

Revised demographic criteria to calculate population size, update sustainable mortality rates, and revise the area within which mortalities are counted for the Greater Yellowstone Area

PROPOSED SUPPLEMENT TO THE 1993 GRIZZLY BEAR RECOVERY PLAN

Summary

We propose to change portions of the demographic criterion 3 for the Yellowstone grizzly bear population based on new scientific analyses and information. These proposed changes are:

1. Revise the area within which mortalities are counted against the mortality limits for independent females and males and dependent young so the area where the population is estimated is the same area where mortalities are counted and we will no longer count mortalities of bears in areas where they have no possibility of future occupancy outside suitable grizzly bear habitat.
2. Revise the method to estimate population size based on better techniques in order to more accurately represent the true population size and apply the mortality limit percentages for all age and sex classes to this improved population size estimate.
3. Revise the sustainable mortality limit for independent females to reflect new vital rate data on the population since 2001.

Background

In 2007, we supplemented the 1993 Grizzly Bear Recovery Plan with revised demographic criteria for the Greater Yellowstone Area (GYA) population (72 FR 11376, March 13, 2007). Since that time, new information and scientific techniques relevant to these demographic criteria have become available. Consistent with Task Y11 of the Grizzly Bear Recovery Plan (U.S. Fish and Wildlife Service 1993, p. 44) that directs the Service to “Reevaluate and refine population criteria as new information becomes available,” we are proposing several revisions to the demographic criteria, based on the best available science.

In 2000, we began a process to reevaluate and update methods to determine the status of the bear population, reevaluate and update methods used to estimate population size, and reevaluate and update methods to determine the sustainable level of mortality in the GYA. The Wildlife Monograph: “Temporal, Spatial, and Environmental Influences on The Demographics of Grizzly Bears in The Greater Yellowstone Ecosystem” (Schwartz et al. 2006); the report: “Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear” (hereafter referred to as the Reassessing Methods Document) (Interagency Grizzly Bear Study Team 2005); and the report: “Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear Workshop Document Supplement 19-21 June, 2006” (hereafter referred to as the Supplement to the Reassessing Methods Document) (Interagency Grizzly Bear Study Team 2006) provided the scientific basis for revising the demographic recovery criteria in the GYA in 2007. Similarly, the revisions we propose here are based on updated demographic analyses using the same methods at Schwartz et

al. (2006) and the Interagency Grizzly Bear Study Team's 2012 report: "Updating and Evaluating Approaches to Estimate Population Size and Sustainable Mortality Limits for Grizzly Bears in the Greater Yellowstone Ecosystem". This 2012 Study Team report provides the scientific basis for the changes proposed below.

There are currently 3 demographic criteria in the 1993 Grizzly Bear Recovery Plan that are measurable and objective (U.S. Fish and Wildlife Service 1993; U.S. Fish and Wildlife Service 2007). The first and second criteria pertaining to the model-averaged Chao2 estimate of the number of females with cubs of the year and the distribution of females with offspring will remain unchanged. We propose to revise the third criterion for sustainable mortality limits to reflect updated demographic analyses, revised methods to calculate population size, and current methods based on the best available science. We propose the following demographic recovery criteria to supplement the 1993 Recovery Plan:

- Demographic Recovery Criterion 1 — Maintain a minimum of 48 females with cubs of the year in the GYA (Figure 1), as indicated by the model-averaged Chao2 estimate for that year. The number of females with cubs of the year cannot drop below 48 for any 2 consecutive years.
- Demographic Recovery Criterion 2 — Sixteen of 18 bear management units within the Recovery Zone (Figure 2) must be occupied by females with young, with no 2 adjacent bear management units unoccupied, during a 6-year sum of observations. 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.
- Demographic Recovery Criterion 3 — For independent females (at least 2 years old), the current annual mortality limit, not to be exceeded in 2 consecutive years and including all sources of mortality, will be 7.6 percent of the total number of independent females. For independent males (at least 2 years old), the current annual mortality limit not to be exceeded in 3 consecutive years and including all sources of mortality, will be 15 percent of the total number of independent males. For dependent young (less than 2 years old), the current annual mortality limit, not to be exceeded in 3 consecutive years and including only known and probable human-caused mortalities, will be 9.0 percent of the total number of dependent young.

