GRAZING MANAGEMENT THAT ACHIEVES MULTIPLE-USE GOALS: RUSS STINGLEY

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

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GRAZING MANAGEMENT THAT ACHIEVES MULTIPLE-USE GOALS: RUSS STINGLEY

By

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Abstract

Russ Stingley runs a cow-calf operation in Kittitas, Washington, with his three sons and his daughter. The Stingleys lease rangeland from Puget Sound Energy (PSE) and the Washington Department of Fish and Wildlife (WDFW), and manage grazing on these lands under a Coordinated Resource Management (CRM) plan. This plan, developed in collaboration with the landowners and with the input of multiple stakeholders, is designed to simultaneously achieve cattle production and wildlife habitat goals. The approach is to focus on the health of the rangeland vegetation, which can also reduce wildfire risk and increase resilience to changing climatic conditions.

This case study is part of the Rancher-to-Rancher Case Study project, which explores innovative approaches regional ranchers are using that increase their resilience in the face of a changing climate. Though each case study is specific to the conditions of the particular rancher being profiled, insights and strategies from each case study may be applicable elsewhere.

Information presented is based on ranchers' experiences and expertise and should not be considered as 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 or in the WSU Extension Learning Library.

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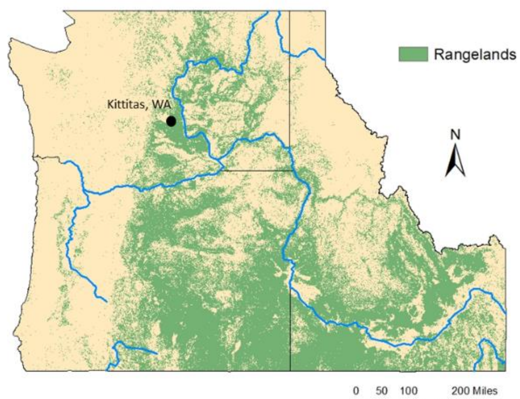
Grazing Management That Achieves Multiple-Use Goals: Russ Stingley

Photo: Darrell Kilgore.

Location: Kittitas, WA

Average Annual Precipitation: 12 inches (305 mm)

Production System: Cow-calf operation combining spring and summer grazing on native shrub-steppe rangeland with wintering on crop stubble in the Columbia Basin.



Map: Sonia A. Hall, Washington State University.

Introduction

Russ Stingley, a native-born Washingtonian, runs a cow-calf operation with the help of his three sons and daughter in the agricultural and shrub-steppe lands of central Washington State. Stingley grew up ranching and has been running his own operation since the 1970s. The Stingley Ranch currently runs about 850 cows, grazing across 25,000 acres (10,117 ha) of rangeland—mostly native sagebrush steppe—in the spring and summer, and wintering in the Columbia Basin, on corn, wheat, and other crop residues. Stingley also farms about 2,000 acres (809 ha) of irrigated land in the Kittitas Valley, mostly for hay production, though in dry years he sometimes replaces the second hay cut with grazing cows.

The Kittitas Valley, where Stingley ranches, is part of the Upper Yakima River watershed, at the eastern edge of the Cascade Mountains in central Washington State. These mountains' rain shadow creates a strong precipitation gradient, from 100 in. (2,540 mm) annually at Snoqualmie Pass to 6 in. (152 mm) along the banks of the Columbia River. The conifer forests that cover the montane slopes give way to more arid vegetation to the east, with different shrub-steppe communities extending, historically, all the way to the foothills of the Rocky Mountains in northern Idaho.

Today, lands with deeper, more productive soils and with access to irrigation water are dominated by agricultural production. In the Kittitas Valley, the main crops are hay, fruit trees, and pasture. Rockier areas with shallow soils, particularly eastward towards the Columbia River, remain dominated by native sagebrush steppe. These shrub-steppe rangelands can provide a critical spring and summer forage resource for livestock operations like Stingley's, as well as being potential habitat for wildlife such as deer, wintering elk, and songbirds.

Stingley has been grazing on much of his current rangeland since 1985. Most of the land Stingley manages is leased, and he has adapted to changes in ownership over the years. When he started operating the Stingley Ranch, most of his rangeland leases were from other private landowners. He initially subleased his grazing lands east of the Valley from another operation, taking over the main lease in the late 1990s.

Soon after, Puget Sound Energy (PSE), a local energy company serving over one million electric customers, became interested in acquiring some of this land to develop a wind facility, as part of efforts to increase their renewable energy production. Since the extensive acreage contained sagebrush-steppe lands which PSE did not need for their facilities, they partnered with the Washington Department of Fish and Wildlife (WDFW)and together purchased the land from the private owner.

These changes in ownership could have led to grazing being eliminated from these lands. Stingley was interested in continuing to graze this matrix of now privately (PSE) and publicly (WDFW) owned rangelands, as, in his words, “the biggest drawback we have is just having enough grazing ground.” Puget Sound Energy supports traditional uses of the land, and was interested in continued grazing on their lands to build and maintain relationships with the local community. Washington Department of Fish and Wildlife was interested in fostering the local support necessary to obtain funding for their portion of the purchase. These shared interests facilitated collaboration between the Stingleys, PSE, and WDFW, which continues today.

