63	44	95	202	-29

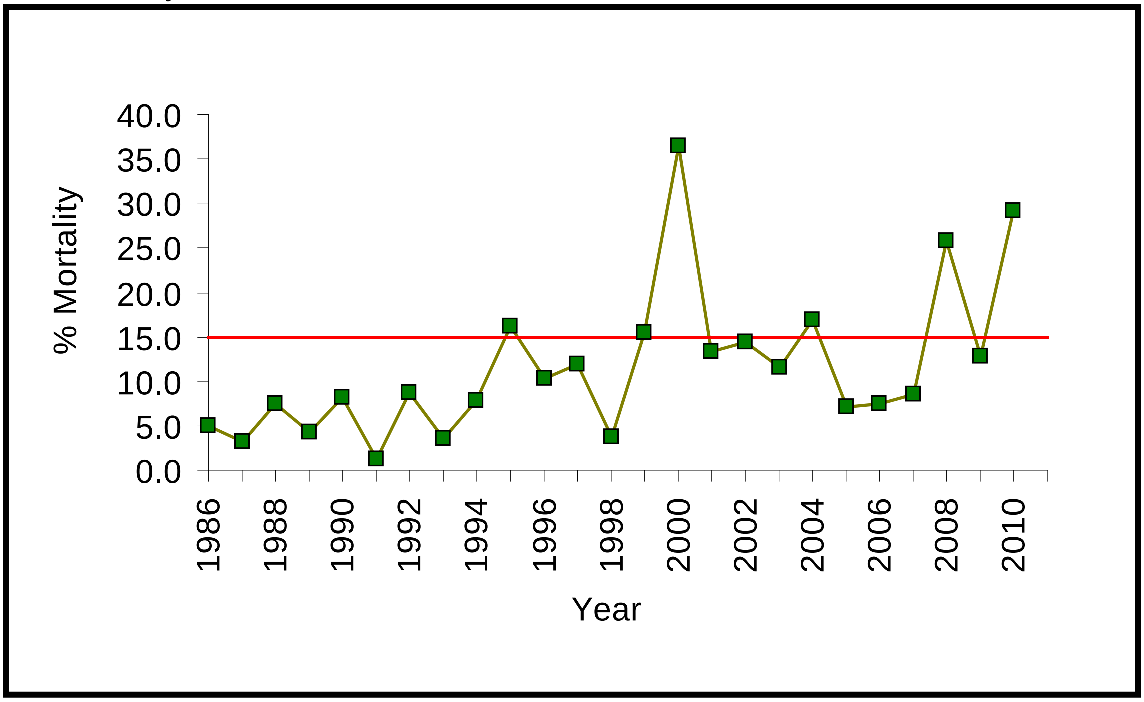
Appendix E

Yearly results for sustainability of independent females under the current 9% mortality limit (red horizontal line), Greater Yellowstone Ecosystem, 1986–2010. Independent female mortalities were exceeded in 3 years under current methods.



Appendix F

Yearly results for sustainability of independent males under the current 15% mortality limit (red horizontal line), Greater Yellowstone Ecosystem, 1986–2010. Independent male mortalities were exceeded in 6 years under current methods.



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Appendix N. Grizzly Bear Management Plan for the Wind River Reservation

Grizzly Bear Management Plan for the Wind River Reservation

Image courtesy of www.firstpeople.us

Eastern Shoshone and Northern Arapaho Tribes
Ft. Washakie and Ethete, WY
&
Shoshone and Arapaho Tribal Fish and Game Department
Ethete, WY

Assisted by the U.S. Fish and Wildlife Service
Fish and Wildlife Conservation Office
Lander, WY

March 3, 2009

3/3/09

Ivan Posey, Chairman Eastern Shoshone Tribe Date

3/3/09

Harvey Spoonhunter, Chairman Northern Arapaho Tribe Date

Summary

- The intent of this plan is to support the co-existence of grizzly bears and people. It looks neutrally upon grizzly bears and considers them as a wildlife species for which management is essential due to tensions that will arise between the needs of grizzly bears and the needs of people. Traditional views of the Eastern Shoshone and Northern Arapaho Tribes (Tribes) recognize grizzly bears as an elder relative, as strong, as great and as deserving of respect and placed here by the Creator for a purpose.
- Tribes have sole authority for managing grizzly bears within the Wind River Reservation (Wind River) boundaries, and will seek assistance from and cooperation with the Yellowstone Grizzly Bear Coordinating Committee (YGBCC, a subcommittee of the Interagency Grizzly Bear Committee), the Interagency Grizzly Bear Study Team (IGBST) and the Wyoming Game and Fish Department (WGFD). Since the Yellowstone Ecosystem grizzly population crosses jurisdictional boundaries, cooperative efforts are necessary.
- Monitoring of the grizzly bear population within Wind River's boundaries will be done by the Tribes working in cooperation with the IGBST. Monitoring protocols and annual reports of monitoring efforts on Wind River will be part of the IGBST's annual reports.
- At this time, the Tribes do not designate a specific number of individual grizzly bears for which it will manage.
- Grizzly bears will likely confine themselves to remote areas in the Owl Creeks and Wind River mountains; however, they may occasionally wander near developed areas.
- Grizzly bears will be managed as a trophy game animal for which a hunting tag is required. Harvest may occur at the discretion of the Tribes' Joint Business Council (JBC) once the grizzly bear population reaches a sustainable size and will manage within the mortality limits as set forth by the Final Conservation Strategy (Conservation Strategy) for the Grizzly Bear in the Greater Yellowstone Area (GYA) 2007.
- Efforts to manage grizzly bears include trapping and radio-collaring, surveying by plane and remote cameras, conducting surveys for cone production on whitebark pine trees, expanding availability of food storage poles and metal containers at trailheads and campsites in the Owl Creek and Wind River mountains, and providing information to the public. Options to handle depredating grizzly bears will be evaluated on a case-by-case basis, and will include but are not limited to: no action, using non-lethal methods, radio-collaring and releasing on-site, relocating or immediate removal by lethal means. Tribes will not reimburse for grizzly bear depredations of livestock.
- This plan applies to all lands within the 1868 exterior boundary of Wind River, as modified by the Lander Agreement of 1872 and Thermopolis Agreement of 1896.

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Introduction

The grizzly bear (*Ursus arctos*) conjures images of power, respect, fear, solitude, and wilderness. Traditional tribal views often hold the grizzly bear in esteem while some contemporary views see them as a serious threat to human safety, competitors, livestock killers and in other negative ways. The intent of this plan is to support the co-existence of grizzly bears and people. Management is essential due to tensions that will arise between the needs of grizzly bears and the needs of people. Grizzlies have the potential to affect resources important to Tribal people such as outdoor recreation, big game populations and livestock. People have the potential to affect grizzly bears by changing habitat and food resources through development, climate change and harvesting of big game. This plan will guide the Tribes in conserving and sustainably managing grizzly bears for this and future generations on all lands within the 1868 exterior boundary of Wind River, as modified by the Lander Agreement of 1872 and Thermopolis Agreement of 1896 (the Lander Agreement removed the South Pass portion of Wind River and the Thermopolis Agreement removed the northeast corner of Wind River in the Thermopolis area).

In 1975, the grizzly bear was designated as threatened under the Endangered Species Act in the lower 48 states. Since then, its population grew and expanded throughout the GYA, including Wind River (Schwartz *et al.* 2006). In 2007, the grizzly bear was delisted and primary management was turned over from the federal government to the states and tribes. The Conservation Strategy requires a minimum of 500 grizzly bears be maintained in the GYA. As of 2007, there was an estimated 571 grizzly bears in the GYA (Schwartz *et al.* 2008).

Coordination between parties involved in grizzly bear conservation is important, especially since bears routinely cross jurisdictional boundaries. With coordination, mutual benefits occur between parties that ultimately lead toward better conservation and management of grizzly bears. The Tribes are members of the YGBCC, which is the local sub-committee of the IGBC that is responsible for overseeing conservation of grizzly bears in the GYA. Tribes are also in the process of establishing a cooperative Memorandum of Understanding with the IGBST. The IGBST is an interdisciplinary group of scientists and biologists responsible for long-term monitoring and research efforts on grizzly bears in the GYA, and works closely with the IGBC. The Memorandum of Understanding will allow assistance and data-sharing to occur.

