

## **ISSUE 19:**

Some commenters questioned our interpretation of bear density in the GYE. Commenters claimed that the core population density has decreased because the population has stabilized since the early 2000s while simultaneously the distribution has increased (i.e., the same number of bears are spread across an ever-increasing area). Additionally, one commenter stated that “the density index directly based on the number of bears trapped and radio-marked in a given area during a given year” has not been reviewed to confirm its reliability.

Commenters also took issue with our conclusion from our analysis density-independent and density-dependent effects on grizzly bear population dynamics in the GYE. Several commenters noted that, though we analyzed four factors to determine the relative influence of density-dependent and density-independent effects, only one factor (home range size) differed between the analyses of density-dependence and density-independence. Commenters suggest that both density-dependent and density-independent causes lead to decreased cub and yearling survival, increased age of first reproduction, and decreased reproduction; these factors thus cannot be used to distinguish between the influence of density-independent and density-dependent effects on the grizzly bear population, especially when these effects potentially stem from limited resources. Others commented that the density-dependence analysis failed to account for temporal changes in the abundance of key foods and habitat. Commenters questioned the causal link we suggest between density dependence and declining vital rates; these commenters expressed confusion as to why we only explained one of the four factors from our analyses, cub survival.

Finally, one peer reviewer suggested that we review our use of the words “cause,” suggesting causality, as opposed to “association” in our density-dependence analysis.

## **Language in the Conservation Strategy**

### **Population Trend**

Harris *et al.* (2006) analyzed survivorship of cubs-of-the-year, yearlings, and independent bears based on whether they lived inside Yellowstone National Park, outside the Park but inside the Recovery Zone or Primary Conservation Area (PCA), or outside the PCA entirely. The PCA boundaries (containing 23,853 sq km (9,210 sq mi) correspond to those of the Yellowstone Recovery Zone (U.S. Fish and Wildlife Service 1993) and will replace the Recovery Zone boundary (Figure 1). They concluded that grizzly bears were approaching carrying capacity inside Yellowstone National Park. Consistent with this conclusion, the IGBST (2012) documented lower cub and yearling survival than in the previous time period. Importantly, annual survival of independent females (the most influential age-sex cohort on population trend) remained the same while independent male survival increased (IGBST 2012). Collectively, these two studies indicate that the growth rate of the grizzly bear population inside the DMA had slowed as bear densities may bear nearing carrying capacity, particularly in the core area of occupied range. Recent work by van Manen *et al.* (2016) confirms that the population is showing evidence of density-dependent population regulation in portions of the DMA where bear densities are high.

## **Language in the Proposed Rule**

## Population Ecology – Background

When a population is at or near carrying capacity, mechanisms that regulate or control population size fall into two broad categories: density-dependent effects and density-independent effects. Generally, factors that limit population growth more strongly as population size increases are density-dependent effects, or intrinsic factors, usually expressed through individual behaviors, physiology, or genetic potential (McLellan 1994, p. 15). Extrinsic factors, such as drought or fire that kill individuals regardless of how many individuals are in a population, are considered density-independent effects (Colinvaux 1986, p. 172). These extrinsic factors may include changes in resources, predators, or human impacts. Population stability (i.e., fluctuation around carrying capacity or a long-term equilibrium) is often influenced by a combination of density-dependent and density-independent effects. Among grizzly bears, indicators of density-dependent population regulation can include: (1) decreased yearling and cub survival due to increases in intraspecific killing (i.e., bears killing other bears), (2) decreases in home-range size, (3) increases in generation time, (4) increases in age of first reproduction, and (5) decreased reproduction (McLellan 1994, entire; Eberhardt 2002, pp. 2851–2852; Kamath *et al.* 2015, p. 10; van Manen *et al.* 2015, pp.8–9). Indicators that density-independent effects are influencing population growth can include: (1) larger home-range sizes (because bears are roaming more widely in search of foods) (McLoughlin *et al.* 2000, pp. 49–51), (2) decreased cub and yearling survival due to starvation, (3) increases in age of first reproduction due to limited food resources, and (4) decreased reproduction due to limited food resources. As a result of these sometimes similar indicators, determining whether a population is affected more strongly by density-dependent or density-independent effects can be a complex undertaking. For long-lived mammals such as grizzly bears, extensive data collected over decades are needed to understand if and how these factors are operating in a population. We have these data for the GYE grizzly bear population, and the IGBST has been able to tease apart some of these confounding effects to find that density-dependent effects are the likely cause of the recent slow in population growth (see *Changes in Food Resources* under Factor E, below, for more detailed information).

