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Considerations for Sage-Grouse Management Objectives

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In March 2010, the U.S. Fish and Wildlife Service (FWS) identified the greater sage-grouse (*Centrocercus urophasianus*; sage-grouse) as a candidate species for protection under the Endangered Species Act (ESA) because of habitat loss and fragmentation and that regulatory mechanisms needed to protect the species and its habitat were inadequate. However, after further review of on-going range wide conservation efforts by federal, state, and local partners in September 2015, the USFWS removed sage-grouse as an ESA candidate species because the collective conservation actions had sufficiently mitigated threats. Utah, along with other western states, the Bureau of Land Management (BLM), and the U.S. Forest Service (USFS), developed and are implementing conservation plans designed to manage sagebrush (*Artemisia* spp.) areas which afford sage-grouse the best habitats. In Utah, the state has identified 11 priority conservation areas, known as sage-grouse management areas (SGMAs).

In the 2015 decision, the FWS reemphasized the need to focus conservation efforts on protecting and enhancing priority habitats for species conservation. Many sage-grouse conservation plans have established either population or habitat management objectives within priority conservation areas. For management objectives to be valid, they must be realistic and achievable. In other words, managers must have some degree of control of the factors which most influence outcomes. If factors that influence objectives are outside the control of the manager or not within the natural variability of the systems being managed, failure and frustration is inevitable. Management objectives should also be based on the best available science and information. Thus, an understanding of sage-grouse population dynamics and how they relate to habitat characteristics (e.g., vegetation cover, scale, and fragmentation) and other environmental factors is paramount to setting effective management objectives. For example, setting objectives for the

Figure 1. Sage-grouse brood in late summer (photo by Les Flake).

conservation of wet meadow complexes within sagebrush systems would provide forbs and insects that could be critical for chick survival in drought years (Fig 1). Another example might be to employ a rotation grazing system where different pastures are left ungrazed each year during the nesting season to provide concealment cover.

Population Dynamics

Population dynamics include the changes in population size, sex ratio, and age composition and the biological and environmental processes driving them, such as birth and death rates, etc., in other words "vital rates" (Fig. 2). Important sage-grouse vital rates include hen survival (the percent of hens that stay alive annually), chick survival (the percentage of chicks that survive the summer), clutch size (the number of eggs in a nest), nest survival (the percent of nests that hatch), and nest initiation (the percent of hens that begin a nest). Sage-grouse are relatively long-lived (up to 4-8 years) with lower reproductive rates compared to other gamebirds (Taylor et al. 2012, Dahlgren et al. 2016a). This comparatively longer life history is uniquely adapted to the semi-arid sagebrush landscapes they inhabit. Based on our research, sage-grouse females are the most important driver in population change because only a small portion (~ 10-30 %) of sage-grouse males actually breed each year (Dahlgren et al. 2016a).

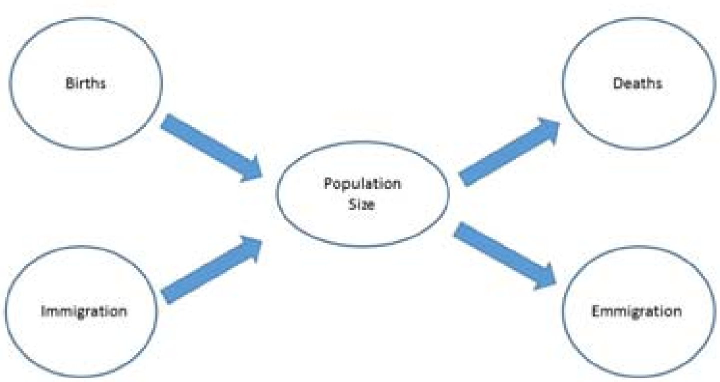

Figure 2. Basic population dynamics diagram.