The third criterion was changed because it no longer represents the best scientific and commercial data nor the best technique to assess recovery of the Yellowstone grizzly bear population because – (1) There are updated demographic analyses for 2002-2011 indicating that the rate of growth seen during the 1983–2001 period has slowed; (2) there are updated methods to estimate total population size; and (3) there is consensus among scientists that the area within which we apply mortality limits should be the same area we use to estimate population size. Recent data and revised methods since the development of the 2007 Supplement to the 1993 Grizzly Bear Recovery Plan allow improved

mortality management based on more accurate calculations of total population size and biologically sustainable mortality limits for independent females.

Like the methods adopted in 2007, the revised methods would continue to count deaths of independent (at least 2 years old) male and female grizzly bears from all sources against annual mortality limits while counting only known and probable human-caused mortalities against annual mortality limits for dependent young (less than 2 years old). For independent females and males, counted mortalities include: (1) known and probable human-caused mortalities; (2) reported deaths due to natural and undetermined causes; and (3) calculated unreported human-caused mortalities.

The Study Team will continue to use the methods of Cherry et al. (2002) to calculate and estimate unknown/unreported mortalities each year based on the number of known, reported deaths (Cherry et al. 2002, p. 179; Interagency Grizzly Bear Study Team 2005, pp. 39-41).

The proposed revised population criterion 3

The demographic criterion would apply within the smoothed suitable habitat area in Figure 1 (the blue plus the red areas on Figure 1). It would replace Demographic Criterion 3 and 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.

- For independent females (at least 2 years old), the current annual mortality limit, not to be exceeded in 2 consecutive years and including all sources of mortality, will be 7.6 percent of the total number of independent females. Simulations have shown that a 7.6 percent adult female mortality rate allows a stable to increasing population 95 percent of the time (Harris et al. 2006, p. 50).
- For independent males (at least 2 years old), the current annual mortality limit, not to be exceeded in 3 consecutive years and including all sources of mortality, will be 15 percent of the total number of independent males. The Study Team chose this limit because it approximates the level of male mortality in the GYA from 1983 to 2001 (Haroldson et al. 2006, p. 38), a period when the mean growth rate of the population was estimated at 4 to 7 percent per year (Harris et al. 2006, p. 48). Independent males can tolerate a higher rate of mortality compared to females without affecting the overall stability or trajectory of the population because they contribute little to overall population growth (Mace and Waller 1998, pp. 1009-1013; Interagency Grizzly Bear Study Team 2005, p. 39).
- For dependent young (less than 2 years old), the mortality limit, not to be exceeded in 3 consecutive years and including only known and probable human-caused mortalities, will be 9 percent of the total number of dependent young (Interagency Grizzly Bear Study Team 2005, pp. 36-38). This limit is less than the 15 percent human-caused mortality documented for each sex

from 1983 to 2001, a period of population growth and expansion (Interagency Grizzly Bear Study Team 2005, pp. 36-38). Although it is known that dependent bears experience far higher natural mortality rates than independent bears (Schwartz et al. 2006b, p. 30), there is no known way to sample these mortalities directly in the field. Instead, these rates are calculated from consecutive years of observing radio-collared females with offspring..