The Lander Fish and Wildlife Conservation Office (LFWCO) of the FWS has had a long and productive relationship assisting the Tribes in managing their fish and wildlife resources on Wind River since 1941. The JBC and TFG were assisted by the LFWCO in developing this plan.

Tribal Elder Views

Interviews of Shoshone and Arapaho Elders were conducted from August 2005 to February 2007. Visits were made to the Ft. Washakie, Ethete and Arapaho senior centers, Rocky Hall, individuals' homes, the Tribal College, and the Shoshone Cultural Center. During these interviews traditional history, stories, meanings, and memories along with current opinions were obtained and collated into the following:

Traditional views recognize grizzly bears as an elder relative, as strong, as great, as master of the forest and as deserving of respect and placed here by the Creator for a purpose. The Shoshone word for grizzly bear, "Bee-yah-ah-gwy" means "big bear." Grizzlies were like a wise uncle that knew best. When appearing in a vision, one was to follow what the grizzly bear showed you. Both Shoshones and Arapahos have a traditional Pow Wow dance honoring the grizzly bear.

Grizzlies were to be left alone and people were supposed to be careful around them. Bears generally wouldn't bother you; however, sometimes people had to kill them. If they were killed, then all parts were to be used. Bear oil was used to treat arthritis, rugs were used to stay warm and of course the meat was eaten. Claws were used in decorative dress and were worn by men because it was impressive and showed high status. A segment of the Arapahos' are members of a bear clan and see the grizzly bear as sacred. Members of the clan are not supposed to harm the bear.

Grizzlies modeled virtuous things to people such as strength, independence and care for family. One traditional story told of a bear family that stayed in a cave, caring for their young. The bear talked to an old man and told him that they were very much alike - that it had a family just like the man and was trying to care for them and to exist just the same. The grizzly bear, along with other animals, used to talk with people through telepathy.

As for current opinions, some Elders said that grizzly bears should be protected. Some said grizzly bears were dangerous and to stay away from them. Another mentioned that as long as grizzly bears stayed away from her house, she was OK with them. One man wanted the Business Councils to talk with the elders directly and ask the elders themselves for their input.

Biology and Current Status

Biology: Grizzly bears are large omnivores averaging 425 pounds for males and 295 pounds for females in northwest Wyoming (Schwartz *et al*. 2006). However, weight varies greatly during the year due to a bulk-up in fall that sustains them during winter hibernation. Females generally have a litter size of 2, breed every 3 years and have their first litter at age 4 to 6. Females peak reproductively at about 9 years and can produce cubs until 25 years of age. Breeding occurs between mid-May and mid-July. Typical annual survival rates are 0.77 for adult males, 0.94 for adult females, 0.80 for subadult females, and 0.84 for cubs. Home range size for females and males in northwest Wyoming averaged 105 mi^2 and 325 mi^2, respectively (Schwartz *et al*. 2006).

Feeding Habits: Grizzly bears consume a wide variety of vegetation, insects and mammals (Schwartz *et al.* 2003). Foods of major importance include whitebark pine cones (*Pinus albicaulis*), army-cutworm moths (*Euxoa auxiliaries*), elk calves (*Cervus canadensis*) and ungulate carcasses. Whitebark pine cones are an important high-quality food source for grizzly bears, particularly during the late summer and fall (Mattson and Reinhart 1994). Substantial whitebark pine stands occur in both the Owl Creek and Wind River mountains (Figures 1 & 2). Bear-human conflicts are often reduced during years in which cone production is high because bears remain in high elevation areas where whitebark occurs and are thus distant from human developments (Mattson and Reinhart 1994).

Grizzly bears' reproductive success increases during years of abundant cone production (Mattson and Jonkel 1990). Blister rust and pine beetle infestations throughout the west are causing major declines in whitebark (Keane and Arno 1993). This too is apparent on Wind River as large stands of whitebark are succumbing to pine beetle as evidenced by the red-topped trees in Figure 3. Tree mortality appears to be more prominent in the Owl Creek Mountains; however, stands in the Wind River Mountains are showing effects as well.

Army-cutworm moths aggregate in large masses under high alpine talus slopes throughout the Absaroka and Wind River Mountains. These moth aggregation sites are an important high-quality food source for grizzly bears (Mattson *et al.* 1991) and can comprise nearly ½ of their annual caloric intake (White 1996). There are 2 known army-cutworm moth sites in the Absaroka Mountains that have been visited by grizzly bears that were radio-collared on Wind River in 2006. Additional moth sites do occur in the Wind River Mountains, but at this time grizzly bears have not been observed using them (Dave Moody, personal communication 2007).

Elk calves, winter-killed ungulate carcasses and gut piles from harvested big game provide a major source of protein-rich food for grizzly bears. In a 3-year study in Yellowstone National Park, black and grizzly bears accounted for 55 to 60% of mortalities of elk calves that were less than 30 days old (Barber *et al.* 2005). Estimates of wintering ungulates on Wind River are: 6500 to 7500 antelope, 3200 to 4800 deer, 7000 to 9000 elk, 100 to 200 moose, and 350 to 450 bighorn sheep. In 2007, approximately 1,130 Tribal hunters harvested 96 pronghorn antelope, 495 deer, 527 elk, 3 moose, and 16 bighorn sheep. Gut piles from harvested big game provide an important food source for grizzly bears prior to entering the den (Dave Moody, personal communication 2008).

Stands of whitebark pine in the Owl Creek Mountains

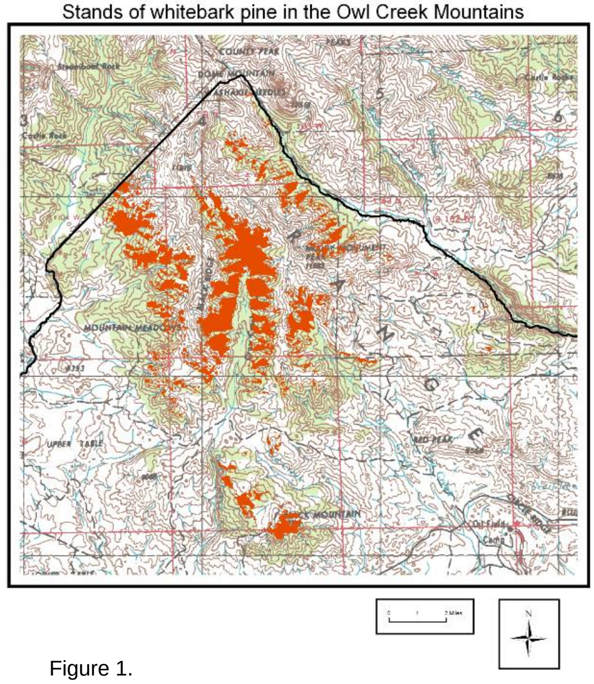

Figure 1.

Stands of whitebark pine in the Wind River Mountains

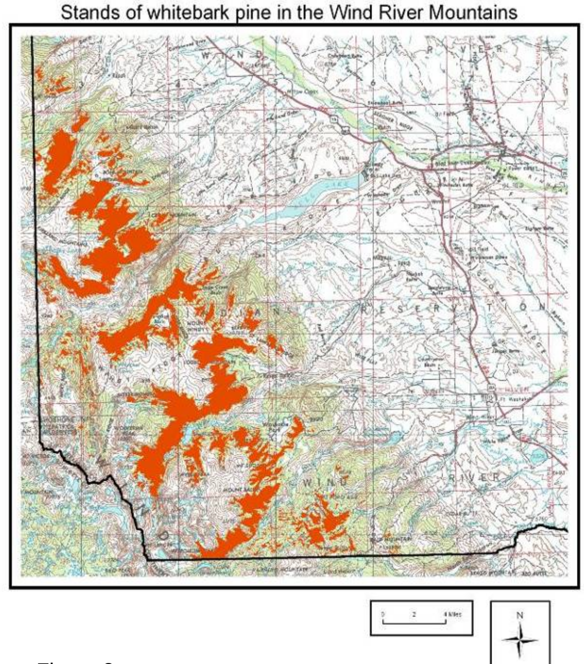

Figure 2.

Figure 3. Dying and dead whitebark pine due to pine beetle infestation, Trail Ridge, Owl Creek, 2007.

