BUILDING A TRADITION OF ADAPTIVE RANGELAND MANAGEMENT: JACK SOUTHWORTH

RANCHER-TO-RANCHER CASE STUDY SERIES: INCREASING RESILIENCE AMONG RANCHERS IN THE PACIFIC NORTHWEST

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BUILDING A TRADITION OF ADAPTIVE RANGELAND MANAGEMENT: JACK SOUTHWORTH

By

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Abstract

Jack Southworth runs a cow-calf-yearling operation in the high-desert rangelands and dry forests around Seneca, Oregon. Southworth has been using holistic management for decades, with a strong focus on managing for rangeland and soil health. He grazes with relatively high densities and frequent rotations, uses plant phenology to decide when to graze, has seeded degraded rangeland with a diverse seed mix with non-native perennial bunchgrasses, and monitors plant communities annually to track the soil and vegetation's response to management. These practices, in combination with the ability and willingness to be flexible, have allowed Southworth to maintain rangeland health and an economically viable operation. This translates to a resilience that can help him manage the risks posed by changing climatic conditions.

This case study is part of the Rancher-to-Rancher Case Study project, which explores innovative approaches ranchers in the region are using that increase their resilience to a changing climate.

Information presented is based on ranchers' experiences and expertise and should not be considered university recommendations. Mention of trade names or commercial products is solely for the purpose of providing specific information and does not imply recommendation or endorsement. Rancher quotes have been edited slightly for clarity, without changing the meaning.

Readers interested in other case studies in the Rancher-to-Rancher and the Farmer-to-Farmer series can access them on the CSANR website as well as at the WSU Extension Publications Store.

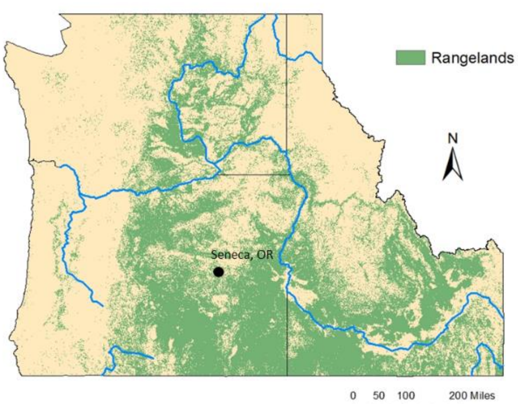
Building a Tradition of Adaptive Rangeland Management: Jack Southworth

Jack Southworth. Photo: Darrell Kilgore.

Location: Seneca, OR

Average Annual Precipitation: 14 inches (355 mm)

Production System: Cow-calf-yearling operation, grazing high-desert shrub steppe, native and seeded grassland, and feeding alfalfa and other hay over the long, cold winters.



Map: Sonia A. Hall and Kaelin Hamel-Rieken, Washington State University. Occurrence of rangelands mapped using 250 m resolution data from Reeves and Mitchell (2011).

Introduction

Jack Southworth has been managing the Southworth Brothers Ranch in the Bear Valley in central Oregon since 1978, when he took over operations from his father. The name of the ranch refers to his grandfather and great-uncle, the brothers who grew their father's original 160-acre homestead into a working cattle ranch. Southworth attributes their ability to expand to their having a diverse set of business enterprises: "By having a stagecoach stop, a little store, and a post office, they had a little bit of money when no one else had any, and were able to buy up an occasional homestead, and gradually put together an outfit."

The Bear Valley, on the south side of the Strawberry Mountains, crosses the transition zone from dry, fire-prone forest to high-desert shrub steppe, where cattle grazing is the main productive activity (Figure 1). It receives 14 inches of precipitation a year, much of it falling as snow. With limited precipitation, long winters with minimum temperatures reaching as low as -50°F (-45°C), and short growing seasons for the vegetation—generally from May through July—this is a challenging environment for people and cattle alike. Yet the quality of life this environment and their cattle enterprise provides Southworth is more than enough to counteract these challenges.

The Art of Range Podcast

Jack Southworth was recently interviewed on the Art of Range podcast, where he provides more detail on his management philosophy. In the Art of Range podcast series, Tip Hudson, Associate Professor at Washington State University Extension in rangeland and livestock management, interviews researchers, ranchers, and resource professionals, discussing a variety of topics related to grazing and rangeland management in the inland Pacific Northwest.

Figure 1. Cattle grazing is the main productive activity in the high desert and dry forest landscape of the Bear Valley, near Seneca, Oregon. Photo: Jack and Teresa Southworth.

Southworth runs the cow-calf-yearling operation with the help of his wife Teresa and four full-time employees. They graze and manage 12,000 deeded acres (4,856 ha) and approximately 30,000 acres (12,141 ha) of leased U.S. Forest Service land adjacent to their property. Southworth runs about 800 cow-calf pairs and keeps the weaned calves until they are yearlings. All heifers are bred to bulls they develop through their own bull program. Replacement heifers are selected from these bred heifers, and the remainder are sold. Steers are sold as yearlings, marketed directly through the Country Natural Beef program.

Southworth has a long winter feeding period, as snow generally covers the ground from December to mid-February or early March. He waits until early May to put the herd out to graze, giving rangeland grasses on his lands a chance to actively grow and become productive before the cows harvest them. A large part of their deeded lands was significantly degraded through past overgrazing—continued heavy grazing which exceeds the recovery capacity of the plant community and creates a deteriorated range (SRM 1998)—and Southworth has replanted these areas, where tillable, with different species of wheatgrasses (mostly *Agropyron cristatum*, with some *Thinopyrum intermedium* and *Pascopyrum smithii*), yellow-blossom sweetclover (*Melilotus officinalis*), and a forage turnip (*Brassica rapa*).

After grazing his rangeland and seeded pastures in ways compatible with Southworth's utilization objectives, the herd is moved to the leased National Forest lands at higher elevation while the yearlings stay on the ranch, grazing on native meadows, which stay productive later in the season. Yearlings are sold generally in September, after which the herd is brought back onto the ranch.