Annual survival of females that can reproduce is the most important vital rate for sage-grouse populations and has been traditionally divided into two age classes, yearlings (a female in her first breeding season) and adults (a female in her second or more breeding seasons). Female survival can vary by season (breeding, summer, winter, etc.) within a year (Blomberg et al. 2013). The next most important vital rate is the number of females added to the breeding population or, in other words, fertility rate. Thus, a sage-grouse population's fertility rate consists of consecutive stages: nest initiation, clutch size, nest success, chick survival, and juvenile survival (from end of summer to first breeding).

Thus, the number of sage-grouse within a population are dependent on the interaction of the fertility rate and female survival and how each vital rate fluctuates in relation to other vital rates. For example, one population may have high female survival but low fertility rates and have the same population growth rate as another population with lower female survival and higher fertility rates. Similarly, a population can show high nest success with many chicks hatching but poor chick survival and have a similar fertility rate as another population with low nest success but high chick survival. Ultimately, population growth comes from the multiple interactions of all vital rates.

Since a sage-grouse female has a high probability of surviving several years, she may not nest in years when conditions are poor (e.g., drought). Thus, in times of stress the proportion of females nesting in a population may be lower than normal (Connelly et al. 2000). Conversely, in years with average or above average precipitation, she may have a higher likelihood of successfully reproducing and thus more females may start the reproductive process. Once she initiates breeding activities such as attending a lek, laying eggs, incubating a nest, and tending a brood, she has a lower chance of survival than females that did not try to reproduce that year (Blomberg et al. 2013). Additionally, research in Utah shows if a female is successful one year she will likely have a harder time being successful the following year, and younger females tend to have lower reproductive rates, such as nest initiation and success, compared to adults (Caudill et al. 2014, Dahlgren et al. 2016a).

In summary, the most influential vital rates affecting sage-grouse population growth are adult, yearling, and juvenile female survival. Thus, the survival of female sage-grouse in each of these life stages tends to influence changes in population numbers relatively more than reproductive rates. Specifically, adult females are key because they produce more chicks than younger females. Thus, successfully hatching nests and raising chicks (i.e., reproductive success), though not as important as female survival, is still a critical step in maintaining populations.

Movements, Habitat, and Climatic Interactions

In its 2015 decision, the FWS acknowledged that better knowledge of sage-grouse seasonal movements is essential to conservation. Generally, sage-grouse seasonal habitats have been defined using three broad categories: breeding, summer, and winter (Connelly et al. 2000). Breeding habitats consist of areas where pre-laying, lekking, nesting, and early brooding activities occur. Summer habitats consist primarily of late brooding areas. Winter habitat occurs in areas where sagebrush is accessible throughout the winter for food and cover. Some populations are considered non-migratory, using a specific landscape to meet all their habitat requirements while other populations may migrate > 30 miles between habitats. Within a population, individuals may migrate differently between habitats. For example, within the same area a breeding population may contain different individuals than a wintering population.

Seasonal movements of sage-grouse populations reflect the availability of habitat space and environmental conditions. For example, in smaller need to move farther to meet some of their needs, such as moving from winter to breeding areas, but may also have lower survival rates when doing so. Furthermore, female sage-grouse tend to move shorter distances from nests to brood rearing areas in landscapes with less sagebrush habitat compared to populations in larger more continuous sagebrush landscapes (Beck et al. 2006; Dahlgren et al. 2016b).

Sage-grouse nest success tends to fluctuate across populations and by year within a population (Fig. 3). Nest success in the same area can be higher in a year with more precipitation and better cover than

Figure 3. Female sage-grouse on a nest.

in a drought year when cover may be sparser (Holloran et al, 2005). Chick survival tends to be best when forb and insect abundance is high (Connelly et al. 2000), however other related environmental factors, such as timing and amount of precipitation also influence chick survival (Guttery et al. 2013). Abundance of forbs and insects can vary based on yearly weather patterns or the location of a brood on the landscape. For example, broods using wet meadows, irrigated alfalfa fields and pastures, or wetter areas located at high elevations may find more forbs and insects as the summer progresses compared to broods using drier habitats. There are many environmental factors (e.g., climate, habitat, fragmentation, disturbance, etc.) that can affect sage-grouse vital how each vital rate will respond in a given year.

