Chapter 2 Demographic Criteria and Monitoring

Introduction

To maintain a healthy (recovered) grizzly bear population in the GYE, it is necessary to have adequate numbers of bears that are widely distributed with a balance between reproduction and mortality. Because grizzly bears are a difficult species to monitor and manage, multiple criteria are identified to provide sufficient information upon which to base management decisions.

In assessing and identifying demographic criteria for post-delisting management, this Conservation Strategy applies best available science, such as the IGBST implementation of the integrated population model (IPM) in 2021.

The IGBST has generated extensive information useful to determine the status of the GYE grizzly bear population. Few populations have benefited from the amount of effort in data collection, as has the GYE population. Agencies responsible for management will continue their commitment to data collection so population status can be determined and all designated criteria maintained.

Under this Conservation Strategy, all mortalities and all reports of unique females with cubs-of-the-year will be monitored within the Demographic Monitoring Area (DMA) (Figure 1) (*see Chapter 1*). The reduction in the area monitored for population estimates and estimating mortality rates focuses the monitoring efforts to the DMA, which corresponds to the area monitored by the IGBST. The DMA is based on delineation of suitable grizzly bear habitat, along with narrow areas along valleys bounded by suitable habitat that could act as potential mortality sinks (IGBST 2012).

The demographics and vital rates of the GYE grizzly bear population have changed over time, and the IGBST has periodically reviewed and adjusted mortality limits to ensure a total GYE population of at least 500 bears and to meet the occupancy criterion for breeding female bears.

The GYE population has far surpassed the USFWS recovery criterion for a minimum population size of 500 grizzly bears for more than two decades. Beginning in the early 2000s, the GYE population growth rates slowed, and the population began exhibiting signs of density dependence in core portions of the DMA, as documented in peer-reviewed literature (e.g., population growth fluctuations, decreased home-range size, reduced dependent young survival, and increased competition as more bears occupied the same suitable habitat) (van Manen *et al.* 2016).

In 2021, the IGBST adopted the integrated population model (IPM) framework, based on a Bayesian statistical framework, as the estimator of population size and vital rates for the GYE.[1] The IPM continues to use documentation of females with cubs-of-the-year and the Chao2 estimate, which has been used for GYE population estimation since 2007, with refinements in the interim (IGBST 2021). The IPM also uses other modeled and field-collected data inputs, such as survival, mortality, and reproduction data. The IPM allows the agencies to estimate population vital rates annually by sex- and age-specific cohorts, and to derive mortality limits incorporating those rates. With the adoption of the IPM, the management agencies are able to apply a more responsive approach for evaluating mortality rates on an annual basis.

The demographic criteria and objectives in this Conservation Strategy reflect the IGBST's adoption of the IPM and related updates. The IGBST has used the IPM to estimate the population size (abundance) in the DMA and the annual population growth rate for the DMA for the period from 1984 to 2022 (Figures 3A and 3B). Data from each additional monitoring year will be added to the IPM model in the future and extend the time period of the population size estimates. (As new data are added to the model in the future, the IGBST will not retroactively adjust all prior year estimates to reflect variations in subsequent individual model runs.)

[1] The IPM population size estimate is reported as a median value.

Figure 3A. Population size in the DMA, estimated by the IPM for the period 1984 – 2022. The 95% credible intervals are shown as the shaded area. The IPM was developed by the IGBST in collaboration with SpeedGoat, LLC.