Holistic Management at Southworth Brothers Ranch

Jack Southworth has been practicing holistic management since the 1980s. Holistic management, as popularized by Alan Savory (Savory and Butterfield 1998), is a practical, goal-oriented approach to ecosystem management, incorporating a holistic view of the land, the people, the biological, the financial, and other resources (SRM 1998). The Southworths started by defining a quality-of-life goal for their ranch, then identifying component goals they needed to achieve on the way, including such things as profitability and ecological goals. And, critically, they defined the landscape that would support such goals and the day-to-day decisions that support efforts to achieve that landscape. This landscape included open, fire-resistant forests, healthy riparian areas, rangelands well covered by bunchgrasses, and abundant wildlife. For Southworth, this way of thinking about the ranch has proven profitable and has supported investment in practices and landscape features that they would otherwise have had a hard time sustaining. This includes the protection and management of healthy riparian areas, which not only support birds, fish, and other wildlife but also help reduce erosion and raise water tables (Batchelor et al. 2015), benefiting the rangeland and cattle production on the ranch. This way of thinking influences how they manage their cattle and their grazing, and it led to some important grazing management practices that have improved the resilience of their rangelands to future changes, including climate change and increased disturbance.

Managing for Grass as Well as Cattle

Southworth considers his operation a grass-cattle-people ranch, which "transforms sunlight into meaningful lives." As he says, "a whole lot of things have to go right" to get from one to the other. In particular, rangeland health is the driver of most of those things that must go right: a rangeland in decline can result in an unprofitable ranch (Teague et al. 2009). Southworth balances maximum forage production with other ecological goods and services—such as wildlife habitat and stabilizing soils—through intensive, adaptive range management. In fact, it is a combination of conservative grazing practices and intensive management that seems to be the key. These practices maintain or enhance critical ecosystem processes which are necessary for profitability: water cycling, nutrient cycling, and plant reproduction.

Managing Grazing

The Southworth Brothers Ranch maintains approximately 800 cow-calf pairs and 700 yearlings on 42,000 acres (16,997 ha), using both private and Forest Service land. This equates to an average of 52 acres (21 ha) per animal. To maximize forage production on high-elevation, semi-arid range on the edge of the ponderosa pine precipitation zone, Southworth practices intensive grazing control. Southworth grazes relatively small areas at a time, and then gives that paddock (or grazing unit; see the *Pasture or Paddock?* sidebar) a long time to recover from grazing. He is also careful not to graze rangelands too early in the spring, using a phenological stage between three and four leaves of new, green growth—what he calls the "three-and-a-half leaf stage"—as the threshold that determines plants can tolerate spring grazing without undue impacts to their vigor (see the *To Graze or Not to Graze* sidebar).

Pasture or Paddock?

Tipton D. Hudson, *Associate Professor, Rangeland and Livestock Management, Washington State University Extension*

According to *Terminology for Grazing Lands and Grazing Animals* (FGTC 1991) a paddock is defined as "a grazing area that is a subdivision of a grazing management unit, and is enclosed and separated from other areas by a fence or barrier." This term is more consistent with the authors' understanding and application of a unit of land delineated by various topographic and manmade boundaries for the purpose of controlling the distribution of domestic livestock, a unit that we have heretofore referred to as a "pasture." A pasture is defined by the same publication as "a type of grazing management unit enclosed and separated from other areas by fencing or other barriers and devoted to the production of forage for harvest primarily by grazing." The terms are nearly synonymous, but the term pasture may have connotative baggage that communicates the idea that this piece of land has only one purpose—supporting livestock. Most rangelands function very well as wildlife habitat and provide an array of ecological goods and services in addition to supporting livestock.

To Graze or Not to Graze

Tipton D. Hudson, *Associate Professor, Rangeland and Livestock Management, Washington State University Extension*

Southworth starts grazing on native rangeland and seeded pastures at the "3½ leaf stage" (Figure 2). This practice has been successful for him, but is this rule of thumb a rule that is applicable everywhere? Key to answering this question is how the initiation of spring grazing decision fits into the overall grazing management, because grazing early in the spring may not be a problem if plants are allowed to recover later in the season.

Bunchgrass plants growing in any climate dominated by winter precipitation are vulnerable to grazing during bolting (what plant scientists call internode elongation), such that they lose the lowest elevated meristem (growing point). Bunchgrasses depend on seed production rather than tillering from rhizomes for reproduction. If they are grazed annually during bolting, and insufficient soil moisture is available to support developing a seedhead, they will lose vigor and eventually die, relinquishing their soil niche to another species that is more grazing tolerant or resistant.

Recommendations for herbicide applications on grasses, seeding timing in late summer, and grazing initiation all reference the three- to four-leaf phenological milestone because there is a critical level of hardiness achieved at this stage, especially in a seedling. However, the four-leaf stage often coincides, in established perennial bunchgrasses, with the initiation of reproductive growth. As has been well-established, "when grazing initiation dates and sufficiently high grazing intensities coincide with reproductive tiller elongation through the boot stage, productivity of native cool-season grasses can be significantly reduced" (Perryman et al. 2005). Alf Bawtree, in his 1989 literature review, asserted that "grazing bunchgrasses during the boot stage is more damaging than at any other stage of growth" (Bawtree 1989; Perryman et al. 2005). This is why grazing management that ensures bunchgrasses are given sufficient rest later in the growing season—as Southworth's grazing management does—is as, or more, important than not grazing before grasses have grown sufficiently in the spring (i.e., have reached the "3½ leaf" stage).

Figure 2. A bluebunch wheatgrass tiller at the "3½ leaf stage," which Southworth uses as a rule of thumb for when he can turn out his cattle to graze in the spring, a management decision that he combines with strategically timed rest periods later in the growing season. Photo: Jack Southworth.

It is important to distinguish between factors involved in initiating grazing on new seedings versus grazing established plants that green up in spring. Grazing new seedings requires knowledge of the individual species. For example, *Pasture and Grazing Management in the Northwest* (Shewmaker and Bohle 2010) provides a table of minimum plant heights, by species, for grazing commencement. The "before grazing" height identifies at what plant size the species will tolerate grazing; the "stubble" height identifies how much of the plant needs to be left after grazing in order for survival and regrowth to occur. These tables also consider the growth form of the plant. Rhizomatous (sod-forming) species respond favorably to more frequent defoliation than caespitose (bunched) species.