Coordinated Resource Management

Around the time that land ownership was settling into its current pattern (Figure 1), an independent but relevant community process was occurring. The WDFW and the Kittitas County Cattlemen’s Association convened what became known as the Big Game Management Roundtable (BGMR), to look for solutions to the problem of elk spending increasing amounts of time on irrigated crop and pastureland in the Kittitas Valley, leading to impacts and losses to growers.

The history of elk in this area includes extirpation followed by reintroduction in the 1910s (Bernatowicz 2006). That history notwithstanding, one of the suspected drivers of these more recent changes in elk distribution was the decline in forage quality on the rangeland between the Valley and the Columbia River; lands that were changing hands to WDFW and PSE (Figure 2). This decline was due, in part, to lack of fire and lack of grazing to remove or trample dead plant material. Among other actions, the BGMR recommended that this rangeland, even though owned and managed by different entities, be grazed under a single grazing plan to comprehensively address these issues.

Figure 1. Checkerboard land ownership east of Kittitas, Washington. Orange sections are managed by the Washington Department of Fish and Wildlife (WDFW); pink sections are managed by the Washington Department of Natural Resources (WDNR); green sections are federal lands, and sections without colored overlay are in private ownership. The private lands surrounded by public lands in the western (left) portion of the image are owned by Puget Sound Energy (PSE). Photo: Tipton Hudson.

The BGMR decided to spin off a sub-group to generate a prescribed grazing solution through a more formal collaborative process called Coordinated Resource Management (CRM). This sub-group, which became the Wild Horse CRM, began meeting in 2005 to develop a grazing plan for the mixed-ownership landscape with input from a multitude of stakeholders and interest groups.

Figure 2. Elk herd grazing the Puget Sound Energy-owned rangeland. Photo: Tipton Hudson.

Through this CRM process, Stingley obtained leases on 25,000 acres (10,117 ha) owned by PSE, WDFW, and the Washington Department of Natural Resources, to be managed under a single grazing plan, with strict guidelines on how the grazing of these rangelands would be managed, to ensure that such grazing was compatible with the needs of healthy and diverse native plant communities, elk, and greater sage-grouse (Wild Horse CRM 2010). The Wild Horse CRM group hoped that this grazing plan would be a model for public lands grazing in the Northwest, both in terms of the process and in the grazing management details.

Managing Grazing to Achieve Multiple Goals

The Wild Horse CRM group was intent on accommodating multiple resource values, tangible and intangible, in the planning process. Their CRM plan objectives articulate their interest in balancing forage production for domestic livestock with healthy native plant communities and habitat attributes necessary for semi-migratory elk and greater sage-grouse (Wild Horse CRM 2010). The participation of all the major landowners also gives them a voice in ensuring that the plan provides for their unique needs, such as limiting wildfire risk on PSE's new wind energy facility, which spans roughly 15,000 acres (6,070 ha).

Grazing management was necessarily oriented toward effects on the rangeland plant communities, since meeting the CRM group's other values depend on the plant communities' health. In order to meet the goal of maintaining or increasing rangeland health (as defined in NRC 1994), the following principles were set forth:

- Apply a conservative (relatively low) stocking rate by including elk in forage use calculations and by planning to remove less than 35 percent of the annual growth of grazable plants.
- Allow native perennial bunchgrasses to set seed at least every other year.
- Graze during the critical period of internode elongation, roughly late spring through early summer, only one year out of three.
- Limit grazing duration to less than half the active growing season.
- Maintain 6 in. (15 cm) of residual grass height for greater sage-grouse breeding and brood-rearing habitat.
- Maintain at least 4 inches (10 cm) of stubble on upland herbaceous species within 100 meters of watering sites and streams.

The various stakeholder groups and land agencies believed that this grazing regime would promote the wide variety of ecosystem goods and services desired. However, while establishing a sustainable stocking rate is relatively achievable on vast and heterogeneous landscapes like this one, realizing desired livestock distribution across the landscape can be challenging. Ten mother cows on 10,000 acres (4,047 ha) can cause overgrazing if they stay in the same subset of the area all the time. Further, variability in precipitation and only partly reliable water sources require management adjustments throughout the growing season and from year to year.

To address these challenges, PSE partnered with Stingley to develop water sources at known springs or seeps and install cross-fencing to better manage livestock distribution (see the *Developing Water Sources for Improving Grazing Distribution and Risk Management* sidebar). Many of the spring developments were re-developments of historical watering sites (see the *Developing Water Sources from Natural Springs* sidebar).

Developing Water Sources for Improving Grazing Distribution and Risk Management

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

Animal nutritionists commonly focus attention on total digestible nutrients, protein and feedstuffs and take for granted the importance of providing water. A cow requires about 10 gallons per day (37.9 L/day) when the air temperature is about 40°F (4.4°C) and roughly 30 gallons per day (113.6 L/day) at 90°F (32.2°C), though intake depends on a variety of environmental factors. If livestock do not drink enough water, feed intake will drop and production will fall, decreasing the economic efficiency of the livestock enterprise.