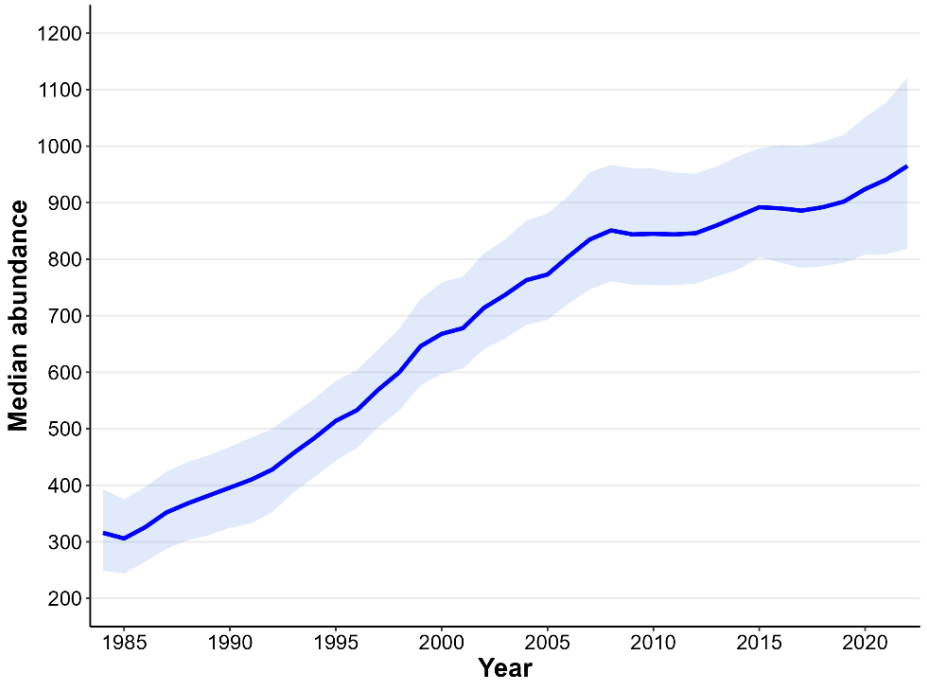
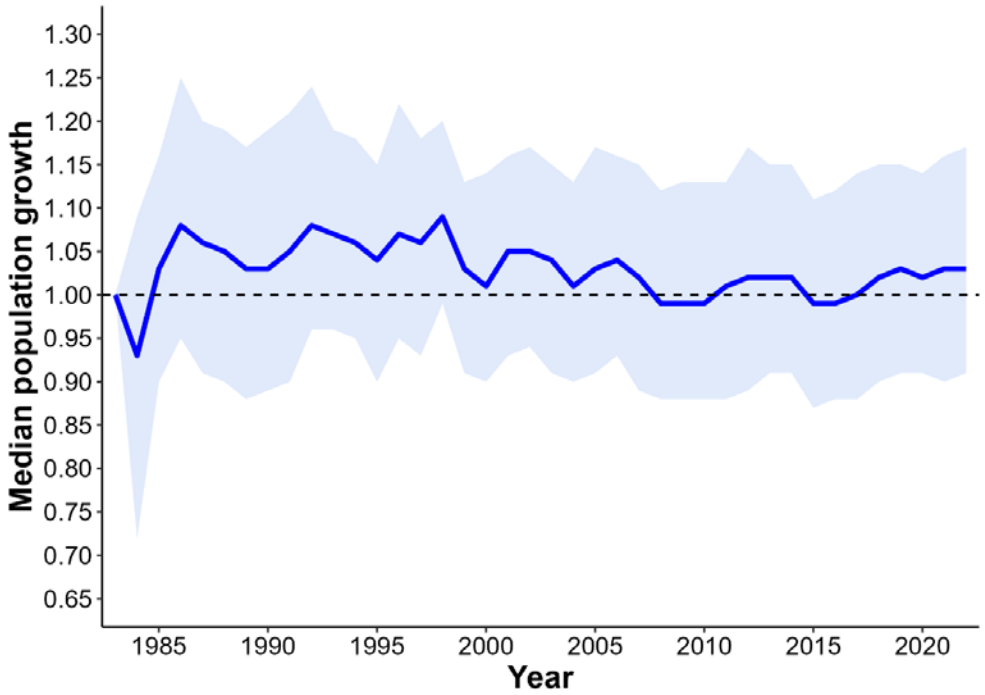


Figure 3B. Annual population growth rate (λ, blue line) estimates for grizzly bears in the DMA for the period 1984 – 2022, based on the IPM. The 95% credible intervals are shown as the shaded area.



Population Monitoring

Demographic monitoring protocols for the GYE population focus on the area within the DMA. These protocols will monitor and document population size, distribution of females with young, and all forms of mortality. Additional monitoring and research may be conducted as determined by the IGBST.

Demographic Criteria for the Greater Yellowstone Ecosystem

The demographic criteria below were developed to maintain a recovered population and reflect implementation of the IPM.

Demographic Criterion 1 — Maintain a minimum population size of 500 grizzly bears[2] and at least 48 females with cubs-of-the-year, as calculated by the IGBST using the most updated Protocol (posted on IGBST website) and peer-reviewed methods. The estimate of total population size cannot drop below 500 or 48 females with cubs-of-the-year in three consecutive years. The 48 females with cubs-of-the-year metric will be evaluated by the estimated number of unique females with cubs-of-the-year based on the IPM (*see* Monitoring Protocol section).

Demographic Criterion 2—Sixteen of 18 bear management units within the PCA (Figure 2) must be occupied by females with young, with no two 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 PCA and are not concentrated in only one portion of the ecosystem.

[2] The identification of a minimum population size of 500 in Demographic Criterion 1 is consistent with USFWS' recovery criterion for the GYE to ensure short-term genetic fitness; it is not the agencies' objective for managing the population. Demographic Criterion 3 reflects the agencies' population management objective for the DMA.