Most notably, our largest and most stable sage-grouse populations in Utah and across the range tend to occupy large undisturbed continuous landscapes that contain adequate amounts of sagebrush habitat (> 60% of the landscape is sagebrush) (Johnson et al. 2011, Knick et al. 2013). But, even these stable populations will fluctuate with large increases and decreases depending on rates, thus it is difficult to predict with certainty changing environmental conditions (Garton et al. 2011).

Management Objectives

Federal and state plans have proposed specific objectives to protect, maintain, and enhance sage-grouse populations and habitats within established priority areas. Most of these plans rely on annual spring counts of males attending leks to estimate population trends. Leks are the center of breeding activity for sage-grouse and provide managers with a way to monitor population trends (Fig 4). For example, the Utah Sage-grouse Conservation Plan proposes to sustain an average male lek count at 4100 males and increase the population of males to 5000 within the established SGMAs (both numbers are based on the ten-year rolling average on a minimum of 200 monitored leks).

Figure 4. Male sage-grouse strutting at sunrise.

Because population growth rates from male lek counts correlate with growth rates based on female vital rates (Dahlgren et al. 2016a), long-term lek count trends provide the best method to determine and monitor population change. In other words, counts of males can tell us how the females are doing, too. Thus, lek counts, not individual vital rates, should be used to assess population response and set management objectives. Sage-grouse populations tend to cycle on a ~ 10-year basis and sagebrush systems response relatively slowly to management actions. It is important to consider multiple year trends and preferably multiple 10-year cycles rather than year to year or short-term (< 10 years) information (Garton et al. 2011). It is important to note that sage-grouse populations can make large swings up and down within a few years and still be considered stable in the long-term.

An example of a well-intended but misguided approach would be setting a management objective based on a single vital rate such as nest success. This is inappropriate because, as shown above, the nest success rate's influence on the population is relative to its relationship with all the other vital rates within that population. Basing management objectives on a single vital rate is also not practical because managers cannot influence all the environmental factors that influence individual vital rates (e.g., temperature, weather events, etc.).

For example, if achieving a specific nest success rate was established to measure the effectiveness of a specific management action, how might a manager successfully meet that objective? Certainly, habitat characteristics, such as shrub cover, grass cover and height can be managed to an extent. However, the manager has no influence on the amount of snowpack and spring precipitation that also contributes to, and may ultimately drive, grass height and cover in nesting areas. Or, how would a manager influence the dynamics within predator communities, especially protected avian predators, which can fluctuate annually and influence nest success regardless of habitat quality? Alternatively, a manager should set objectives under their control. The most important objective might be to keep the sagebrush landscape intact at the larger scale and then within that landscape help meet specific seasonal habitat objectives for sage-grouse. These objectives should fall within the natural variability of the local sagebrush community (Connelly et al. 2000). The above considerations are central tenants to effective sage-grouse conservation.

Conclusion

Sage-grouse conservation and management is inherently complicated and uncertain. Population dynamics can be variable between populations and even year to year within a single population. Understanding how vital rates interact to effect population change and the factors that influence those changes is critical to designing appropriate management objectives. In the case of sage-grouse, the most important approach for a manager includes protecting high-quality sagebrush habitat at landscape scales, enhancing impaired habitats where needed, and restoring habitats when possible for sage-grouse populations in priority areas. In Utah, this toolkit includes increasing the available habitat space and connectivity by removing conifers that have encroached into sagebrush habitats and through rangeland management techniques, such as livestock grazing (Messmer et al. 2013, Dahlgren et al. 2015, Dahlgren et al. 2016b). Long-term (i.e., multiple cycles) lek count trends can then be used to assess how the overall sage-grouse population dynamics are doing within the available habitat in response to management actions and other environmental factors.

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