On the Southworth Brothers Ranch, the 3½ leaf stage rule is primarily applied to seeded rangeland pastures. This stage of growth corresponds to a height that indicates there is enough root material such that the cattle will not be able to pull plants out of the ground in the act of grazing. And Southworth grazes for a short period of time, then allows those plants to regrow well beyond the height they had achieved when first grazed, making this grazing rule applicable to either bunchgrasses or drought-tolerant sod-forming grasses. It is important to note that this rule would not work if livestock stayed on the same pasture for a long time; that is, the 3½ leaf stage rule works for Southworth because the combination of a short grazing period and long regrowth periods within a single growing season is effective in nearly any context.

Southworth monitors his pastures annually. This practice can provide early warning of whether his use of the 3½ leaf stage rule, combined with later rest periods, is detrimental to the native or seeded bunchgrasses. Continued vigilance will be even more important in the future as climate change impacts the timing of plants' phenology and potentially shifts factors that have allowed Southworth's use of the 3½ leaf stage rule to be effective in his operation so far.

Grazing relatively small areas and rotating through multiple paddocks is not uncommon on irrigated pastures. Irrigated pastures' higher forage production per unit area allows a smaller paddock to hold a herd of cattle for longer. But the strategy is not common on semi-desert rangeland. The concept remains the same—the amount of time a given paddock is not exposed to a grazing animal is directly related to how many paddocks are in use. And longer recovery periods tend to favor higher plant diversity and support higher yield.

To consider a simple example, if a rancher has 10,000 acres (4,047 ha) and divides it in half, planning to graze from May through October, they will graze each piece a total of 90 days, even if they move animals back and forth several times. There is at least the potential for individual plants to be clipped multiple times anywhere in the 90 days. If the rancher takes the same 10,000 acres and creates 12 paddocks of approximately 833 acres (337 ha) each and moves the herd through each one over the same six months, animals will graze in each one only 15 days. One must exercise greater control over the duration of grazing because overgrazing can occur much more quickly with a few hundred animals confined to 833 acres rather than confined to 5,000 (2,023 ha). However, this area is still large enough to provide animals access to a wide variety of plant functional groups and plant species, and the likelihood of overgrazing these smaller paddocks is relatively small.

Southworth recognizes that historical grazing practices—including early spring grazing, and continuous grazing into June—have impacted the current condition of his rangeland. That is why he uses what he has learned about plants' response to defoliation to guide when he starts grazing in the spring and how he manages his cattle through the growing season. The combination of delaying grazing until grasses have enough biomass and leaf area to sustain light to moderate grazing and providing extended regrowth periods are key components of his efforts to graze in ways that allow him to sustain a desirable plant community, high forage production, and healthy, well-covered soils.

From a landscape-scale and longer-term perspective, overgrazing occurs when the dominant perennials most preferred by grazing animals are not able to maintain vigor and stand dominance. Sustainable grazing maintains the preferred plant community over time. Notice that the term "sustainability" only has meaning if we are specific about what we intend to sustain. Where Southworth grazes native rangeland, he intends to maintain vigorous native bunchgrasses as the dominant functional group in the plant community. These bunchgrasses mostly reproduce by seed and are not sod-forming, so their vigor can be negatively impacted by late spring grazing that interrupts bolting and seed set. Southworth's practice of monitoring annually to verify whether his grazing management is sustaining these species (see the section on monitoring the range, below) is, therefore, a critical part of his overall management.

Southworth's approach to grazing the introduced grasses he has seeded is also focused on balancing utilization with maintaining the vigor of perennial grasses: "if we can just take one bite off that plant and let it recover from grazing for most of the grazing period—say 45 to 60 days between early May until the end of June—then we should be able to come back to a plant that has very few seed heads, has high-quality leaves in the regrowth, and is ready to handle more grazing" (Figure 3). The rate of regrowth is proportional to how much photosynthetically active plant material is left standing (green leaf), so the more severe the defoliation—the higher the percentage of current biomass removed—the longer the recovery period to regrow that biomass. Southworth's goal is to graze pastures no more than once each year in order to maximize growing season recovery times and increase the ungrazed forage that will eventually help cover the soil.

Figure 3. Intensive grazing does not translate to overgrazing if cattle are moved frequently and the grazed pasture is then given sufficient recovery time. Photo: Jack and Teresa Southworth.

Although the period of active grass growth is only about four months, Southworth is able to graze for seven months out of the year by deferring grazing in some areas in order to "stockpile" forage. That is, Southworth's grazing management and stocking rates allow him to produce enough forage during the four-month growing season to feed his herd for seven months. During those three additional months, the cattle graze dormant vegetation, harvesting the recently-ended growing season's production. In this way, Southworth limits the period when he needs to feed hay from roughly December through the end of April or early May. Hay is purchased rather than harvested on the ranch. Feeding hay for five months, therefore, imports nutrients to the ranch, and allows Southworth to use his home-grown forage resources to maximize the length of time his animals harvest forage for themselves.

Taking Care of the Soil

The open rangelands of the inland Pacific Northwest are generally considered arid or semi-arid, because plant growth is limited by water. However, semi-arid ecosystems are also characterized by variability in precipitation, and primary nutrients, such as nitrogen, are an important additional limitation (see the *Key Factors That Limit Plant Growth and Their Management Implications* sidebar). Under these conditions, it is critical for rangeland managers to strive to conserve existing water, enhance resilience, and cycle nutrients between biomass and soil.