Demographic Criterion 3

Maintain the population in the DMA within or above a range of 800-950 (applying the IPM population size estimate), by determining and applying annual mortality limits for independent females and independent males, according to the management framework in Table 2 (see Appendix O). The population range of 800-950 is reflective of population sizes that have exhibited density dependent effects since the early 2000s, as well as other considerations (see Appendix O).

Table 2. **Management Framework based on DMA Population Size (IPM Population Size Estimate)**

(See Appendix O, Tri-State MOA)

800* – 950	> 950
➢ Manage to maintain the population within or above this range. ➢ Use IPM to determine mortality limits for population stability, slight increase, or slight decrease, remaining within or above the population range: $0.98 \leq \lambda \leq 1.02$ ➢ Manage conflicts and authorize hunting at individual agency discretion, based on allocated mortality limits. The agencies' choices may result in $\lambda > 1.02$.	➢ Manage to maintain/reduce population. ➢ Use IPM to determine mortality limits for population stability or decrease. $0.95 \leq \lambda \leq 1.00$ *If mortality limits are determined for a population decrease, the decrease will not exceed* 5% ($\lambda \geq 0.95$). ➢ Manage conflicts and authorize hunting at individual agency discretion, based on allocated mortality limits. The agencies' choices may result in $\lambda > 1.00$.

* See below for management strategies if the population falls below the 800 IPM population size estimate.

Note: Lambda (λ) denotes the change in population size from one year to the next: $\lambda = 1.0$ represents no change in population size between two years: $\lambda > 1.0$ indicates population increase and $\lambda < 1.0$ indicates population decrease.

As described in Appendix O, if the IPM population size estimate for the population within the DMA is less than 800, which should not occur due to interagency commitments, the agencies will:

- Manage the population for increase above 800. (Use the IPM to determine mortality limits based on $\lambda > 1.0$).
- Request an IGBST biology and monitoring review, and consider the results of the IGBST review in determining appropriate changes to the management framework.
- Close the DMA within their respective jurisdictions (Idaho, Montana, and Wyoming) to hunting until the population increases above 800 grizzly bears.

Process for Determining Annual Mortality Limits

The adoption of the IPM provides the capability to review vital rates and demographics for the GYE population annually. Each year the IGBST will estimate the total population size for grizzly bears in the DMA by demographic class (independent males, independent females, dependent young) using the IPM. These estimates will be used to establish mortality limits for the upcoming year within the DMA as per Tables 2, above, and 4, below, consistent with the respective management scenario (stability, increase, decrease).

Mortalities are tracked and reported annually using data obtained within the DMA. Tables C1 and C2 in Appendix O provide examples of the process for deriving available harvest mortality and allocation of available harvest mortality by management jurisdiction.

Unique Females with Cubs-of-the-Year

Background

Females with cubs-of-the-year occupy all of the existing bear management units within the PCA as well as areas outside the PCA (Table 3). Not all portions of the DMA currently have observations of females with cubs-of-the-year, however, several have been observed outside the DMA in recent years.

Monitoring Protocol

Monitoring unique females with cubs-of-the-year provides information to demonstrate adequate reproduction and to derive annual estimates of *total* population size. Beginning in 2007, the IGBST estimated total population size using the model-averaged Chao2 estimate (as refined since the 2021 monitoring year) of females with cubs-of-the-year within the DMA, using the sightings and re-sightings of unique females with cubs-of-the-year within the DMA. Sightings and re-sightings of females with cubs-of-the-year inside the DMA are obtained from numerous sources, including systematic observation flights conducted annually in the DMA, and opportunistic confirmed sightings from aerial and ground observations.

Observation flights are primarily designed to survey the DMA and the number of flights conducted is standardized to ensure consistent effort in obtaining data. The IGBST verifies the reliability of all sightings. The IGBST plots all sightings and summarizes data for unique females and numbers of cubs-of-the-year seen for the entire population. Methodology developed by Knight *et al*. (1995) is used to separate duplicated from unduplicated sightings.

As the grizzly bear population increased, model-averaged Chao2 estimates became increasingly prone to underestimation, primarily due to the use of a conservative distance criterion of 30 km in the rule set to distinguish sightings of unique females with cubs-of-the-year. The original rule set was conservative by design and reduced the risk of identifying more female with cubs-of-the-year than actually existed during the early stages of population recovery. When initially used, the technique was relatively unbiased because of the lower number and density of females with cubs. In 2021, the IGBST updated the rule set to use a 16-km distance criterion (IGBST 2021).