## Changes in Food Resources

During years of low whitebark pine seed availability, we know grizzly bear-human conflicts may increase as bears use lower elevation, less secure habitat within their home ranges (Gunther *et al.* 2004, pp. 13–15; Schwartz *et al.* 2010, pp. 661–662). Approximately six more independent females and six more independent males die across the ecosystem in poor whitebark pine years (IGBST 2013, p. 25, figure 5). These mortalities are primarily due to defense of life encounters and wildlife management agency removals of conflict bears (Gunther *et al.* 2004, pp. 13–14; IGBST 2009, p. 4). Additionally, both litter size and the likelihood of producing a litter may decrease in years following poor whitebark pine years (Schwartz *et al.* 2006b, p. 21). Despite these effects on survival and reproduction, using data from 2002 to 2011, the IGBST documented an average annual population growth rate for the GYE grizzly bear population between 0.3 and 2.2 percent (IGBST 2012, p. 34). Although the population was still increasing in this more recent time period, it was increasing at a slower rate than in the previous time period (1983–2001). Therefore, the IGBST examined the potential influence whitebark pine was

having on this population growth rate. Because extrinsic, density-independent factors (e.g., whitebark pine availability) and intrinsic, density-dependent factors (i.e., a population at or near carrying capacity) can produce similar changes in population vital rates, the IGBST conducted several analyses to clarify and tease apart these two similar effects. The results of these analyses were summarized in a single report titled “Response of Yellowstone grizzly bears to changes in food resources: a synthesis” (hereafter referred to as “the Food Synthesis Report”) (IGBST 2013). Regardless of whether these changes are being driven by declines in whitebark pine or are simply an indication of the population reaching carrying capacity, our management response would be the same: to carefully manage human-caused mortality based on scientific monitoring of the population.

For the Food Synthesis Report, the IGBST developed a comprehensive set of research questions and hypotheses to evaluate grizzly bear responses to changes in food resources. Specifically, the IGBST asked eight questions: (1) How diverse is the diet of GYE grizzly bears? (2) Has grizzly bear selection of whitebark pine habitat decreased as tree mortality increased? (3) Has grizzly bear body condition decreased as whitebark pine declined? (4) Has animal matter provided grizzly bears with an alternative food resource to declining whitebark pine? (5) Have grizzly bear movements increased during the period of whitebark pine decline (2000–2011)? (6) Has home range size increased as grizzly bears sought alternative foods, or has home range size decreased as grizzly bear density increased? (7) Has the number of human-caused grizzly bear mortalities increased as whitebark pine decreased? (8) Are changes in vital rates during the last decade associated more with decline in whitebark pine resources than increases in grizzly bear density? The preliminary answers to these questions are contained in the Synthesis Report and the final results have been (or will be) published in peer-reviewed journals (in their entirety: Schwartz *et al.* 2013; Bjornlie *et al.* 2014a; Costello *et al.* 2014; Gunther *et al.* 2014; Schwartz *et al.* 2014; van Manen *et al.* 2015; Ebinger *et al.* *in review*; Haroldson *et al.* *in prep.*)

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We recognize that changes in food resources can have some influence on population vital rates. These research questions and results do not refute that possibility, but the preponderance of evidence supports the conclusion that bears are finding sufficient alternative food resources to maintain body condition (Schwartz *et al.* 2013, p. 75; IGBST 2013, p. 20). Evidence suggests that observed changes in population vital rates since the rapid decline of whitebark pine that began in the early 2000s are being driven by density-dependent effects and have resulted in a relatively flat population trajectory (van Manen 2016, *in litt.*). Van Manen *et al.* (2015, entire) found cub survival, yearling survival, and reproductive transition from no young to cubs all changed from 1983 to 2012, with lower rates evident during the last 10–15 years. Cub survival and reproductive transition were negatively associated with an index of grizzly bear density, indicating greater declines where bear densities were higher. Their analysis did not support a similar relationship for the index of whitebark pine mortality. The results of van Manen *et al.* (2015) support the interpretation that slowing population growth during the last decade was associated more with increasing grizzly bear density than the decline in whitebark pine. In other words, the population is approaching carrying capacity (van Manen *et al.* 2015, entire). This evidence further supports the recovered status of the GYE grizzly bear population. Despite significant changes in food resources in the GYE in the last 15 years, grizzly bear population growth increased or stabilized.