Key Factors That Limit Plant Growth and Their Management Implications

Tipton D. Hudson*, Associate Professor, Rangeland and Livestock Management, Washington State University Extension; and*
Georgine G. Yorgey*, Associate Director, Center for Sustaining Agriculture and Natural Resources, Washington State University*

Western rangelands are characterized by aridity, with most of the United States west of the 100th meridian receiving less than 20 inches (508 mm) of precipitation per year. Evidence also suggests that arid western lands are likely to expand in the future, as climate changes causes the "line of aridity" to move eastward (Seager et al. 2018a, 2018b). In western rangelands, precipitation limits plant growth, and it is therefore critical to manage landscapes in ways that capture as much of that rain or snow as possible, enabling its storage in soils and its use by plants. Practices that increase soil water holding capacity, reduce evaporation from the soil surface, and moderate soil temperatures are thus extremely beneficial to enhancing the productivity and resilience of western rangeland ecosystems (Figure 4).

Recent analyses have suggested that inter-annual variability characterizes western rangelands even more than aridity. These ecosystems are subject to variability in the timing, frequency, and spatial distribution of precipitation, as well as in seasonal temperatures (Sayre 2017). Therefore, rangeland practices which increase resilience to variable climate factors, both within a year and between years, are highly valuable. Such practices can include managing to enhance ecological health and avoid degradation, reducing bare soil, operational practices such as de-stocking and re-stocking strategies to match herd size to available forage resources, and social or policy factors (Branson et al. 1981; Brown et al. 2005; Smith et al. 2007).

Figure 4. High ground cover, by litter and bunchgrasses, protects the soil and reduces loss of moisture through evaporation, factors that help improve rangeland health and productivity. Photo: Darrell Kilgore.

Arid and semi-arid ecosystems are as limited by nitrogen as they are by water (Havstad et al. 2009). Rangeland plant communities respond to improved nitrogen availability with increased biomass production, assuming precipitation is held constant. Thus, grazing management which returns the nutrients in above-ground biomass back to the soil helps to overcome limiting factors in range forage yield. This can include strategies that put plants and plant litter in contact with the ground as well as strategies that reduce water loss from the landscape.

Southworth understands the importance of reducing bare soil in these semi-arid ecosystems and actively manages his cattle to favor increasing both plant and litter cover. Southworth's use of high animal density helps break down the standing dead biomass to help cover the soil. Trampled forage becomes litter cover, reducing evaporation of scarce moisture and conserving it for the plants as well as recycling nutrients into the soil. Southworth's grazing practices also stimulate tillering in bunchgrasses, which increases forage production and reduces areas of bare soil. These practices help shade and cover the soil and protect the scarce moisture it collects.

In the pastures that Southworth has tilled and seeded with higher-production, introduced species (see below for more details on seeded pastures), the initial tilling leads to loss of soil organic matter by stimulating its decomposition. Southworth's efforts to increase plant and litter cover in these pastures, however, should gradually build organic matter back up, as long as the land is not tilled again. Southworth's goal is to not have to re-till and re-seed these pastures, and his grazing management targets that goal.

Improving Forage Production

The native bunchgrasses that dominated this region before cattle arrived were productive and nutritious for livestock. Such rangelands can be grazed successfully without losing the most preferred species out of the mix. However, improper historical grazing practices tended to maximize grazing use rather than rangeland health. Such practices resulted in large areas of the Southworth Brothers Ranch being overgrazed and degraded. As a friend of Southworth's once told him when discussing the reduced vigor of rangeland plants in these areas: "Well, that's because you don't have the native perennials. You have the battered remnants of native perennials from the overgrazing that you and your ancestors have done."

Southworth's solution has been to augment these remnants by seeding non-native plants across approximately 5,000 acres (2,023 ha). The non-native species function in the landscape similarly to some of the native bunchgrasses. These species establish readily on a variety of soil types, do not depend solely on seed production for reproduction, and have similar (or improved) attributes to native bunchgrasses in terms of forage value, soil stabilization, and, to some extent, habitat value (Figure 5; see the *Seeded Rangelands and Wildlife Habitat—Balancing Trade-Offs* sidebar). Southworth has also added other forage species to his seed mix, including a forage turnip and yellow-blossom sweetclover. From a business perspective, investing in seeding rangeland would be economically risky without the grazing control necessary to capture the value, over time, of this forage-centric plant community, which is a hybrid of an agroecosystem and a natural rangeland ecosystem (see the *Establishing Introduced Rangeland Grasses* and *Cost Considerations of Establishing Introduced Rangeland Grasses* sidebars). This hybrid system functions more like grazed dryland cropping than like native rangeland.

Figure 5. Where the soil is tillable and the topography is relatively flat, Southworth has seeded degraded rangeland with non-native plants that are functional equivalents of the native bunchgrasses, as well as other species that increase forage production. Photo: Darrell Kilgore.

Seeded Rangelands and Wildlife Habitat—Balancing Trade-Offs

***Sonia A. Hall**, Sustainable Systems Analyst, Center for Sustaining Agriculture and Natural Resources, Washington State University*

Millions of acres across the western United States have been seeded with non-native perennial grasses, most frequently crested wheatgrass (*Agropyron cristatum*) (Pellant and Lysne 2005). In many cases, the reason for seeding crested wheatgrass was to increase forage production. In other cases, land was seeded during post-fire rehabilitation efforts, as crested wheatgrass seed is more available and less expensive than seeds of native species, is easier to get established, and can keep out invasive annual grasses, such as cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*) (Pellant and Lysne 2005).

Crested wheatgrass's ability to dominate the vegetation community has detrimental effects on the habitat value of those rangelands, through the loss of shrub cover and plant diversity, especially wildflower species (called forbs). Studies have shown that species that use these steppe habitats, such as Greater sage grouse, sage sparrow, and certain small mammals, are less abundant or successful in these non-native perennial grasslands relative to native sagebrush steppe (Crawford et al. 2004; Krausman et al. 2009; Earnst and Holmes 2012). Other species appear to be unaffected, such as burrowing owls or grasshopper sparrows (Coates et al. 2014; Rottler et al. 2015).