Available Habitat: The vast majority of Wind River's 2,260,000 acres is remote and sparsely populated. Elevations range from 4,500 to 12,250 feet. Habitat types include desert, grassland, shrubland, agriculture, montane, and alpine. Specifically, 458,000 acres are forests, 1,290,000 acres are shrubland, and 183,000 acres are grassland and alpine meadow. There are at least 734,000 acres of potential grizzly bear habitat with 161,000 acres and 100,000 acres currently occupied by grizzly bears in the Owl Creek and Wind River mountains, respectively (Figure 4).

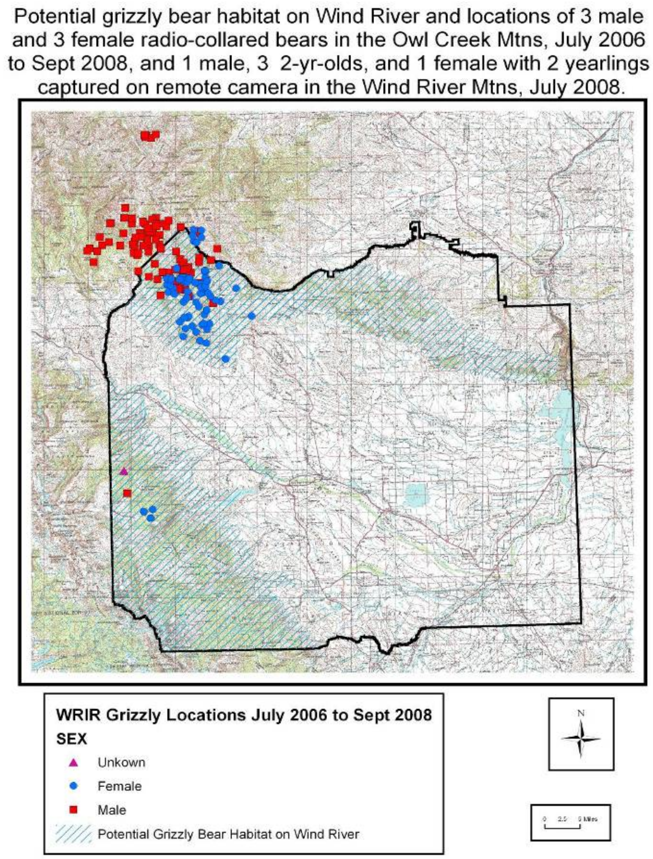

Figure 4.

Current Population Status: As of September 2008, there were 3 grizzly bears with active radio-collars in the Owl Creek Mountains. These included #531 (a 10 to 12 yr-old female), #532 (a 5 to 6 yr-old male) and #537 (a 5 to 6 yr-old female) (Figure 4). Bear #459 (an 11 yr-old male) recently dropped its collar in May 2008 and likely still occurs on Wind River. All of these bears were captured and radio-collared in the Crow Creek Basin and East Fork areas during a joint trapping effort between the TFG, WGFD and LFWCO lasting 2 ½ weeks in July and August 2006 (Figure 5). Two additional grizzly bears were radio-collared, however one died in August 2006 and the other dropped its GPS collar in May 2007 (Figure 6). The number of bears trapped during this short period greatly exceeded all expectations.

During July and August 2008, a remote camera study was conducted in the Wind River Mountains between Bob Creek and Bull Lake Creek to document presence and distribution of grizzlies (Lockwood *et al.* 2008). During the 49-day study, there were 8 detections of grizzly bears as follows: an adult female with 2 yearling cubs on 6 occasions in the Kirkland Park area, an adult male on 1 occasion in the Bold Mountain area, and three 2-year-olds in the Bob Creek drainage (Figure 4). Based on the aforementioned data, Wind River has a moderate and expanding population of grizzly bears. Supporting evidence for this observation is that the population in the Greater Yellowstone Ecosystem grew at a 4 to 7 % annual rate between 1983 and 2001 (Conservation Strategy 2007) and has continued to grow since.

Figure 5. TFG wardens Western Thayer, Ben Warren and Herman St. Clair with sedated grizzly bear, Crow Creek, 2006.

Livestock: Though generally not a food source, cattle, primarily calves, can be depredated upon by grizzly bears. In 2 cattle allotments near Blackrock just west of Togwotee Pass, Wyoming, grizzly bears were responsible for 78 of 182 calves that were lost (43%) between 1994 and 1996 (Anderson *et al.* 2002). However, this loss represented only 1 to 2% of the 6,000 calves that ranged on the allotments during that time period. Grizzly bear density was high as there were at least 10 bears on the allotments. Three grizzlies were responsible for 90% of the losses and once removed by management action, calf depredations were reduced dramatically. During this time period fewer than 9 adult cows were depredated by grizzly bears. Cattle are the primary livestock utilizing range on Wind River. There are approximately 135 permittees that ran 23,100 cow/calf pairs utilizing 163,400 Animal Unit Months on Tribal lands in 2001 (Bureau of Indian Affairs 2002). Approximately 140 horses also ranged on these lands. There are no free-ranging domestic sheep or other livestock utilizing Wind River.

Areas of use for grizzly bear #538 (5 yr-old male) between Aug 2006 - May 2007. GPS collar was used to collect 1,297 locations. Wind River Reservation, WY.

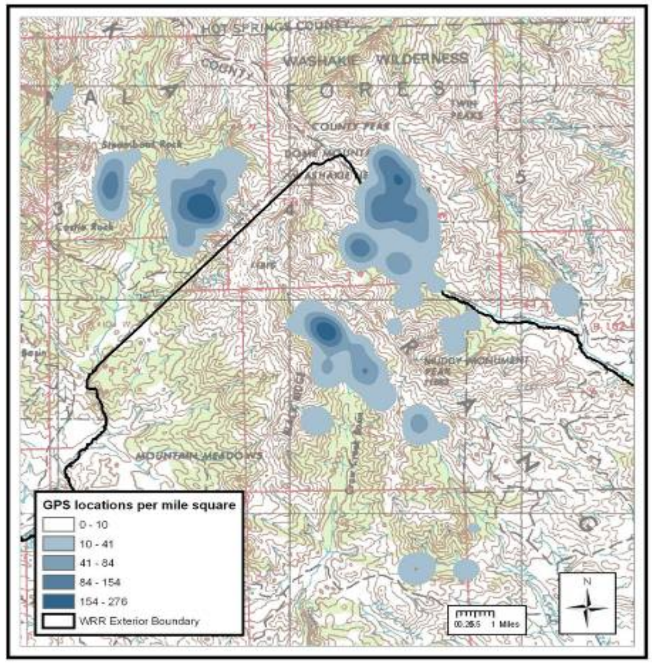

Figure 6.

Management

As mentioned previously, this plan attempts to balance the needs of grizzly bears and the needs of people. In order to do this, adequate knowledge of the distribution and population size of grizzlies is essential. With this knowledge, appropriate management decisions can be made that will ensure Wind River's grizzly bear population will be sustained in perpetuity for the benefit of the bear and the benefit of current and future tribal members, while allowing removal of bears as needed for the protection of human safety and personal property.

Population Monitoring: Methods for monitoring include radio-collaring, remote camera surveys, aerial surveys, and public reports. Trapping and radio-collaring efforts will adhere to approved practices so that grizzly bears are handled humanely and efficiently. Currently, the TFG has one bear trap that was constructed by a TFG warden. A second is planned for construction (Figure 7).

Figure 7. Western Thayer investigating TFG bear trap in Crow Creek Basin, 2006.

As mentioned in the Biology and Current Status section, a cooperative remote camera study was done in the

Wind River Mountains in 2008 (Figure 8). Excellent data were obtained on the distribution of grizzly bears in the northern third of the Wind River Mountains, from Bob Creek to Bull Lake Creek. A similar study will be conducted on the southern two-thirds of the Wind River Mountains between Bull Lake Creek and Trout Creek within the next 2 years. This will further our knowledge of distribution throughout the remaining portion of the Wind River Mountains located on Wind River.

Telemetry flights are an important monitoring tool. Flights for the 3 radio-collared grizzly bears in the Owl Creek Mountains will continue to be contracted by the WGFD. Flights typically occur every 10 days beginning in April and continuing until it's documented that a bear has denned, usually in November or December. Monitoring radio-collared bears provides important information related to distribution, seasonal habitat utilization, dates of denning, den site selection, cause of death, and survival rates by age and sex class.