The IPM continues to use documentation of females with cubs-of-the-year and the Chao2 estimate. The IPM also uses other modeled and field-collected data inputs, such as survival, mortality, and reproduction data. Starting with the 2022 monitoring year, the IGBST has used the

IPM to provide population size estimates and population growth rates for prior years for data comparability from 1984 to the present (Figures 3A and 3B).

This methodology provides the basis for mortality management and trend monitoring of the grizzly bear population in the DMA.[3] Mortality from all causes is tracked within the DMA for independent females (≥ 2 years old) and independent males (≥ 2 years old), and human-caused mortality is tracked for dependent young (< 2 years old). The total population size estimate is used to determine available mortality as per Table 2 based on the specified growth rate.

The IGBST will continue to investigate improved and new methods for population estimation as appropriate. Should a new population estimation method be incorporated to estimate size and evaluate survival/mortality of the GYE grizzly bear population, managers will recalibrate population metrics used to determine mortality limits (see Appendix O).

Distribution of Females with Young

Background

The Demographic Criterion of having 16 of 18 BMUs occupied, with no two adjacent units vacant, during a 6-year sum of observations continues to be met (Table 3). This criterion is important as it ensures that reproducing females occupy the majority of the PCA and that successful reproductive females are not just concentrated in one portion of the ecosystem. Distribution of females in the DMA with young of all ages is presented by decade for 1975–2022 (Figure 4).

[3] The original methodology of the *1993 Recovery Plan* focused mortality management and population monitoring on the Conservation Management Area. The *2007 Recovery Plan Supplement* identified revised methodology in which a total population estimate using the model-averaged Chao2 method was made based on sightings of unique females with cubs-of-the-year within the Conservation Management Area.

Monitoring Protocol

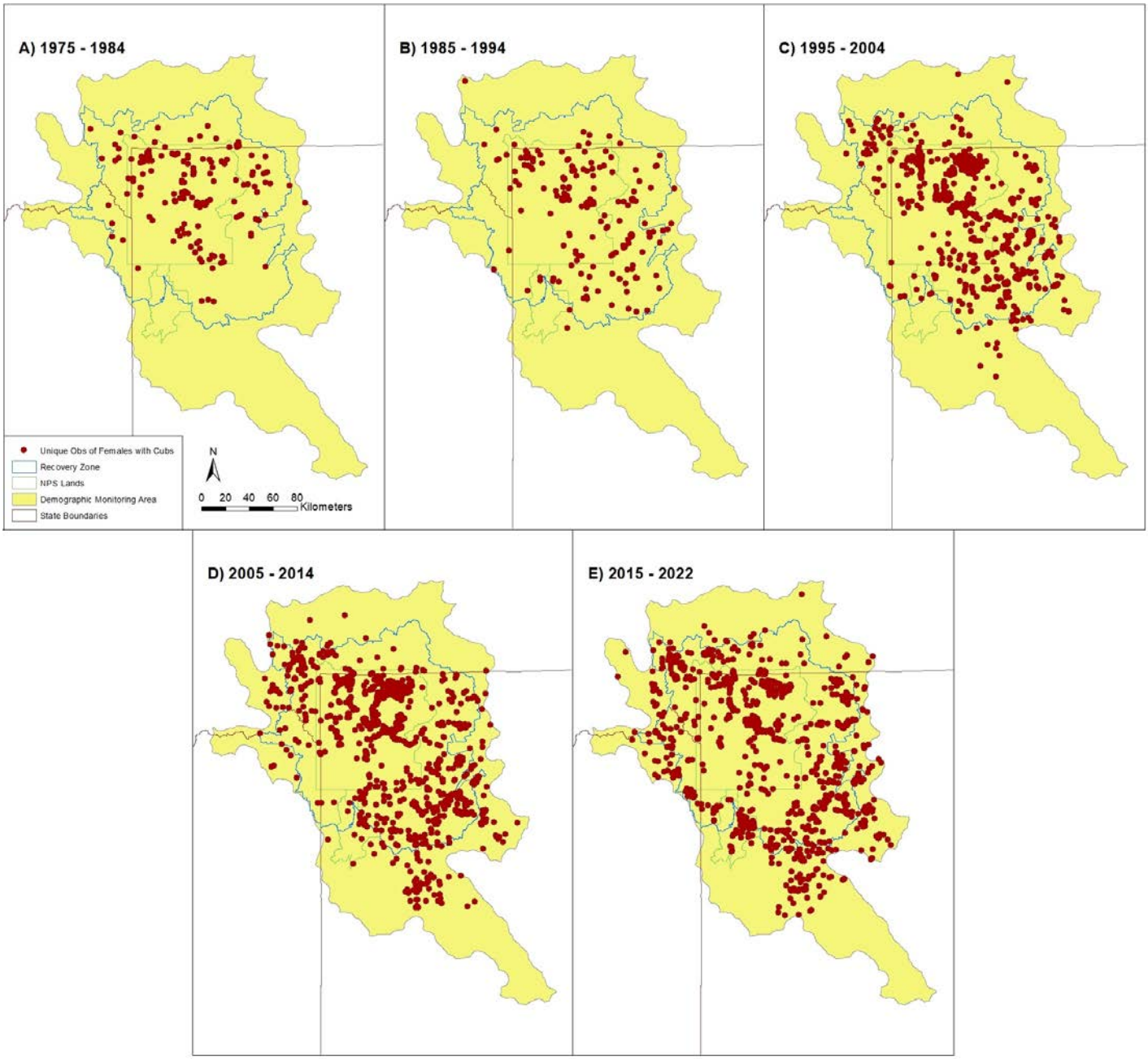
This effort provides information to assess distribution of the reproductive cohort in all occupied habitats, although the specific distribution criterion for reproducing females applies only to the PCA. A recovered population should be well distributed throughout grizzly bear range. Successful reproduction is one indicator of habitat sufficiency, thus distribution of family groups of grizzly bears is one indicator of suitable habitat in areas where such sightings occur. Since subadult females usually establish home ranges adjacent to that of their mothers, the distribution of family groups is also an indication of future occupancy of these areas by grizzly bears. Radio tracking flights, observation flights, agency personnel sightings, and verified reports from other individuals are the primary methods employed to collect female distribution data. The IGBST verifies all reports and maintains these reports and other data.