Yet the trade-offs between forage production or rehabilitation and wildlife habitat are complex. In many cases, rangeland in poor condition does not provide much habitat value either. Annual invasive grasses, such as cheatgrass and medusahead, are able to colonize burned areas more effectively than the native rangeland plants (D'Antonio and Vitousek 1992; Balch et al. 2013), potentially becoming monocultures by promoting—and benefiting from—greater fire occurrence. A review of the impact on birds and mammals of conversion of sagebrush steppe to non-native grasslands concluded that, though both annual and perennial non-natives can negatively affect these species, the conversion to annual grasses as a stable state is "especially difficult" for wildlife (Rottler et al. 2015).

If the degradation extends to changes in soil characteristics, such as loss of top soil or soil organic matter, re-establishing native bunchgrasses may be difficult (e.g., there is a documented effect of soil fertility islands on post-fire seedling establishment [Boyd and Davies 2010]). A successful crested wheatgrass seeding can increase the soil's organic matter (Krzic et al. 2000), though the introduced grasses can also interfere with the establishment of native species (Nafus et al. 2015).

If preparation of the seed bed includes tilling, that could reduce soil organic matter. Research in this area has focused on conversions from rangeland to agriculture (e.g., Paustian et al. 1997; Rasmussen et al. 1998; Franzluebbers and Follett 2005). The impact of a single tillage event on soil organic matter has not, to our knowledge, been quantified in the Northwest. However, a study evaluating impacts of a single tillage event on temperate grasslands in Germany (mean annual temperature of 48°F [9°C], and mean annual precipitation of 30 inches [762]) found significant decreases in soil carbon two years after tillage. The soil differences between native and once-tilled grasslands were much smaller five years after tillage. It is important to note that the wetter and warmer environment (Seneca has a mean annual temperature of 40°F [4.4°C], and mean annual precipitation of 13 inches [WRCC 2018]) as well as the different vegetation (grassland versus shrub steppe) complicates extrapolating those results to the Oregon high desert. Global soil carbon modeling studies also found that improved rangeland management did not necessarily lead to improved carbon sequestration in dry areas (13 inches [330 mm] of precipitation or less [Conant and Paustian 2002]).

The size of crested wheatgrass monocultures, whether they are adjacent or surrounded by native habitats, and whether sagebrush has been reintroduced or moved in, all affect their habitat value (Pellant and Lysne 2005). For example, research in Washington State has shown that lands under the Conservation Reserve Program (earlier enrollments were commonly planted to non-native perennial species) are important for Greater sage grouse, especially those that are adjacent to native shrub-steppe habitat (Schroeder and Vander Haegen 2011).

Southworth's approach has been to plant relatively small acreages at a given time, focusing on the most degraded rangeland, and then to monitor the production of these seeded pastures. His results have led him to diversify his seed mix in more recent seedings. Such an approach, combined with an understanding of the factors weighing towards and against this practice and a clear quantification of costs and benefits, all contribute to supporting well-informed decisions. Seeding rangelands is therefore a tool that ranchers looking to improve their profitability and the resilience of their operations to a changing climate can consider, evaluate, and test, understanding that it has downsides as well as benefits.

Establishing Introduced Rangeland Grasses

***J. Shannon Neibergs**, Professor, Extension Economist, School of Economic Sciences, Washington State University*

Practices that establish non-native grasses in rangelands have been used to increase forage for livestock and to improve ranches' economic returns. Studies that have evaluated mechanical renovation practices on western rangelands to improve forage production have shown that (a) they are feasible from an agronomic perspective, (b) they have improved rangeland carrying capacity, and (c) they have the potential to increase economic returns over time (Griffith et al. 1985; Schuman and Rauzi 1985; Hawn 1991; Shewmaker and Bohle 2010). Renovation practices can range from no tillage inter-seeding into an existing rangeland, to using herbicides to kill the existing grasses, forbs, and shrubs, to mechanically developing a complete seedbed.

Several critical factors need to be considered when evaluating efforts to establish non-native rangeland plant species to determine if they are economically feasible:

- Can the degraded rangeland be rehabilitated through improved grazing management? This will be the lowest cost remediation practice. However, its success depends on why the rangeland was degraded in the first place and on whether it has transitioned to a stable degraded state.

- Are the terrain and soil suitable for mechanical operations and seeded plant growth? Shallow, rocky soils or rangelands with invasive woody shrubs are not likely to economically justify extensive renovation operations.
- Can the competition from unwanted plants be removed or reduced through herbicide applications and tillage? Such ability is critical for the establishment of the seeded species.

Additional considerations are involved in how to design the project:

- The proper seed-to-soil contact is critical and requires management decisions regarding direct seeding into the existing vegetation or to mechanically develop a seedbed.
- The seed mixture, seeding rates, and seeding depth to ensure proper seed-to-soil contact need to be determined. The seed mixture is dependent both on management objectives and the availability and cost of locally adapted seed varieties. Seed quality and the seeding rate must be sufficient for stand establishment but not so dense that individual seedlings compete with one another. Access to a rangeland drill or seeder can be through ownership or rental and requires the ability to calibrate and operate correctly (Kees 2006).
- Inadequate precipitation will be a risk. Adequate water is needed for seed germination and sufficient growth that can compete against weeds.
- When precipitation is adequate, fertilization becomes critical. Soil tests and local agronomic expertise should be used to determine application rates.
- Proper grazing management following any reestablishment effort is critical.

Southworth has been interseeding or re-seeding these non-native forage species into certain paddocks every ten years or so. He continues to adapt his management of these seeded rangelands in an effort to eliminate the need to reseed after the initial seeding, thereby reducing impacts to soil health, including loss of soil organic matter. It is important to highlight, however, that not all acres are plowed and seeded; over half of the Southworth Brothers Ranch's deeded lands and all the leased lands are untilled rangeland with a respectable complement of native grasses. The seeded pastures become active earlier and have higher productivity than the native bunchgrasses, so using them early means that native rangelands are only lightly used during the early season. Thus, the planted pastures play an important role in his grazing plans, thereby helping improve the productivity, reproduction, and ecological health of his native rangelands.