Figure 8. Grizzly female with yearling cubs captured by digital image during remote camera survey, 2008.

Another important monitoring method are summer observation flights. Members of the IGBST conduct annual survey flights throughout the GYA. In 2007, 74 flights were conducted, each lasting approximately 2.5 hours (IGBST 2007). Aerial monitoring will involve conducting 2 summer surveys of 2 to 2.5 hours in length in each of 3 observation units: West Owl Creek (#46), North Wind River (#48) and South Wind River (#49) (Figure 9). All grizzly bears observed will be plotted with GPS and recorded to age and number in group. Females with cubs-of-the-year (COY) are especially important to document. The number of females with COY are used to estimate population size and the allowable mortality thresholds for the entire ecosystem. Typically, a pilot and one observer conduct the survey. Currently, there is a shortage of flight services that can conduct these surveys. Sky Aviation, the company that performs these flights in this part of Wyoming, may have difficulty conducting addtional flights on Wind River due to limited staff and equipment (Dave Stinson, personal communication 2008). Another flight service may be available in 2009. All data from flights will be provided to the WGFD and the IGBST for inclusion in the Yellowstone ecosystem database maintained by the IGBST.

Grizzly Bear Observation Units and Summer Aerial Search Areas on the Wind River Reservation.

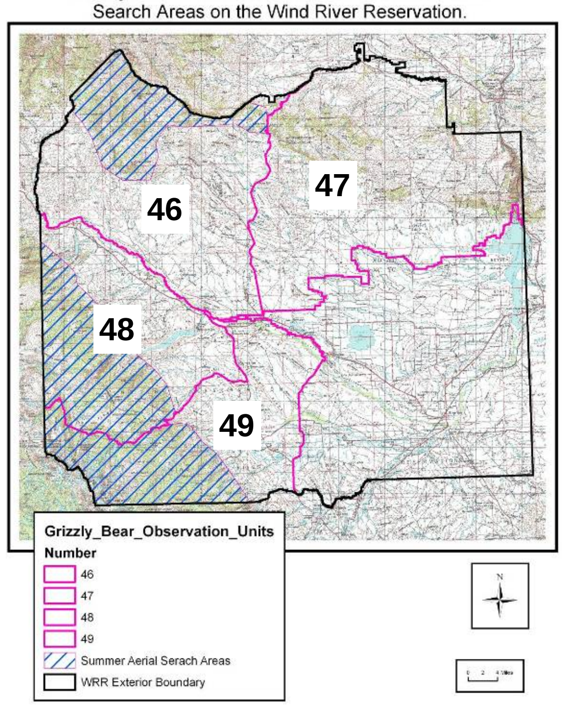

Figure 9.

Population Management: Tribes have the sole responsibility for managing grizzly bears on Wind River, but will seek assistance from and cooperation with the

IGBST and WGFD. At this time, the Tribes do not designate a specific number of grizzly bears for which it will manage, and future strategy will depend on the number of grizzly bears present on Wind River and the direction the Tribes wish to take.

Occasionally, grizzly bears may conflict with people. For example, a hungry bear becomes habituated and spends an inordinate amount of time around human developments, threatening human safety. Or, a grizzly bear becomes a habitual livestock depredator. These are termed "Grizzly Bears of Concern" and will require management action (see Table 1 below for further discussion). Removal of grizzly bears by management action takes precedence over hunter harvest.

Relocating Grizzly Bears of Concern to areas outside Wind River is an option. Prior to relocating, TFG personnel will contact the WGFD to coordinate an appropriate release area and to ensure that bears are radio-collared with the appropriate frequency. Once a grizzly bear is moved off Wind River, it becomes the jurisdiction of the WGFD. Personnel from the Bridger-Teton National Forest (BTNF) and Shoshone National Forest (SNF) indicated that they are willing to accept livestock depredating bears. When relocating is desired, the TFG will contact the North Zone Wildlife Biologist for the BTNF in Jackson or the Wildlife Biologist for the SNF in Cody who will then contact their respective Forest Supervisor for approval. Personnel with Yellowstone National Park stated that it's highly unlikely that they will accept grizzly bears from Wind River since they do not accept bears from anywhere outside the park.

Once the grizzly bear population is of a sustainable size, the Tribes may allow hunter harvest if so desired. Currently, the grizzly bear is designated as a trophy game animal for which the season is closed. Given the limited number of grizzly bears on Wind River and within the GYA, the season may remain closed for a period of time. Because individual grizzly bears each require vast areas of secure habitat and because this habitat is relatively limited on Wind River, the population will remain small. Consequently, when hunter harvest is allowed, take will be very limited to help ensure future sustainability of the population.

Once hunter harvest is allowed, the season timing and length, harvest quota and other specifics will be proposed annually by the TFG and LFWCO for approval by the JBC in accordance with the following requirements:

- The Tribes will attempt to follow mortality limits as laid out in the Conservation Strategy. Mortality from all causes should not exceed 15% for males $\geq$2 yrs-old and 9% for females $\geq$2 yrs-old in order to sustain grizzly populations. Types of mortalities include known natural-caused and all human-caused such as human-related accidents, management action, and hunter harvest.
- Tribal hunters must posses a grizzly bear tag issued by TFG.
- Selection of hunters will be by random drawing.
- Young or females with young may not be harvested.
- Hunters will be required to report harvest to the TFG and the LFWCO within 72 hours. The LFWCO will record all known removal (harvest, management action, illegal, accidents and any other removal) and provide this information to the TFG and IGBST. All mortality information will be provided to the IGBST as soon as possible by phone, preferably within 24 hours of the mortality. This rapid reporting will allow the IGBST to keep track of the annual mortality levels throughout the ecosystem to help assure the mortality limits are not exceeded.

Table 1. Summary of take. Take means removal of a grizzly bear by placing in captivity, relocating to another location, or killing and may occur in the following instances:

Provision	Allowance
Take in self defense.	Any person may take a grizzly bear in self defense or the defense of others.
Protection of human life and safety.	The Tribes may promptly remove any grizzly bear determined by the Tribes to be a threat to human life or safety.
Tribal government take of Grizzly Bear of Concern.	''Grizzly Bear of Concern'' is defined as a grizzly bear that attacks humans or any domestic animal including livestock, dogs (excludes hounds that are in pursuit of a bear), and livestock herding and guarding animals, damages personal property, or becomes habituated to human food and/or people and spends an inordinate amount of time around human developments, threatening human safety. Management removal by TFG or other authorized personnel will occur on a case-by-case basis and will consider history of offending bear's behavior, threat to human safety, evidence of the attack, potential for future conflicts, degree of damage, presence of unusual grizzly bear attractants, any previously specified animal husbandry practices that have been implemented, effectiveness of other methods, etc. Non-lethal methods (relocating, hazing, rubber bullets, electric fencing, etc.) will be considered on a case-by-case basis when depredation has occurred. Lethal removal will be used if non-lethal methods are impractical and ineffective.
Additional take provisions for Tribal government employees.	Authorized tribal agents (i.e., employees of the TFG authorized by the JBC to manage grizzly bears), acting in the course of official duties, may take a grizzly bear from the wild, if such action is for: (1) scientific purposes; (2) to avoid conflict with human activities; (3) to relocate a grizzly bear to improve its survival and recovery prospects; (4) to aid or euthanize sick, injured, or orphaned grizzly bears; (5) to salvage a dead specimen which may be used for scientific study; and (6) to aid in law enforcement investigations involving grizzly bears.
Hunter Harvest by enrolled member.	Under authorization of the JBC, the TFG may issue tag(s) that allow for the harvest of grizzly bear(s) by licensed hunters during approved seasons. Hunters must apply for a tag and be entered into a random drawing. At the writing of this plan, the grizzly bear season is closed.