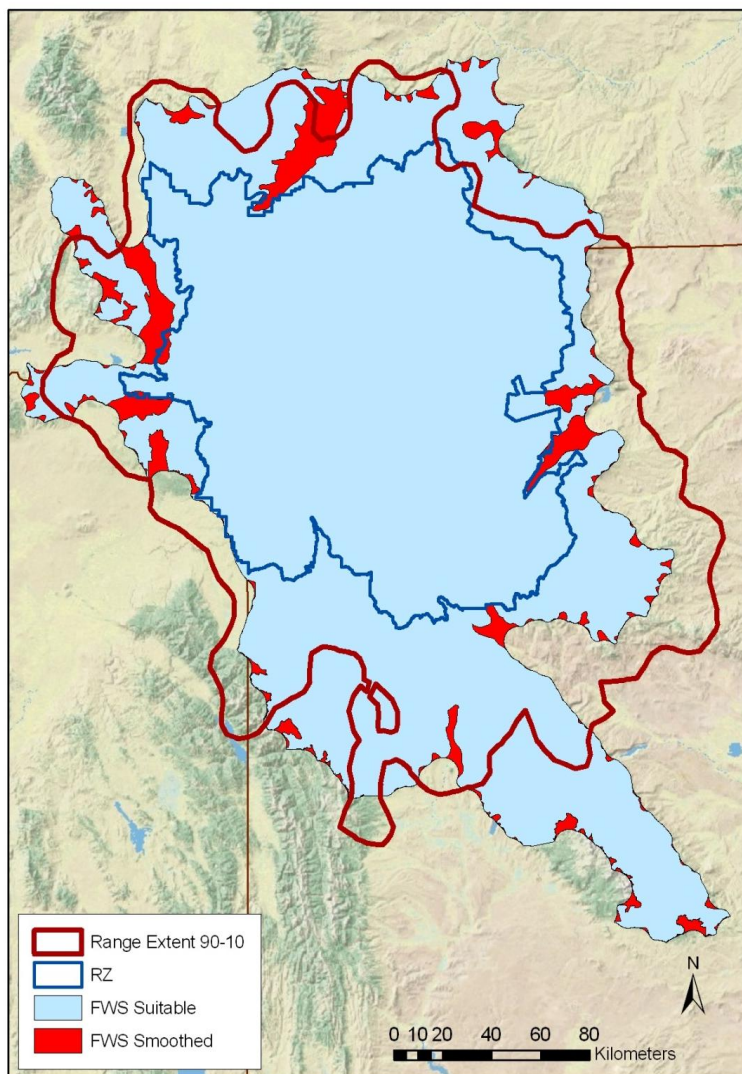
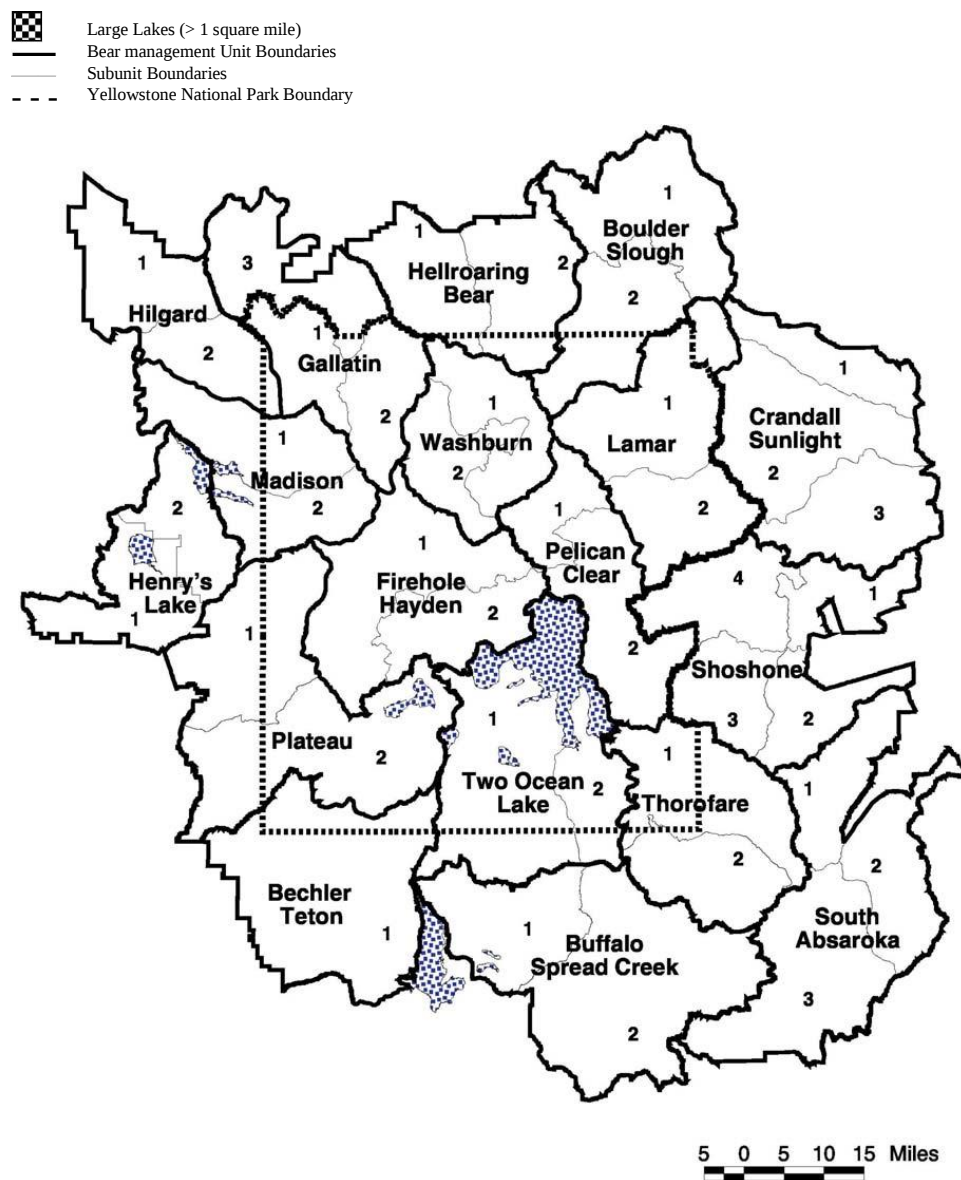