Monitoring the Range

Southworth's successful range management also relies on a practice that is much-discussed but rarely implemented: long-term monitoring that tracks any positive changes that are occurring in the plant community over time, and which serves as an early warning system for negative changes, such as declining perennial grass vigor, increasing invasive plants, or declining soil stability (Figure 6). His rangeland monitoring system is closely tied to his goals for taking care of the soil, his intensive grazing management, and improvements in forage production through seeding non-native species. He measures several attributes widely recognized as critical indicators of rangeland health:

1. Species composition—higher diversity, called species richness, translates into improved animal health and rangeland resilience.
2. Plant density—higher density tends to represent successful reproduction of all plants, especially grasses.
3. Soil cover—less bare soil is better; soil cover is comprised of a combination of litter and live plants.

Southworth does his monitoring annually, in the fall. "It is after most of the summer grazing has occurred. It gives us a good chance to see how much residual forage we have going into the winter. And it's a time of year when we can find the time to do it."

Measuring indicators of plant community health provides important information that Southworth incorporates into his management plan moving forward. For example, if he finds bare soil increasing over time, he may shorten a grazing period in spring to allow more plant growth before grazing; he may defer grazing until after plants are dormant and more brittle in order to lay down more dead stems and leaves on the soil as litter; he may provide a longer regrowth period between grazing events. By using his fall monitoring results to inform his grazing plan for the next year, Southworth says, "we can do an amazing job of improving our rangeland with really rudimentary tools."

Figure 6. Long-term monitoring allows Southworth to track changes in the plant community over time, and the results serve as an early warning system of changes that could affect rangeland health. Photo: Darrell Kilgore.

Cost Considerations of Establishing Introduced Rangeland Grasses

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The cost to establish forage species will be highly site specific, depending not only on agronomic factors but also the machinery and labor costs. For example, using older, fully depreciated machinery will lead to lower machinery costs. On the other hand, a farming operation that continually re-invests in new machinery, incurring the associated costs, will have lower breakdown risk.

The following budget table provides an example of the machinery and input costs needed for rangeland seeding (Table 1). The representative cost per acre is $137 ($337 per hectare). The budget does not include any land or management costs because those costs would be incurred regardless of the rangeland seeding decision.

Table 1. Representative costs for rangeland seeding with non-native plant species.

Item	Quantity per Acre	Unit	Price per Unit	Cost per Acre
Herbicides: Glyphosate	20	oz	$0.16	$3.20
Herbicides: Sprayer Rental	1	acre	$2.00	$2.00
Fertilizer: N-P-K-S	70	lb	$0.53	$37.10
Seed: Wheatgrass, Legume Mix	7	lb	$4.75	$33.25
Labor: Machinery Operations	2	hr	$17.00	$34.00
Machinery: Fuel/Oil	1	acre	$5.42	$5.42
Machinery: Repairs	1	acre	$7.65	$7.65
Machinery: Depreciation	1	acre	$11.32	$11.32
Machinery: Interest Insurance	1	acre	$2.73	$2.73
Total Costs per Acre				**$136.67**

Seeding non-native species in rangelands can enhance economic returns through expanding carrying capacity, increasing weight gains, potentially extending the grazing season, plus any nonmonetary benefits to wildlife.

These seeded pastures will also have maintenance costs, such as fertilizer and weed management. There are two approaches to economically evaluate seeding of pastures. It can be considered a capital investment project where the present value of future cash flows is compared to the seeding investment cost. If the discounted future returns present value is larger than the investment cost, the project is economically feasible. However, determining expected future cash flows will be particularly difficult for ranches. For example, the same seeded pasture would have different expected future cash flows depending on the time of year it is grazed, or if it is not grazed at all certain years. In addition, future cash flows should be limited to cash flows in excess of those expected if the pasture were to be managed in its current condition. Further, the number of years the seeded pasture is grazed will directly affect the economic return. As more years are considered, the economic return to the seeding investment cost increases.

An alternative approach is to consider rangeland seeding as a maintenance cost, similar to what is needed to maintain a tractor's effective use and prolong its useful life. Tractor maintenance is a decision based on cash flow available for parts, oil and labor, the magnitude of maintenance needed, the need to minimize the risk of future breakdowns, and the importance of the tractor to the overall operation.

A research study with a "no disturbance" control treatment showed that rangeland seeding costs were recovered in four to five years and notes a life of mechanical renovation practices ranging from 15 to 25 years (Griffith et al. 1985). Given that Southworth has established non-native species in some pastures more than 20 years ago, it is evident that costs are economically justified over time, making rangeland seeding an important tool to consider when seeking to improve a ranch's forage resources.

Being Adaptable to Change

In addition to his focus on healthy rangelands, Southworth has a highly adaptable operation. Both are key to being resilient to the high levels of year-to-year variability in weather and prices. Because variability is likely to increase in the future, such resilience is also critical for the ranch's continued viability (see the *No-Regrets Strategies That Benefit Ranching Operations and Provide Climate Resilience* sidebar). While high levels of resilience are important across western rangelands, Southworth highlights that the specific strategies that allow him such adaptability are in part determined by the environment he is in. He expects that ranchers working in different environments may have different strategies that help them adapt to their specific conditions.

Stocking and De-stocking

One aspect of Southworth's adaptability is their ability to modify herd size in response to the yearly variation in forage availability. As a cow-calf-yearling operation, the yearlings can be kept through the full year when forage is available, or can be sold early—even as soon as they are weaned—in drought years, for example. The summer grazing on the ranch is critical for making this part of their operation profitable: weaned steers gain approximately 300 lb (136 kg) of weight during the season. If summer forage is reduced, or needed to maintain his core cow herd, Southworth would sell these steers and heifers off early. Southworth is also able and willing to cull older cows sooner, or to not keep back as many replacement heifers, as alternate approaches to de-stocking in years of low forage abundance. These strategies allow him to maintain a baseline of economic return in years when forage is reduced, while being able to harvest the abundance of forage in wet years, improving the economics of his operation.