Bear Depredations: Grizzly bears will likely spend the bulk of time in remote areas of the Owl Creeks and Wind River mountains where the majority of suitable habitat resides. Cattle are also present in these areas during the late spring, summer and fall and may be subject to grizzly bear depredation. Grizzly bears may also occasionally occur in lower elevation sagebrush uplands and near agricultural lands. Cattle are present in these areas during winter months and calving season. Consequently, grizzly bears may kill livestock and may need to be relocated or lethally removed. This will be assessed on a case-by-case basis as mentioned above. Compensation for livestock losses will not be provided by the Tribes. The Tribes will cooperate with and utilize assistance offered by the LFWCO, Animal and Plant Health Inspection Service (APHIS) - Wildlife Services and WGFD when capturing or lethally removing grizzly bears. All mortality due to removal of depredating bears will be provided to the IGBST as soon as possible by phone, preferably within 24 hours of the mortality. TFG personnel have received and will continue to receive training in determining grizzly bear kills of livestock, capturing techniques, and appropriate care and handling. Any illegal take will be investigated by the TFG in cooperation with the local Special Agent of the FWS if desired.

A typical depredation scenario is as follows:

- A livestock owner finds a dead calf in his pasture. He covers the carcass with a tarp to protect the scene. He notifies the TFG.
- TFG contacts the local APHIS Wildlife Services personnel and/or the LFWCO for assistance if needed. TFG visits scene and determines whether calf was killed by a grizzly bear.
- TFG will discuss options with owner to determine course of action. Actions could include: no action to see if depredation continues; attempt to trap and radio-collar grizzly bear to assess presence near livestock and identification of grizzly bear if depredation

continues; relocate grizzly bear; remove livestock carcasses or other items that may be acting as an attractant; suggest confining or moving livestock if feasible to deter future depredation; consider using non-lethal methods such as rubber bullets and the like; or lethally remove grizzly bear by shooting or trapping and euthanizing humanely.

Habitat Management: New human developments (wind turbines, oil and gas wells, homesites, and the like) should be avoided or minimized within occupied grizzly habitat. The density of roads, the vehicular use of those roads, and human developments have a major impact on how suitable an area is for grizzly bears (Conservation Strategy 2007). The BIA's Wind River Reservation Forest Management Plan (2004) recognizes the importance of grizzly bears and their habitat by the following guidelines. The plan has a no net increase in roads in the Wind River Roadless Area and in the Monument Peak area of the Owl Creek Mountains. In addition, throughout the remaining portion of grizzly habitat a road density of 1 mile of open road per $mile^2$ or less will be maintained in order to sustain the integrity and security of grizzly bear habitat.

In order to assess the level of cone production for whitebark pine, transects will be established and surveys conducted each year. A transect was established on Bold Mountain in August 2008. Additional sites will likely be established in Washakie Park and on Trail Ridge. On each transect, 10 trees are marked permanently and all cones attached to the tree from that year are counted. These are recorded and sent to the IGBST annually.

Food Storage: Minimizing contact of bears with non-natural foods is an effective method of reducing bear habituation to people. Habituation can result in a bear becoming a threat to human safety and personal property (IGBST 2008). The TFG has erected food poles at campsites in Crow Creek Basin and will be installing metal storage containers as well. Efforts will be expanded to include the Wind River Mountains. In bear habitat, homeowners will be encouraged to store garbage, grain, etc. in bear-proof buildings or containers. For those with beehives, use of electric fencing will be encouraged. To further minimize human/bear conflicts, the prohibition of baiting bears will continue.

Public Outreach: The TFG and LFWCO will be jointly responsible for the creation and distribution of outreach materials. Pamphlets will be developed for handout to tribal hunters and other interested individuals and will provide information on grizzly bears biology, tribal management, depredation protocols, etc. This will also be incorporated into existing outreach programs (for example, hunter safety). Signage will be installed and maintained in bear habitat and backcountry users will be encouraged to carry pepper spray. Sample signs that encourage good food storage in bear habitat and that help differentiate black bears from grizzly bears are attached in Appendix A.

Disposition of Grizzly Bear Parts: Grizzly bear parts resulting from confiscation of illegal harvest or from management removal will be housed by TFG and disseminated at the discretion of the JBC for religious, cultural, traditional and/or educational purposes. Sale of parts disseminated by the JBC is not permitted. To obtain a grizzly bear part, a tribal member must submit a letter of request to the TFG stating the intended use and purpose. Once received, a minimal delay may occur in order to confirm the legitimacy of the request with the JBC. Surplus parts may be donated for educational purposes to schools on Wind River.

Definitions

APHIS: Animal and Plant Health Inspection Service.

BTNF: Bridger-Teton National Forest.

COY: cubs-of–the-year. These are cubs that are < 1 year old.

Depredation: a grizzly bear attack that resulted in the immediate or recent (< 1 week) death of a domestic animal.

Domestic animal: animals that have been selectively bred over many generations to enhance specific traits for their use by humans, including use as pets. This includes livestock and dogs (excludes hounds that are in pursuit of a bear).

Enrolled Member: a person officially recognized by the Eastern Shoshone or Northern Arapaho as a member of their tribe.

FWS: US Fish and Wildlife Service.

GYA: Great Yellowstone Area – portions of Wyoming, Montana, and Idaho near Yellowstone National Park, including Wind River.

Grizzly Bear of Concern: a grizzly bear that attacks humans or any domestic animal including livestock, dogs (excludes hounds that are in pursuit of a bear), and livestock herding and guarding animals, damages personal property, or becomes habituated to human food and/or people and spends an inordinate amount of time around human developments, threatening human safety.

IGBC: Interagency Grizzly Bear Committee – a multi-agency group created in 1983 to lead the effort to recover the grizzly bear in the lower 48 states.

IGBST: Interagency Grizzly Bear Study Team - an interdisciplinary group of scientists and biologists responsible for long-term monitoring and research efforts on grizzly bears in the Greater Yellowstone Area. Representatives are from the U.S. Geological Survey, National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, Montana State University, and the states of Idaho, Montana, and Wyoming. The Tribes are currently working on a cooperative MOU with the IGBST.

JBC: Joint Business Council of the Eastern Shoshone and Northern Arapaho Tribes.

Livestock: cattle, sheep, horses, mules, domestic bison, and herding and guarding animals (llamas, donkeys, and certain breeds of dogs commonly used for herding and guarding livestock).

LFWCO: FWS Lander Fish and Wildlife Conservation Office.

Private land: all land that is not under Federal Government ownership and administration. Tribal land is considered private land.

Remove: place in captivity, relocate to another location, or kill.

SNF: Shoshone National Forest

Take: to remove.

TFG: Shoshone and Arapaho Tribal Fish and Game Department.

Tribal land: Tribal trust, allotted, and fee-title Indian-owned land within the exterior boundaries of Wind River.

Tribes: the Eastern Shoshone and Northern Arapaho Tribes of the Wind River Reservation.

Ungulate: hoofed animal.

WGFD: Wyoming Game and Fish Department

YGBCC: Yellowstone Grizzly Bear Coordinating Committee – the local sub-committee of the IGBC responsible for the Greater Yellowstone Area. Tribes are members.

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Mark Haroldson	Interagency Grizzly Bear Study Team, Wildlife Biogst.	406-994-5042	570-7754	mark_haroldson@usgs.gov
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Roy Brown	US Fish and Wildlife Service, Special Agent	307-332-7607		Roy_brown@fws.gov
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Tracy Frye	APHIS Wildlife Services	307-850-4015		

Appendix A.

FOOD STORAGE

Protect your family and wildlife. Store all foods and attractants properly. Make them unavailable to wildlife at night and when unattended during the day.

ATTRACTANTS ARE:

Food, beverages, toiletries, game meat, carcass parts, processed livestock food, pet food and garbage.

UNAVAILABLE MEANS:

- **Hung at least 10 feet high and 4 feet from any vertical support.**
- **Stored inside a bear-resistant container or hard sided vehicle.**
- **Game meat, if properly stored, at least 100 yards from sleeping area, recreation site, or Forest Service Trail System.**

- **Game meat, if left on the ground, at least one-half mile from any sleeping area or recreation site, and 200 yards from a Forest Service System Trail.**

Coolers ARE NOT Bear-Resistant!

BEAR SAFETY FOOD STORAGE PRECAUTIONS STRONGLY RECOMMENDED BETWEEN MARCH 1 AND DECEMBER 1.

PLEASE KEEP A CLEAN CAMP!

www.IGBConline.org

Montana Fish, Wildlife & Parks

Center For Wildlife Information
www.BeBearAware.org

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HUNTERS
KNOW YOUR BEARS
Grizzlies are protected by State and Federal Law

Black Bear

Grizzly Bear

Color and Size can be misleading
Look for a combination of characteristics.