The number of BMUs occupied by females with young will be reviewed on a rolling six-year sum of observations. Females with young outside the PCA are also reported, but only those females with young within the PCA are used to document achievement of this distribution criterion.

Table 3. Bear management units occupied by females with young based on verified reports, 2017–2022 (Haroldson and Karabensh 2023).

Bear Management Unit	2017	2018	2019	2020	2021	2022	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	X	6
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	X	6
10) Firehole/Hayden	X	X	X	X	X	X	6
11) Madison	X	X	X	X	X	X	6
12) Henry’s Lake	X	X	X	X	X	X	6
13) Plateau	X	X	X	X	X	X	6
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	X	X	X	X	X	X	6
18) Bechler/Teton		X	X	X	X	X	5
Totals	17	18	18	18	18	18	

Figure 4. Initial sightings of unique females with cubs-of-the-year in the GYE DMA by decade, 1975–2022 (IGBST Data).



Mortality

Background

Agencies have invested significant effort aimed at limiting human-caused deaths for grizzly bears. These efforts have reduced human-caused mortality and allowed the population to increase since it was listed in 1975.

The distribution of known and probable human-caused mortalities in the DMA during 1975–2022 is shown in Figure 5. As the population has continued to expand, the percentage of known and probable mortalities occurring outside the PCA and outside the DMA has increased, which was expected due to increased conflicts in these areas.

Monitoring Protocol

Management of human-caused mortality of grizzly bears is vital to the successful maintenance of the grizzly bear population in the GYE. Mortality limits are a necessary tool for managers in regulating human impacts to any wildlife population, including grizzly bears. Managing mortality is necessary to avoid the unregulated killing that occurred with European/American settlement of the GYE during the late 1800s, and to build support for long-term survival of the population. Higher numbers of mortalities can be expected in areas outside the DMA as the grizzly bear population expands, particularly in areas on the periphery of occupied range when bears move onto private lands or in areas with higher levels of human development. Mortality management recognizes the need for some bears to be removed to address recurring conflicts to meet management needs for conflict bears, human safety issues, etc.

State wildlife agencies (Montana, Wyoming, and Idaho) have signed a Memorandum of Agreement setting forth how they will coordinate bear management actions and limit discretionary mortality to ensure it will not jeopardize the recovery and survival of the GYE

grizzly bear population (Appendix O). This document also summarizes each state's regulatory mechanisms for regulating discretionary mortality, including harvest (*see* Chapter 7). The states may use regulated harvest as a management tool when and where appropriate. All known and probable mortalities will be limited by the overall mortality limits within the DMA, as described in Tables 2 and 4.

As per the States' Memorandum of Agreement (Appendix O), they will conduct an annual meeting to evaluate the status of the population and develop allowable discretionary mortality by the States. The States will confer with the National Park Service (NPS), the U.S. Forest Service (USFS), and the Bureau of Land Management (BLM) annually and will invite representatives of both GYE National Parks, the NPS regional office, the GYE USFS Forest Supervisors, Tribes of the Wind River Reservation (WRR) (Eastern Shoshone and Northern Arapahoe tribes), and a representative from the BLM to attend the annual meeting.