Figure 1. FWS suitable habitat area in blue, Primary Conservation Area (PCA) boundary in dark blue, and estimate of grizzly bear range extent, 1990-2010 in red. Mortalities will be counted against the mortality limits within the blue plus the red areas on this map.

Figure 2. Yellowstone recovery zone boundary showing bear management unit (BMU) and subunit boundaries for application of demographic recovery criterion 2.



Application of the revised demographic criteria

Annual allowable mortality limits for each bear class (independent female, independent male, dependent young), are calculated based on total population estimates of each bear class for the current year (Interagency Grizzly Bear Study Team 2012, pp. 23-27). To evaluate Demographic Recovery Criteria #1 and #3, the estimate of 48 adult females will be calculated by the Interagency Grizzly Bear Study Team based on the model averaging technique described in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 2-10).

The Interagency Grizzly Bear Study Team will use the following procedures to establish and track sustainable mortality and calculate the number of adult female grizzly bears in the Greater Yellowstone Area:

1. Raw observations of sightings of females with cubs of the year will be obtained using 2 systematic aerial surveys annually.
2. When a female with cubs of the year is observed, use telemetry receivers will be used to determine whether or not that particular female is wearing a radio collar (i.e., determine if the female is marked).
3. Estimate the detection probability using aerial survey data from 1997 through the present and apply this overall resighting probability to each individual year.
4. Exclude any bears (marked or unmarked) observed at moth sites.
4. Use the mark-resight estimation technique described in IGBST (2012: section 3.3; attached) to -Bayesian approach, in which uncertainty in the probabilities of re-sightings obtained from data on marked animals is incorporated to obtain an estimate of the total number of females with cubs of the year for areas of the GYA that are ≥ 5 km from confirmed army cutworm moth aggregation sites; observations at moth aggregation sites are omitted from this estimate because remoteness of those sites reduces the ability to mark bears, potentially violating the assumption of equal observability among marked and unmarked bears; covered by observation flights, excluding the moth sites.
5. Observations of females with cubs of the year at moth sites < 5 km from moth aggregation sites and obtained during dedicated moth site aerial surveys are added to the mark-resight population estimate to obtain a total estimate of females with cubs of the year.
- 5.6. As Because annual estimate for numbers of females with cubs in the population will vary due to natural vagrancies in cub production and other factors, a smoothing procedure will need to be applied to reduce wide, annual fluctuations in population estimates and mortality limits derived from them. -A model-averaged estimate of females with cubs of the year using an array of candidate models of trend on time (e.g., linear, quadratic, asymptotic), weighted using AIC, or similar information-theoretic methods will be used as an objective assessment of population trends linear and quadratic models of the annual estimates of females with cubs of the year with year (IGBST 2006; Harris et al 2007;) will be develop as annual estimates accumulate (IGBST 2012, p 28).
- 6.7. Total grizzly bear P population size estimates will then be projected based on

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Comment [rs1]: Frank/Mark: Is this true? The workshop report says you considered 3 different estimators but it doesn't say which one was ultimately recommended.