- Color varies from blond to black.
- No distinctive shoulder hump.
- Rump is higher than front shoulders.
- Face profile is straight.
- Ears are tall and pointed.
- Front claws are 1-2 inches long and curved to facilitate climbing. Claw marks are not usually visible in tracks.

- Color varies from blond to black.
- Distinctive shoulder hump.
- Rump is lower than shoulder hump.
- Face profile is dished in.
- Ears are short and rounded.
- Front claws are 2-4 inches long, depending on the amount of digging the bear does, and are slightly curved. Claw marks are usually visible in tracks.

Montana Fish, Wildlife & Parks
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Center For Wildlife Information
www.BeBearAware.org

Appendix P. Memorandum of Agreement Regarding the Management and Allocation of Discretionary Mortality if Grizzly Bears in the Greater Yellowstone Ecosystem

Wyoming Game and Fish Commission

Wyoming Game and Fish Department

Montana Fish and Wildlife Commission

Montana Fish, Wildlife and Parks

Idaho Fish and Game Commission

Idaho Department of Fish and Game

MEMORANDUM OF AGREEMENT REGARDING THE MANAGEMENT AND ALLOCATION OF DISCRETIONARY MORTALITY OF GRIZZLY BEARS IN THE GREATER YELLOWSTONE ECOSYSTEM

Among

Wyoming Game and Fish Commission, Wyoming Game and Fish Department, Montana Fish and Wildlife Commission, Montana Fish, Wildlife and Parks, Idaho Fish and Game Commission, and Idaho Department of Fish and Game

This Memorandum of Agreement (MOA) is made and entered into by and among the Wyoming Game and Fish Commission and the Wyoming Game and Fish Department (collectively WGFD), the Montana Fish and Wildlife Commission and Montana Fish, Wildlife and Parks (collectively MFWP), and the Idaho Fish and Game Commission and the Idaho Department of Fish and Game (collectively IDFG), collectively referred to as the Parties.

I. Purpose

The purpose of this MOA is to define the process by which the Parties will coordinate the management and allocation of discretionary mortality of grizzly bears in the Greater Yellowstone Ecosystem (GYE). The Parties enter into this MOA in support of the re-designation of the Distinct Population Segment (DPS) of GYE grizzly bears and delisting of this DPS under the federal Endangered Species Act. The Parties intend this MOA to be consistent with the 2007 interagency *Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area* (Strategy) and individual state management plans, and with revisions to these documents made in conjunction with the delisting process.

II. Background

The Interagency Conservation Strategy Team, with the participation of the Parties and various federal agencies, developed the Strategy to implement regulatory mechanisms, interagency cooperation, and population and habitat management and monitoring, and other actions to ensure continued recovery of the GYE grizzly bear. The Strategy was subject to public comment and scientific peer review. The Strategy's key mechanisms for maintaining a recovered GYE grizzly population are its population and habitat standards, which are based on the recovery criteria originally set forth in the USFWS Recovery Plan. The Strategy incorporated the Parties' individual state management plans that have different, but compatible, management objectives. USFWS has published for public comment draft revisions to the Strategy. The signatories to the Strategy, including representatives of the Parties and federal agencies, will finalize revisions to the Strategy in conjunction with the delisting process.

On February 19, 2016, USFWS approved a draft Supplement to Demographic Recovery Criteria for obtaining public comment. For purposes of this MOA, the Parties assume adoption of the Demographic Monitoring Area (DMA) identified in the 2016 draft

Supplement as the geographic area used to monitor continued achievement of GYE population and distribution objectives. The Interagency Grizzly Bear Study Team (IGBST) and the Yellowstone Ecosystem Subcommittee (YES) of the Interagency Grizzly Bear Committee (IGBC) have recommended the use of the DMA for population monitoring, including mortality monitoring.

USFWS' draft 2016 Supplement would use a recovery criterion for a conservative total population size of at least 500 GYE bears. This minimum population size includes a conservative buffer in addition to the recommendation of Miller and Waits (2003) for a minimum population size of at least 400 bears to adequately mitigate the potential effects of genetic drift and inbreeding depression in light of the relative isolation of the GYE population. This draft 2016 recovery criterion would also reflect a goal of at least 48 females with cubs in the DMA. For purposes of this MOA, the Parties assume the conservative criterion for minimum population size and number of females with young will apply.

USFWS' draft 2016 Supplement would keep in place the conservative recovery criterion for female occupancy standards in the Primary Conservation Area (PCA). For purposes of this MOA, the Parties assume this conservative criterion will remain in place.

The demographics and vital rates of the GYE population have changed over time. USFWS' draft 2016 Supplement proposes a revision to mortality standards to reflect changes in these rates to ensure a total GYE population of at least 500 bears and to meet the occupancy standard for female bears. For purposes of this MOA, the Parties identified adjustable mortality rates (see Paragraph IV. 2) to manage human-caused mortality within the DMA to levels that will sustain a population range based on the 2002-2014 model-averaged Chao2 population estimate of 674 grizzly bears within the DMA (95% Confidence Interval = 600 to 747).

Adjustable mortality levels allow for higher or lower mortality rates and correspond to the upper and lower 95% confidence intervals of the 2002-2014 model-averaged Chao2 estimate. Adjustable mortality rates enable the Parties to address higher human-bear conflict levels that may occur when the bear population is well above the population recovery criterion. They also ensure the population stays above the recovery criterion of a minimum population size of 500 animals in the GYE. The Parties will review the population vital rates and demographics (compiled by IGBST) a minimum of every 5 years to recommend appropriate adjustments to mortality rates.

From 2002 to the present, the IGBST has used the Chao2 estimator and model averaging process to calculate population size on an annual basis. As the bear population has grown, the model-averaged Chao2 estimates have become increasingly conservative (i.e., prone to underestimation). The IGBST has also made population estimates more recently using a mark-resight based technique (IGBST Report, 2012). The mark-resight approach has no known density-associated bias, and should better reflect actual bear abundance; however, current implementation of the approach is less precise than Chao2 at tracking population trend. For purposes of this MOA, the Parties assume that USFWS will, as a matter of best available science and appropriate conservatism, rely on the model-averaged Chao2 estimate for assessing the population size for at least the 5-year post-delisting monitoring period. The Parties recognize that methods for population estimation may change in the future as circumstances warrant and new methods are scientifically vetted and accepted.

III. Definitions

1. "Discretionary mortality" is the amount of human-caused grizzly bear mortality over which agencies have discretionary authority, such as management removals and regulated harvest.

2. "Non-Discretionary mortality" is documented loss over which agencies do not have discretionary authority, such as naturally occurring mortality or human-caused mortality such as illegal shootings, defense-of-human-life shootings, and vehicle collisions.

3. "Greater Yellowstone Ecosystem" (GYE) is defined as that portion of Idaho that is east of Interstate Highway 15 and north of U.S. Highway 30; that portion of Montana that is east of Interstate Highway 15 and south of Interstate Highway 90; that portion of Wyoming south of Interstate Highway 90, west of Interstate Highway 25, Wyoming State Highway 220, and U.S. Highway 287 south of Three Forks (at the 220 and 287 intersection), and north of Interstate Highway 80 and U.S. Highway 30. This definition of GYE was used in the 2007 USFWS rule to designate a distinct population segment (DPS) of grizzly bears under the Endangered Species Act, and to delist that DPS; in 2010 USFWS vacated this rule in response to a court decision. The Parties assume USFWS will re-designate a grizzly bear DPS for the GYE geographic area as defined herein.

4. "The Recovery Zone," also known as the "Primary Conservation Area" (PCA), is the area whose boundaries are approximately depicted on the map attached hereto as Attachment A; the Recovery Zone is divided into 18 Bear Management Units.

5. "Demographic Monitoring Area" (DMA) is the area that includes the Recovery Zone and an additional area surrounding the Recovery Zone, approximately 19,279 mi^2 in area and whose boundaries are depicted on the map attached hereto as Attachment A. The DMA is based on suitable habitat. The DMA is the area within which the GYE population is annually surveyed and estimated and within which the total mortality limits will apply.

6. "Chao2" is the population estimation technique currently used for the GYE population of Grizzly Bears.

IV. Responsibilities

1. The Parties will employ best science and adaptive management approaches to collectively manage grizzly bears within the GYE.