Diversifying Forage Resources

A second element that supports Southworth's adaptability is the diversity of their forage resources, which include native rangelands, both on their own and leased lands, the degraded rangelands they have improved through seeding, and sub-irrigated native meadows that remain productive later in the season and help shorten their winter feeding period (Figure 7). Each forage resource responds somewhat differently to different weather conditions. Combined with past experience and a strong emphasis on monitoring to determine the impact of his grazing management under different yearly conditions, Southworth has options to help him respond in a timely fashion to year-to-year variability.

No-Regrets Strategies That Benefit Ranching Operations and Provide Climate Resilience

Georgine G. Yorgey*, Associate Director, Center for Sustaining Agriculture and Natural Resources, Washington State University*

Ranchers already manage multiple risks—including those related to economics, production, the environment, and weather. Climate change represents an added risk, but one that is challenging to manage because impacts are uncertain, variable over space and time, and often perceived as being only of concern in the distant future (Moser and Ekstrom 2010; Leiserowitz et al. 2011; Akerlof et al. 2012).

However, despite this challenge, there is a growing recognition that the same strategies that make ranches and rangelands more resilient to climate change will also provide other important co-benefits. These include enhanced resilience to current weather-related variability, enhanced ecological functioning, and, in at least some cases, enhanced or more sustainable economic performance.

Implementing these "no-regrets" strategies is thus important for enhancing the resilience of rangelands to a wide variety of shocks, including, but not limited to, climate change. Specific strategies include:

- Management-intensive grazing or other strategies to ensure adequate rest periods. For example, relatively short rotations that ensure that native grasses are allowed to set seed in some years.
- Regeneration and recovery of degraded plant communities by actively managing grazing. The intent is to manage cattle in a way that the plants' phenological stage when they are grazed, the duration of each pasture's use, and the multi-year sequencing of grazing events are selected to promote tillering, seed production, seed-to-soil contact, litter deposition, seed germination, and seedling establishment.
- Grazing management that increases soil water holding capacity, reduces evaporation from the soil surface, and moderates soil temperatures (see the *Key Factors That Limit Plant Growth and Their Management Implications* sidebar).
- Management to reduce fire risk through promotion of native perennial plants and suppression of seed production and establishment of invasive annual grasses.
- Early de-stocking in the face of drought to limit overgrazing and economic losses.

The Adaptation Library, created through four years of workshops with rangeland managers and public lands stakeholders around the western United States, is one resource with a variety of additional ideas for building resilience to climate change for specific regions and vegetation types (Adaptation Partners 2018).

Stewarding Public Lands

As in other areas in the inland Pacific Northwest, access to summer grazing lands in the Bear Valley tends to limit ranchers' ability to expand their operations. Southworth's lease on National Forest land is extremely important in providing summer grazing. He also considers that the lease payments are lower than those he would be able to obtain if he replaced that lease with arrangements on private lands. He is therefore deeply invested in maintaining good relations with the U.S. Forest Service. His efforts include open communications and a sincere interest in understanding the Forest Service's goals and management needs for the leased lands. In Southworth's opinion, improving the landscape health not only on his own property but also on the public lands he leases is an investment towards "a healthy business that people will want to be a part of."

Experimenting and Learning

A final pillar supporting the adaptability of Southworth's operations—and the resilience it confers—is experimentation and learning. A good example is the process he has gone through in improving degraded rangelands by seeding them. Both the mix of species he uses and his management of these seeded pastures has changed over time. Where he originally used a simple mix of crested wheatgrass (*Agropyron cristatum*) and alfalfa (*Medicago sativa*), he has now diversified that mix, including intermediate wheatgrass (*Thinopyrum intermedium*), yellow-blossom sweetclover (*Melilotus officinalis*), and a forage turnip (*Brassica rapa*) (Figure 8). He admits that the clover does not last long in the mix. However, the strong, deep taproot is able to penetrate the clay-rich soils (as does the forage turnip) in ways that grass roots do not, which may improve the structure, aeration, and microorganism activity in the soil. And though he has re-planted some of his earlier seedings, he expects that the current grazing management of these pastures will allow him to maintain them for a very long time without needing to reseed.

Figure 7. Meadows are one of a diverse set of forage resources that support Southworth's ability to adapt to change. Photo: Jack Southworth.

As another example, Southworth experiments and learns as he strives to improve his herd's genetics. Southworth produces his own bulls by artificially inseminating his select cows with what he considers "the best genetics available at a price that we can afford." Through experimenting, he has focused on select cows four years or older that have produced a calf every year, with average or above weaning weight, and that have good udders, good disposition, and no need for treatments beyond regular vaccinations and pregnancy testing. In addition to using the bulls bred from inseminated "select cows," he breeds all his heifers every year. He can then determine which heifers are open or too light, and use this information when selecting his replacement heifers. In this way, Southworth is improving the genetics of his herd in a way that "works for the environment and for the customer."

Figure 8. Diverse seed mix in seeded pastures includes a forage turnip, yellow-blossom sweetclover, alfalfa, and intermediate and crested wheatgrass. Photo: Jack Southworth.

In essence, Southworth strives to "build a tradition of adaptation." This includes reading up on research that could inform decisions he is making, such as whether it is worthwhile fertilizing his seeded pastures. It also includes monitoring to evaluate whether his grazing management is having the expected effect on the vegetation. Planning and then evaluating, rather than doing things as they have been done in the past, is his approach to solving problems, especially since he recognizes that he is subject to significant, and growing, variability—in prices, in weather, and even due to longer-term changes in the needs of his labor force. The adaptive mindset also includes an expectation that others considering adopting his grazing management could and should challenge his decisions and test and evaluate their own variations, because that is what he would do.

Benefits

Southworth's holistic approach to grazing management and his adaptability in the face of changing conditions has provided multiple benefits. The most obvious has been the profitability of Southworth Brothers Ranch. The ranch has emerged from the deep debt it incurred in the 1980s and is now profitable almost every year, enough to allow them to foresee staying in business for the long term.