Comment [rs2]: Frank/Mark: Is this still correct as written. I removed some wordy references to a posterior distribution.

Comment [mah3]: 5 km our estimated exclusion distance. It is the mean distance that radio-collared females bears known to visit moth site were located from moth sited during July and August. We probably need to add an appendix detailing the process used to develop this estimate

Comment [FTvM4]: NOTE: sofar, we have not really discussed how the separate moth site estimate be handled. Based on what we know from doing simultaneous ground and aerial counts, it makes most sense to treat the moth site count essentially as a *census* and add it to the *estimate* of Fcoy based on mark-resight for the remainder of the ecosystem.

- proportions of animals in each age-class from the annual model average estimate of females with cubs (as in the current protocol – see IGBST 2012 attached).
- 7.8. ~~The predicted total estimate number~~ of females with cubs of the year will be divided by the estimated proportion of females ≥ 4 years old ~~estimated to be~~ accompanied by cubs of the year (transition probability = 0.289270). The resulting value represents the best estimate of the total number of females in the population ≥ 4 years old.
- 8.9. 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)~~ via stochastic modeling described in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 10–11). Based on data from 2002–2011, that proportion is 0.844. The ~~resulting~~ value is the best estimate of the number of independent females (≥ 2 years old) in the population that year.
- 9.10. The sustainable mortality limit for independent females is 97.6% of the population estimate of independent females.
- 10.11. Unknown and unreported mortality will be estimated based on the methods of (Cherry et al. 2002, p. 179; Interagency Grizzly Bear Study Team 2005, pp. 39–41).
11. The number of independent males in the population will be based on the estimated ratio of independent males to independent females ~~(1.000)~~ derived via stochastic modeling described in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 10–11). Because female and male survival for the 2002–2011 period is now equal and survival rates of dependent young are not calculated for each sex, the sex ratio is now 1:1. The resulting value represents the best estimate of the number of independent males that year.
12. ~~via stochastic modeling described in the Supplement to the Reassessing Methods Document (Interagency Grizzly Bear Study Team 2006, pp. 10–11). Because female and male survival for the 2002–2011 period is now equal and survival rates of dependent young are not calculated for each sex, the sex ratio is now 1:1. The resulting value represents the best estimate of the number of independent males that year.~~
- 14.13. The sustainable mortality limit for independent males is 15% of the population estimate of independent males.
14. The number of cubs of the year in the annual population estimate will be calculated directly from the ~~model-predicted-mark-resight~~ estimate of females with cubs of the year (Interagency Grizzly Bear Study Team ~~2006~~2012, p. ~~473~~8). The number of cubs of the year will be estimated by multiplying the modeled estimate by the mortality-adjusted mean litter size (~~2.0449~~) observed ~~from during 1983–2002–2002~~2002–2011.
15. 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 (~~0.6380~~0.553) observed ~~from during 1983–2004~~2002–2011 (IGBST 2012, p. 38).
16. The sustainable mortality limit for dependent young (cubs of the year and yearlings) is 97.6% of the annual estimate of dependent young. Only human-caused deaths (reported known and probable) will be tallied against this threshold.
- 17.16. Unknown and unreported mortality will not be estimated for dependent

Comment [rs5]: Frank/Mark: What are the next steps? Could you state exactly how total population size will be determined using this estimate of Fcoy? The remaining enumerated language below is left over from the description of the Chao2 estimator in the current demographic recovery criteria. and needs to be updated or deleted.

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Comment [FTvM6]: This value has changed based on the 2002–2011 analyses but we have no way to reference it (it is not in the new Demographic Workshop report); fortunately, this approach technique has not changed so we thought reference to the supplement document may be the best way to present this.