2. To achieve population criteria to support a recovered GYE grizzly bear population, the Parties will:

   a. Maintain a minimum population size of 500 bears within the DMA of the GYE.

      i. The Parties agree to manage the GYE grizzly bear population within the DMA, to at least within the 95% confidence intervals associated with the 2002-2014 long-term average grizzly bear population estimate calculated using the model-averaged Chao2 estimator (i.e., 600-747).

   b. Ensure that 16 of the 18 Bear Management Units within the PCA are occupied by at least one female with offspring over a six-year period, with no two adjacent Bear Management Units unoccupied over a six-year period.

   c. Ensure annual total mortality rates are not exceeded within the DMA for independent males, independent females and dependent young, as set forth in the following table, based on the 2002-2014 model-averaged Chao2 estimate for the total population with 95% confidence intervals (600-747). These adjustable mortality rates were calculated as those necessary to manage the population around the 2002-2014 Chao 2 modeled average ($\bar{X}$= 674; 95% CI = 600-747) which occurred during the time period when the population reached a biological carrying capacity.

	Total Grizzly Bear Population Estimate		
	≤674	675-747	>747
Total mortality rate for independent <u>FEMALES</u>.	<7.6%	9%	10%
Total mortality rate for independent <u>MALES</u>.	15%	20%	22%
Total mortality rate for dependent young.	<7.6%	9%	10%

      i. The Parties agree to achieve this criterion using an adaptive management framework that will include, but not be limited to, the following:

         - If the population is less than 600, the Parties will not allow discretionary mortality unless necessary to address human safety issues.
         - At any population level greater than 600, if total allowable independent male or female mortality is exceeded, the number exceeding the total allowable mortality will be subtracted from the next year's discretionary mortality available for harvest for that gender.

- If a state meets any of its allocated regulated harvest limits at any time of the year, the respective state will cease hunting within the DMA.
- If the total mortality limit for independent males, independent females, or dependent young is exceeded for three consecutive years and the annual population estimate falls below 612 (the lower bounds of the 90% confidence interval), the Parties will evaluate alternatives to reduce discretionary mortality and request IGBST biology and monitoring review. The Parties will consider the results of the IGBST review in determining appropriate changes to the management framework.
- If the distribution of reproductive females does not meet the criterion for Bear Management Unit occupancy, the Parties will request IGBST biology and monitoring review. The parties will consider the results of the IGBST review in determining appropriate changes to the management framework.

3. The Parties will support the IGBST in the annual monitoring of the GYE grizzly bear population.

4. a. The Parties will meet annually in the month of January to review population monitoring data supplied by IGBST and collectively establish discretionary mortality limits for regulated harvest for each jurisdiction (MT, ID, WY) in the DMA, so DMA thresholds are not exceeded, based upon the following allocation protocol.

   - Begin with DMA Chao2 total population estimate and estimates for independent males, independent females, and dependent young (demographic classes) for the previous calendar year, as reported by the IGBST.
   - Determine the maximum allowable mortality limit for each demographic class based on the mortality rates identified in the table above.
   - Determine total mortality during the previous calendar year for each demographic class.
   - Subtract the previous year's total mortality from the maximum allowable mortality limit for each demographic class. If the difference is negative (*i.e.,* a DMA annual mortality limit is exceeded for any of the three classes), the number of mortalities above the limit will be subtracted from the corresponding DMA discretionary mortality limit for that class for the current year.
   - Allocate discretionary mortality available for regulated harvest for independent males and females to each management jurisdiction as provided in the following table. The Parties may agree to adjust the allocation of discretionary mortality based on management objectives and spatial and temporal circumstances.

Management Jurisdiction*	**% of DMA outside NPS lands**
WY inside DMA	58%*
MT inside DMA	34%
ID inside DMA	8%

*Four percent (4%) of the DMA outside of National Park System lands in Wyoming is under the jurisdiction of the Joint Business Council of the Eastern Shoshone and Northern Arapaho Tribes of the Wind River Reservation.

b. The Parties will prohibit hunting of females accompanied by young, and young accompanied by females, and discretionary mortality of such animals will only occur for management removals.

c. Each party has discretion as to how it applies its allocation of discretionary mortality pursuant to its respective regulatory processes and management plan.

d. The Parties will coordinate with IGBST to review and make any appropriate adjustments to mortality rates at least every five years.

5. The Parties will confer with the National Park Service (NPS) and United States Forest Service (USFS) annually. The Parties will invite representatives of both GYE National Parks, the NPS regional office and GYE USFS Forest Supervisors to attend the annual meeting.

6. The Parties will monitor mortality throughout the year, and will communicate and coordinate with each other and with federal land management agencies as appropriate to minimize the likelihood of exceeding mortality limits.

7. Each party has discretion to manage grizzly bears within its jurisdiction of the GYE that are outside the DMA pursuant to its respective regulatory processes and state management plan.

8. Each party will designate one representative as a respective Point of Contact for purposes of achieving the objectives of this MOA.

V. Authorities and Regulatory Mechanisms

The Parties enter this MOA pursuant to their respective state authorities as set forth in Title 87 Montana Code Annotated, Title 23 Wyoming Statutes Annotated, and Title 36 Idaho Code.

The Parties have the authority, capability and biological data to implement appropriate hunting restrictions, management relocations and removals, and population management. The Parties will use their respective individual authorities to regulate discretionary mortality as allocated to their jurisdictions under this MOA. The Parties' respective regulatory mechanisms to manage, monitor, restrict, and adjust mortality include, but are not limited to, those identified in Attachment B.

This MOA in no way restricts the Parties from participating in similar activities with other states, agencies, tribes, local governments, or private entities.

VI. No Obligation of Funds

This MOA is neither a fiscal nor a funds obligation document. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds among the Parties will be handled in accordance with applicable laws, regulations, and procedures and such endeavors will be outlined in separate agreements or contracts that shall be made in writing by representatives of the Parties. This MOA does not provide such authority.

VII. Term, Termination and Effective Date

This MOA shall become effective upon the date of signature of all Parties. It shall remain in effect until it is terminated by the Parties. Any party may terminate its participation in the MOA by providing one hundred-eighty (180) days written notice to the other Parties, which notice shall be transmitted by hand or other means of delivery confirmation.

VIII. Amendment

The Parties will meet annually to review implementation of the MOA and to recommend any appropriate modifications to the MOA based on changes to the Strategy, state management plans or other pertinent regulatory documents. Any modification to the MOA will only become effective upon the written consent of all Parties.

IX. No Third Party Beneficiary

Nothing contained herein shall be construed as granting, vesting, creating or conferring any right of action or any other right or benefit upon any third party.

X. Severability

Should any portion of this MOA be judicially determined to be illegal or unenforceable, the remainder of the MOA shall continue in full force and effect.

XI. Sovereign Immunity

The states of Wyoming, Montana, and Idaho do not waive their sovereign immunity by entering into this MOA, and each fully retains all immunities and defenses provided by law with respect to any action based on or occurring as a result of this MOA.

In Witness Thereof, the Parties hereto have executed this MOA as of the last written date below.