Figure 5. Distribution of known and probable mortalities from all causes in the GYE DMA, by decade, 1975–2022 (IGBST Data).

Table 4. Framework to manage grizzly bear mortality inside the GYE DMA.

Management Framework	Background and Application Protocol
1. Area within which mortality limits apply	49,928 sq km (19,279 sq mi) Demographic Monitoring Area (DMA) (Figure 1).
2. Conservation Strategy Goal/Demographic Criteria	To ensure the continuation of a recovered grizzly bear population in accordance with the established Demographic Criteria: Criterion 1 (*insert page #*) Criterion 2 (*insert page#*) Criterion 3 (*insert page #*)
3. Population estimator	The integrated population model (IPM) will be used as the population estimation tool for the foreseeable future. The IPM continues to use documentation of females with cubs-of-the-year and the refined Chao2 estimate, along with other inputs.
4. Mortality limit setting protocol	The IGBST will annually produce a total population estimate and review related vital rates for the DMA using the IPM. That population estimate will be used to establish mortality limits for each age/sex class for the following year as per #8 (below) and Appendix O.
5. Allocation process for managed mortalities by demographic and age class (independent females (≥ 2 years old), independent males (≥ 2 years old), dependent young < 2 years old)	Per Table 2 and Appendix O, the States will meet annually to review population monitoring data supplied by IGBST and collectively establish discretionary mortality limits per age/sex class available for regulated harvest for each jurisdiction (MT, ID, WY) in the DMA, so DMA thresholds are not exceeded. If requested, the Wind River Reservation will receive a portion of the available mortality limit based on the 4% of the WRR geographic area within the DMA. Mortalities outside the DMA are the responsibility of each State and do not count against mortality limits.
6. State Regulatory Mechanisms specific to discretionary sport take	For specific state regulatory mechanisms, please reference the Tri-state MOA found in Appendix O.
7. Management review by the IGBST	The IPM provides the capability to review vital rates and make appropriate adjustments to mortality limits annually. A demographic review will also be conducted by the IGBST every 5–10 years at the direction of the YGCC. This management review will assess if the management system is achieving the desired goal of ensuring a recovered grizzly bear population in accordance with Demographic Criteria. The management review is a science-based process that will be led by the IGBST (which includes all State and Federal agencies and the WRR Tribes) using all recent available scientific data to assess population numbers and trend against Demographic Criteria.

Known and probable human-caused mortalities are defined as follows:

Known. Carcass recovered or evidence to indicate known status due to radio telemetry. Known deaths require a carcass, management removal, or a cut radio collar. Found collars having the appearance of being cut should receive additional forensic review for definitive proof.

Probable. Strong evidence to indicate mortality, reported by highly reliable sources, no carcass recovered. Probable deaths include those cases where there is supportive evidence that a bear was wounded. Circumstances of each reported instance should be considered. Probable includes those cases where evidence of blood, hair, or other tissues clearly indicates wounding serious enough to result in death. The literature is unclear on the likelihood of survival for orphaned cubs, therefore, any cub(s) orphaned during its first year of life because of a known mortality of its mother is considered a probable mortality.

Because probable mortalities will be factored into total mortality, and because separate mortality limits apply to independent males and independent females, each probable mortality must be assigned a sex. Sex will be assigned in the following manner:

- Probable deaths of adult bears where cubs-of-the-year are reported present will be classified as female.
- Lone bears classified as probable deaths will be assigned sex based upon statistics available from known deaths in the ecosystem. The percentage of known male and female deaths in the GYE between 1975 and 1998 is 59% and 41% respectively. These estimates exclude natural mortalities, management removals, and females with young. Therefore, sex will be assigned to probable adult mortalities in the GYE at a ratio of 59:41, male: female.
- Cubs-of-the-year that are orphaned and counted as mortalities will be assigned sex based on a 50:50 sex ratio at birth (Eberhardt *et al*. 1994). For each cub, a random number will be drawn between 1 and 100. If the number is 1 through 50, the sex will be assigned as male; if the number is 51 to 100, the sex will be assigned as female.

State agencies will manage mortalities within the limits determined as described in Table 2, Table 4, and Appendix O, by implementing specific regulatory mechanisms in state law and regulation.

It is recognized that established mortality limits might be exceeded in any given year. Any mortality threshold will not affect the immediate management of bears for human safety concerns or for management of conflict grizzly bears. Appendix O describes agency responsibilities and actions to reduce mortality should this occur. State plans provide for the take of conflict bears regardless of the current mortality limit upon consultation among all involved agencies.