One of the important shifts in Southworth's approach when he began to manage holistically was to broaden the spectrum of goals they have for the ranch. Their management has led to benefits in those other areas as well. Southworth can point to his monitoring data to show improvements in the rangeland vegetation and in the cover and protection of the soil. He recently received the National External Range Management Award from the U.S. Forest Service, a statement of their satisfaction with Southworth's grazing management on the leased forested lands. The health of the vegetation and soils are a key part of Southworth's ability to sustain his operation in light of changing weather and market conditions.

To Southworth, these benefits are big pieces of an overall puzzle, but they are not the whole picture. Ultimately, the question is whether this landscape, managed the way it is, can support the quality of life he and his wife want. Southworth points to an array of indicators of progress towards their quality of life goal, including the abundance of wildlife, the healthy willows in the riparian areas on their ranch and leased lands, and their ability to invest time and effort in their community (Figure 9). Improving quality of life continues to be a core pursuit, and Jack Southworth is optimistic: "If we treat the landscape with fairness and respect and create that healthy diverse landscape that's productive through good years and bad, I think we have a good chance of being in business well into the future."

Challenges

Ranching in the high desert of Oregon and achieving the goals the Southworths have set for themselves is not an easy task. Challenges arise and continue because of the environment the ranch is set in, such as the long winters (Figure 10) and arid conditions, leading to short growing seasons. Other challenges are amenable to management and have lessened over time, such as rangeland degradation through past overgrazing and the challenge of obtaining—or in the Southworths' case, maintaining—good summer grazing.

As described earlier, Southworth and his workforce are invested in maintaining a good relationship with the U.S. Forest Service. Southworth considers incorporating the Forest Service's goals and needs into his grazing management plans as part of doing business. And though this may come at a cost, it is also an investment which, at least so far, has helped him overcome the challenge of limited summer grazing. At the same time, Southworth does not take his lease for granted; he keeps an eye out for ideas and opportunities to try new ways to overcome the continuing challenge of limited summer grazing.

Figure 9. Southworth's cattle in a forested system. Forested systems complement the high desert rangelands as part of a diverse landscape managed to fulfill both production and quality of life goals. Photo: Jack Southworth.

Figure 10. The long winter feeding period in the Bear Valley is a fairly significant challenge for the Southworth Brothers Ranch. Photo: Jack and Teresa Southworth.

Planning and monitoring are parts of Southworth's approach to trying new practices and have been integral to his efforts to improve degraded rangeland on his ranch. In some areas, such as riparian areas, improvements have come through changing his grazing management: fencing out cattle from certain areas, allowing willows to reestablish, grow, and fulfill their natural function of stabilizing the creek banks, reducing erosion and raising the water table. Restoration of highly degraded shrub steppe, however, is a more daunting prospect. Southworth acknowledges that he has been lucky in that much of those degraded uplands on his ranch occur on tillable soil and that environmental characteristics—possibly the freezing soils in the winter or the clay content of those soils—have kept invasive annual grasses like cheatgrass (*Bromus tectorum*) from invading these lands, as they have elsewhere across the Great Basin and the inland Pacific Northwest. His ability to till and seed degraded rangelands has allowed him to essentially replace the vegetation with seeded pastures that produce more forage, and do so starting earlier in the spring than the native rangeland on his ranch. In this way he has been able to transform the challenge of degraded rangeland into a productive part of his operation.

Dealing with Risks

Southworth's approach to improving rangeland health (and therefore ecological resilience) and his emphasis on diversity and flexibility (that characterizes his operational resilience) allow him to deal with both environmentally- and economically-driven risks. As with other rangeland and forest landscapes across the inland Pacific Northwest, Bear Valley is at risk of wildfire. Southworth understands, however, that fires can be patchy, so even if the overall extent of a fire is large, there may be areas within the perimeter that can still be grazed. He is hopeful that, if such a situation should occur on the leased grazing lands, he would be able to work with the U.S. Forest Service to effectively graze areas not affected by fire while not inhibiting or delaying recovery of the vegetation in those areas that were severely burned.

Conditions also change from year to year. These can be driven by economic factors, such as cattle prices, or environmental factors, such as temperature and rainfall effects on forage production. Southworth's willingness to modify herd size from year to year in response to such variations is a key part of his operational flexibility. His experience shows it is possible to maintain such flexibility while continuing to maintain the long-term productivity of his cow herd and the profitability of his ranch: "We should be able to adjust our cow herd to graze in a manner that's best for the landscape while still making a profit on a long-term basis."

A resilient system can generally be expected to respond to disturbances, such as fire or a grazing event, and recover without fundamentally changing its characteristics (Chambers et al. 2014). When managing a resilient system, strategies that improve resilience can also mitigate risk. Southworth considers diversity an asset for resilience, and that resilience can help him—and other ranchers—mitigate risk: "There's no best way to make a dollar in the cattle business. You have to adjust your operation to the kind of environment you're in and the amount of risk you're willing to take."

Looking Forward

Farms and ranches across the United States are seen, in many cases, as insufficiently profitable to be attractive to the next generation, who find better opportunities in other sectors of the economy. This trend is a challenge for many ranchers. Jack Southworth has an additional hurdle, which is that he does not have immediate family who could take over the ranch when he and his wife retire. As he looks to the future, Southworth is optimistic that there will be people—employees of the ranch or others—who will connect with the ranch, offering options for the ranch's future viability for him and his wife to consider (Figure 11).

Whether at the time of Southworth's retirement the ranch looks like it does today remains to be seen. Southworth is not done adapting, and the ranching world is likely not done changing. Southworth considers that maintaining their quality of life into the future may require exploring new alternatives for monetizing what they, and potential customers, value about this landscape. Whether that means considering different types of livestock, or ways to offer opportunities for others to enjoy a quiet getaway in this scenic valley, or other products or services that are valuable to others, Southworth is not sure. But in his own tradition of adaptation, he is open to finding and exploring these opportunities, planning, trying, and monitoring how it goes, then further adapting so that he is ultimately able to retire from a profitable, productive ranch that has an optimistic and resilient future ahead of it.

Figure 11. Looking forward, Southworth is optimistic that others will connect with the ranch in ways that will provide options for its future once he and his wife retire. Photo: Darrell Kilgore.

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