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young.

18.17. Allowable mortality limits will be established annually following methods detailed in Cherry et al. (2002). Because we are using modeled predictions, annual variability among years has been addressed and we recommend annual mortality limits based on the current year.

Comment [FTvM7]: model-averaged estimates?

19.18. 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 (Interagency Grizzly Bear Study Team 2006, pp. 10–15).

Comment [FTvM8]: This should be ok but I note we have not yet completed this. The techniques we would use are the same so the reference is appropriate.

20.19. To evaluate Demographic Criterion #1, an annual number of females with cubs of the year will be estimated. The number of 48 adult females each year will be calculated using the predicted number based on model averaging (Interagency Grizzly Bear Study Team 2006, pp. 2-10).

Comment [FTvM9]: I modified this somewhat but not sure this step and step 20 are in the correct place to begin with? Seems more appropriate after step 6?

21.20. If the AICc weight favors the quadratic term (i.e., >0.5) in modeling the rate of change of females with cubs (Interagency Grizzly Bear Study Team 2006, pp. 4–8), a full review of the population's demographics will be undertaken by the Study Team to better understand population status.

Comment [FTvM10]: IF we are to use additional time trends because of the stagnation of population growth (as indicated in the new Demographic Workshop report, p. 28), we may need to revisit this criterion. Something along the lines of "AICc model weights favoring models indicating decline"....?

21. Dead bears reported in years subsequent to the actual year of mortality will be tallied against the estimated year of death and mortality total will be recalculated for that year. If mortality exceeds the threshold for that year, the difference (total mortality minus threshold) should be counted against the current years' threshold. If sex of the dead bear cannot be determined, sex will be assigned randomly using ratio of 591:141 male:female as recommended in Appendix A of Schwartz and Haroldson (2001, pp. 119–121 (see step 12)).

22. Estimation of population size using observations of females with cubs of the year based on the Knight et al. (1995) rule set and Chao2 estimator will continue for the immediate future as population estimates derived from parallel to implementation of the mark-resight technique described in steps 1 through 6 above are accumulated and trend using this technique is assessed (IGBST 2012, p. 29–30).

Comment [FTvM11]: Seems like we should be explicit and indicate this will continue to be done?

Literature Cited

Comment [rs12]: still needs to be updated

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Appendix A.

Comment [rs13]: update?

Implementation Schedule

The following Implementation Schedule outlines actions and estimated costs for the grizzly bear (*Ursus arctos horribilis*) recovery program over the next 5 years. Functioning as a practical guide for meeting the species' recovery goals, this schedule indicates action priorities, action numbers, action descriptions, duration of actions, and estimated costs. In addition, parties with authority, responsibility, or expressed interest in implementing a specific recovery action are identified; however, this neither obligates nor implies a requirement for the identified party to implement the action(s) or secure funding for implementing the action(s). However, parties willing to participate may benefit by being able to show in their own budgets that their funding request is for a recovery action identified in an approved recovery plan and, therefore, is considered a necessary action for the overall coordinated effort to recover the grizzly bear. Also, section 7(a)(1) of the ESA, as amended, directs all Federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation threatened and endangered species.

Key to Implementation Schedule Priorities (column 1)

PRIORITY 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

PRIORITY 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

PRIORITY 3: All other actions necessary to provide for full recovery of the species.

Key to responsible parties in column 6:

USFS = U.S. Forest Service
YNP = Yellowstone National Park
USGS = U.S. Geological Survey
MT = Montana Fish Wildlife and Parks Department
ID = Idaho Fish and Game Department
WY = Wyoming Game and Fish Department
GTNP = Grand Teton National Park

Action Priority	Action Number	Action Description	Action Duration	Responsible Parties	USFWS Lead	Total (annual) Costs	2007	2008	2009	2010	2011	Comments
3	Y11	Monitor total population size by counting females with cubs. Monitor mortality and set annual mortality limits.	Annual	USGS, MT, WY, ID, YNP, GTNP, USFS	N	678,193 ¹	339,097 ¹	0	0	0	0	

¹ The same funding applies to both monitoring population size and mortality management as they are interrelated.