Each State wildlife agency, Tribe, and National Park will provide mortality information to the IGBST, who will update and report ongoing mortalities within the DMA to all agencies so that the states may adjust management actions under their purview if a mortality limit is approached or exceeded. The IGBST will annually summarize all mortality information as to location, type, date, sex, and age for the GYE and produce this information in their annual reports. A statistical estimate of total mortality for each demographic class will be derived annually from the IPM analysis. This estimate accounts for both documented mortalities (e.g., naturally occurring mortality or human-caused mortality, such as illegal shootings, defense-of-human-life shootings, and vehicle collisions) and unknown, unreported mortalities within the DMA (see Cherry *et al.* 2002).

Population Trend

Background

While the actual level of increase since the grizzly bear was listed in 1975 includes uncertainty, all information, including numbers of unique females with cubs-of-the-year, distribution of

reproducing females (Figure 4), and the distribution of verified grizzly bear occurrences support that this population has increased in both numbers of bears and the geographic area they occupy (e.g., Figure 6).

Harris *et al.* (2006) used data from 1983 through 2001 to assess population trend, and the IGBST has examined more recent time periods. Because the fates of some radio-collared bears are unknown, Harris *et al.* (2006) and the IGBST (2012) calculated two separate estimates of population growth rate: one based on the assumption that every bear with an unknown fate had died (a conservative estimate); and the other simply excluding data from bears with an unknown fate from the sample (*i.e.*, individuals whose telemetry transmitter had failed or been lost). The true population growth rate is assumed to be somewhere in between these two estimates because we know from 30 years of tracking grizzly bears with radio-telemetry that not every lost transmitter indicates a dead bear. Based on population projections, Harris *et al.* (2006) found the GYE grizzly bear population increased at a rate between 4.2 and 7.6% from 1983 to 2001.

Beginning in the early 2000s, the GYE population growth rates slowed, and began exhibiting signs of density dependence, indicative of a wildlife population at or above carrying capacity (e.g., population growth fluctuations, decreased home-range size, reduced dependent young survival, increased competition as more bears occupied the same suitable habitat) (see Figure 3B).

Schwartz *et al.* (2006*a*) estimated survivorship of cubs-of-the-year, yearlings, and independent bears as well as reproductive performance to estimate population growth. They examined geographic patterns of population growth based on whether bears lived inside Yellowstone National Park, outside the Park but inside the Primary Conservation Area (PCA), or outside the PCA entirely. The PCA boundary (containing 23,853 sq km (9,210 sq mi)) corresponds to that of the Yellowstone Recovery Zone (USFWS 1993) and will replace the Recovery Zone boundary (Figure 1). They suggested that grizzly bears were approaching carrying capacity inside Yellowstone National Park. Consistent with this interpretation, the IGBST (2012)

documented lower cub and yearling survival than in the previous time period. Importantly, annual survival of independent females (the most influential age-sex cohort on population trend) remained the same while independent male survival had increased (IGBST 2012). Collectively, these two studies indicate that the growth rate of the grizzly bear population had slowed as bear densities may be nearing carrying capacity in portions of the GYE, particularly in the core area of occupied range. Using a derived index of grizzly bear density (Bjornlie *et al.* 2014), van Manen *et al*. (2016) provided further evidence for density-dependent population regulation where bear densities are high.

Monitoring Protocol

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

Methods will be used as supportive information to evaluate population trend as appropriate. For example, IGBST has previously used: (1) mark-resight estimator (Higgs *et al.* 2013); (2) population projections from known-fate analysis (Schwartz *et al.* 2006*a*, entire; IGBST 2012); and (3) population reconstruction (IGBST, unpublished data). The adoption and continued refinement of the IPM will allow estimation of population vital rates annually by sex- and age-specific cohorts.

The IGBST's goal will be to maintain a minimum of 25 adult female grizzly bears fitted with radio collars and a similar representative sample of males (Schwartz *et al*. 2006*a*). To adequately sample survival, these 25 adult females will be spatially distributed throughout the ecosystem. The target distribution of these 25 radio-collared adult females will be determined by the IGBST; the expected distribution of collared females by agency will be assigned. Each female will be monitored using aerial telemetry flights every 10–14 days during the active season and approximately once every month during the denning season. When a radio collar indicates

via a mortality signal that a bear may have died, a field crew will evaluate the bear's status and, if a mortality is observed, determine cause of death. The IGBST will coordinate collection of mortality data on each bear.

Data to estimate reproductive parameters, such as litter size, and survival of cubs-of-the-year and yearlings, are collected in conjunction with telemetry flights in all areas occupied by grizzly bears throughout the DMA. These data sets will be maintained by the IGBST and used to inform the IPM's vital rate and population size estimation and evaluation of population trend.