T. Carrie Little — 8-16-2016

President, Wyoming Game and Fish Commission — **Date**

[signature] — 8/22/2016

Director, Wyoming Game and Fish Department — **Date**

-DAN Vermillion 7/29/2016

Chairman, Montana Fish and Wildlife Commission — Date

M. Jeff Hagener 8/1/2016

Director, Montana Fish, Wildlife and Parks — Date

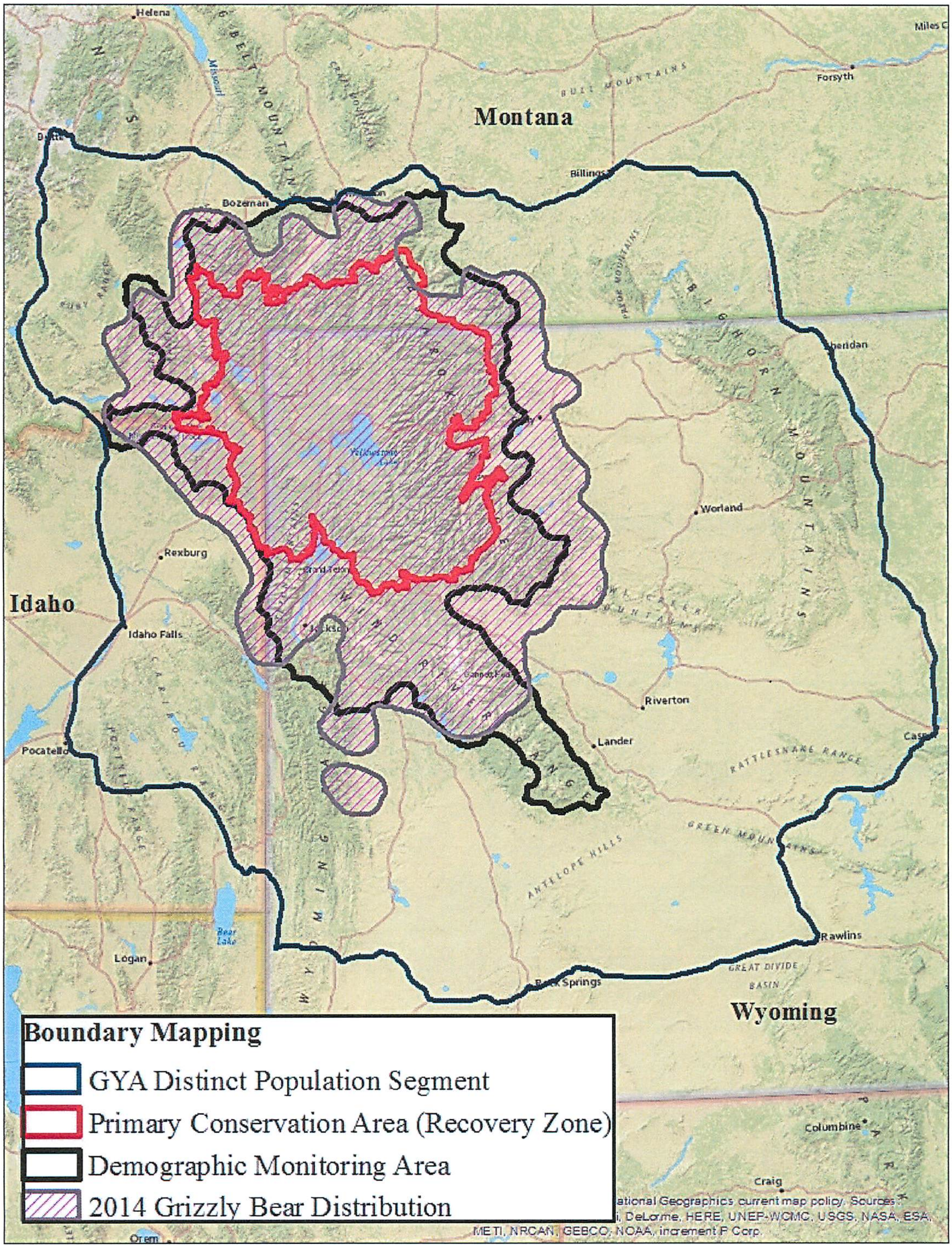
8-8-16

Chairman, Idaho Fish and Game Commission — Date

8/8/2016

Director, Idaho Department of Fish and Game — Date

ATTACHMENT A



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ATTACHMENT B

	Wyoming WS=Wyoming Statute WGBMP=Wyoming Grizzly Bear Management Plan	**Montana** MCA= Montana Code Annotated ARM=Admin. Rules of Montana MTFWC – Montana Fish and Wildlife Commission Regulation	**Idaho** IC=Idaho Code IDAPA=Idaho Admin. Code ISP=Idaho Season Proclamation
Protected Classification	W.S. 23-1-101 (a)(xii)(A) (classified as trophy game animal)	MCA 87-2-101 (4) (classified as a game animal)	IC 36-201 IDAPA 13.01.06.100.01(e) (classified as big game animal)
No Take without Statutory/Commission/Director Authorization	W.S.23-3-102(a)	MCA 87-1-301; MCA 87-1-304; MCA 87-5-302	IC 36-1101(a)
Commission restriction of season, location boundaries, limits, gender, age	W.S. 23-1-302(a)(ii), WGBMP	MCA 87-1-304 (1); MCA 87-5-302	IC 36-104(b)(2) seasons, locations, sex, limits, methods of take; ISP
Commission limit of harvest to automatically close season, including gender-based limits	W.S. 23-1-302(a), WGBMP	MCA 87-1-304; MCA 87-5-302	IC 36-104(b)(2); ISP
Commission authority to restrict hunter effort (e.g., controlled hunts, tag limits)	W.S. 23-1-302(a)(i), WGBMP	MCA 87-1-201(8); MCA 87-1-304 (1); MCA 87-2-702; MCA 87-5-302;	IC 36-104(b)(2) IC 36-104(b)(5) authority to designate controlled hunt IC 36-408(1),(2); ISP
Prohibition against take of females with young present	W.S. 23-1-302(a)	MCA 87-1-304; MCA 87-5-302; MCA 87-5-302	IC 36-104(b)(2) (Commission authority to prohibit in conjunction with season setting); ISP Commission authority to enact through rule (*see* IDAPA 13.01.08.300)
Requirement for license and tag	W.S. 23-3-102(a)	MCA 87-1-201(8); MCA 87-2-701; MCA 87-2-702; MCA 87 2-814; MCA 87-5-302	IC 36-401 IC 36-409(c)
Mandatory Check/Report to Monitor Harvest	W.S. 23-1-302(a)	MCA 87-1-301; MCA 87-5-302	IC 36-104(b)(3) Commission authority for rules for mandatory check and report requirements (see IDAPA

	Wyoming WS=Wyoming Statute WGBMP=Wyoming Grizzly Bear Management Plan	**Montana** MCA= Montana Code Annotated ARM=Admin. Rules of Montana MTFWC – Montana Fish and Wildlife Commission Regulation	**Idaho** IC=Idaho Code IDAPA=Idaho Admin. Code ISP=Idaho Season Proclamation
			13.01.08.420-422 for rules for all big game species open to harvest)
Authority for Emergency Season Closure based on Change in Conditions affecting mortality/habitat	W.S. 16-3-103(b)	MCA 87-1-304 (5); MCA 87-5-302	IC 36-104(b)(3) Commission emergency closure authority IC 36-106(e)(6) Director authority, closure in emergency effective upon written order
Permit required for response to depredation unless self-defense/defense of others/defense of property under threat to human life or domestic animals	W.S. 23-1-302(a)(viii)	MCA 87-1-201(8); MCA 87-1-304(1)(e); ARM 12.9.103(1)(d)	IC 36-1107 (carcass remains property of state)
Mandatory Education	W.S. 23-1-302(a)(xxii)	MCA 87-1-301; MCA 87-1-304 MFWC Black Bear Regulations	IC 36-412(a) Hunter education mandatory for those born after 1/1/1975 IDAPA 13.01.02.100 Recommended additional materials and exam regarding bear identification available on-line.
Penalties	W.S. 23-3-102(d), W.S. 23-6-202, W.S. 23-6-206, W.S. 23-6-208	MCA 87-6-413. (Hunting or killing over limit)	IC 36-1404(c)Misdemeanor IC 36-1404(d) Felony IC 36-1404(e) Revocation of hunting license for certain violations, including for take during closed season, exceeding bag/possession limit IC 36-1404(g): license revocation in Idaho revokes hunting privileges in all 44 states participating in the Interstate Wildlife Violator

	Wyoming WS=Wyoming Statute WGBMP=Wyoming Grizzly Bear Management Plan	**Montana** MCA= Montana Code Annotated ARM=Admin. Rules of Montana MTFWC – Montana Fish and Wildlife Commission Regulation	**Idaho** IC=Idaho Code IDAPA=Idaho Admin. Code ISP=Idaho Season Proclamation
			compact
Civil Penalty	W.S 23-6-204(e)		IC 36-1404(a)(3)
Procedural Aspects of State Regulatory Mechanisms	W.S. 16-3-101, Wyoming Administrative Procedures Act	MCA 2-4-101, et seq, Montana Administrative Procedures Act	IC 74- Open Meeting Requirements, including notice for all meetings of Idaho Fish and Game Commission IC Title 67, Chapter 52 (Idaho Administrative Procedure Act), requirements for public notice and comment, legislative review IC 36-105(3) Public Notice & Publication requirements for season setting