Genetic Management

The GYE supports the southernmost population of grizzly bears remaining in North America, and this population has been isolated from other grizzly bear populations. A previous question of concern was whether genetic factors, now or in the future, would compromise the long-term viability of the GYE grizzly bear population.

DNA analyses conducted on museum specimens by Miller and Waits (2003) indicated a slight decline in genetic diversity in the GYE population since the early 20th century; however, this loss of diversity was less severe than previously hypothesized. Indeed, a more recent study by Kamath *et al*. (2015) using advances in genetic analysis techniques (Luikart *et al*. 2010) indicated that despite isolation, genetic diversity in the contemporary population has not declined. Kamath *et al*. (2015) found that the rate of inbreeding in the GYE grizzly bear population was very low (0.2%) over the period 1985 - 2010. Likewise, the effective population size (N_e), which in its simplest form reflects the number of reproducing individuals in a population, was greater than prior estimates across several techniques evaluated by Kamath *et al*. (2015).

The estimator for parentage assignment (EPA) method indicated estimates near the 500 threshold starting around 2005–2007 (IPM estimates range from 773 to 835 during this time frame) (Kamath *et al.* 2015). Extrapolating beyond 2007, N_e likely consistently exceeded the threshold for long-term evolutionary potential of N_e = 500 (Franklin 1980) starting in 2010. Associated IPM-based estimates for the census population (i.e., total population abundance) during that time period (2005–2010) are between 775 and 845 (Gould *et al.* 2023).

These results collectively indicate that, at population levels consistent with the described management objective (maintain the population in the DMA within or above a range of 800 – 950 grizzly bears, applying the IPM population size estimate) and under current or similar environmental conditions, genetic factors do not pose a risk to the viability of the GYE grizzly bear population. Kamath *et al*. (2015) concluded that nonetheless, the historically small *Ne* , relatively low diversity, and isolation over many generations suggest the grizzly population could benefit from increased fitness with additional gene flow, particularly given the unpredictability of future climate and habitat changes.

Sightings, captures, telemetry data, and mortalities in the past decade indicate that grizzly bears from the GYE and the NCDE are expanding their distribution, and there is considerable potential for these populations to connect (*see* Appendix H, Montana Grizzly Bear Management Plan). Moreover, Montana's plan identifies a long-term goal 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.

Management of non-conflict grizzly bears in areas between the NCDE management area and the DMA of the GYE will be compatible with maintaining some grizzly occupancy. Maintaining presence of non-conflict grizzly bears in areas between the NCDE management area and the DMA of the GYE, such as the Tobacco Root and Highland Mountains, would likely facilitate

periodic grizzly movements (potentially facilitating genetic connectivity) between the NCDE and GYE. The Montana Grizzly Bear Management Plan indicates that the state of Montana will retain a priority around conflict management and removal of problem grizzly bears in this area, similar to the rest of Montana.

Human safety will always be prioritized over facilitation of grizzly movement for genetic connection between the ecosystems. However, the state of Montana has indicated that while discretionary mortality may occur here as needed, they will manage discretionary mortality in this area to retain the opportunity for natural movements of bears between ecosystems. Additionally, it is Montana Fish, Wildlife and Parks' (MFWP) 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 grizzly bear, nor is expansion of habitat restrictions necessary for population recovery. Incorporating the grizzly bear as another component of MFWP's ongoing programs for all wildlife is a more productive approach. The level of social acceptance of grizzly bears 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.

MFWP anticipates that successful implementation of this plan, along with adequate local involvement, can allow this to occur, and MFWP commits to continue to address land-use patterns that promote or hinder bear movement.

Genetic Monitoring Protocol

Genetic samples will be collected from all grizzly bear captures and mortalities in the GYE for analysis via cooperative efforts between the IGBST and recognized genetic experts. Genetic analyses of these samples will be conducted and evaluated for potential evidence of grizzly bears from other populations immigrating into the GYE population and producing offspring. Monitoring of radio-collared grizzly bears will be used to document potential movements between other ecosystems and the GYE.

To address potential threats to the long-term genetic health of the GYE population, the States of Idaho, Montana, and Wyoming have made the following commitment in the Tri-State Memorandum of Agreement (Appendix O):

> By 2025, the States will translocate at least two grizzly bears from outside the GYE into the GYE, unless migration from outside the GYE is detected in the interim. Genetic monitoring of the GYE population will continue, and genetic diversity and effective population size (N_e) will be re-assessed at least every 14 years (*i.e.*, one generation). If effective migration (*i.e.*, an individual bear from outside the GYE that survives, breeds, and whose offspring survive) is not detected, the Parties will continue to make additional translocations from outside the GYE.