Grazing severity is distributed radially out from some central attractant, usually for one to two miles (1.6–3.2 km), depending on topography, forage moisture, and spatial arrangement of preferred forages on the landscape. While many landscape or management features can serve as a central place (salt, supplement, small areas of gentle terrain in steep country) water is, by far, the strongest central attractant for cattle in semi-arid rangelands. Thus, management of watering sources can be a critical tool for improving livestock grazing distribution, with the goal of utilization of forage plants uniformly over an entire grazing management unit. This uniform use, in turn, can improve overall forage condition, per-area production, and in some cases can lead to sustainable increases in stocking rate (Horn 2005). In addition, water sources developed by ranchers, though primarily for livestock needs, can also provide drinking water and habitat for wildlife.

Cattle watering systems can include developed stock water troughs, natural and excavated stock water ponds, and natural surface or groundwater sources (such as springs, creeks, rivers, ponds, and lakes) that sometimes are enhanced to better store water (see the *Developing Water Sources from Natural Springs* sidebar). Natural water sources provide the least expensive source of water. In many circumstances, however, hauling water is an alternative that deserves consideration, if forage quality and availability outweigh the hauling costs.

Climate risk models project that the future will bring less snowpack that melts earlier in the season, and hotter and drier summer weather patterns (USBOR 2016). Stock water ponds may thus dry out sooner, and springs that provide water to troughs and water catchments may become unreliable or stop flowing. Planning for these changes in water availability may be even more critical in the future, especially as heat stress on cattle will increase as well (see the *Impacts of Climate Change on Pacific Northwest Rangelands* sidebar).

The utility purchased the infrastructure, while Stingley matched these investments by providing labor. Where there were no natural springs or developed water sources, Stingley hauls water in a tanker truck when cattle are in those pastures (Figure 3), a costly but important part of his management (see the *Accessibility and Setup Determine Water Hauling Costs* sidebar). These water development projects and his ability to haul water helped address not only the reliability of the cattle's drinking water, but also the distribution of the livestock: "The water's the main factor for having good range utilization, because wherever the water is, that's where the cattle tend to be. So we tried to develop as many springs as possible out here, to spread the cattle out."

The Stingleys and PSE invested in over 25 miles (40 km) of fencing. Permanent barbed wire fence now divides the 25,000 acres (10,117 ha) into eight management units ranging in size from 1,000 acres (405 ha) to 5,600 acres (2,266 ha; Figure 4), allowing the Stingleys to control grazing in a way that meets the rangeland improvement objectives agreed to under the CRM plan. Stingley described the "Pines" pasture, that they prefer to graze in the early spring, as an example of how this allows them to improve their grazing management. "The Pines used to be one pasture. Now it is three pastures. So you can graze early three years in a row. When it was one pasture you only got to use that range ground in early spring once out of three years." These investments would not have been feasible, however, without having a long-term grazing lease: a ten-year lease, recently renewed,

Figure 3. Strategic location of water—sometimes hauled in—helps the Stingleys achieve better distribution of grazing cattle across the Puget Sound Energy-owned pastures. Photo: Shannon Neibergs.

allows them to amortize their capital outlay, improving the return on their investment.

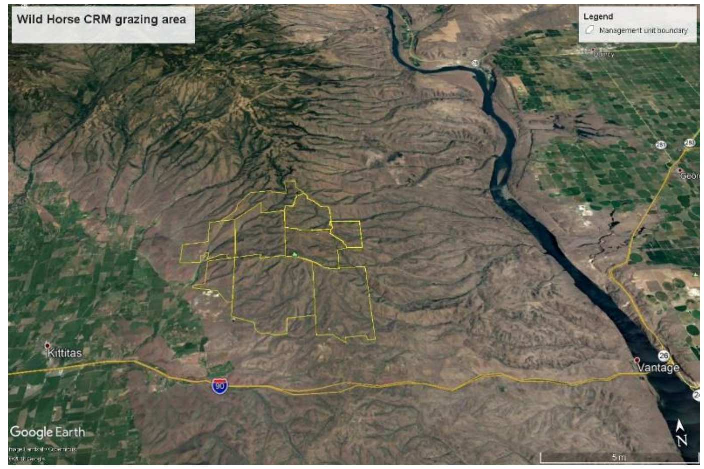


Figure 4. Management unit boundaries (red lines) on the rangeland managed under the Wild Horse Coordinated Resource Management (CRM). Pasture sizes range from 1,000 to 5,600 acres (405 to 2,266 ha). Map produced by Tipton D. Hudson using Google Earth images; January 3, 2019.

Following the guidelines set out in the CRM plan, grazing periods for a given management unit occur at a different time of year every year, and range in duration from 14 days to 45 days. The duration is dependent on expected forage production specific to the site and area of that unit. At the scale of the individual plant, the result of this grazing schedule (Table 1) is very light use. Livestock never graze all bunchgrass plants and most plants that are grazed are grazed partially; i.e., less than 100% of tillers (stems) have been clipped (Figure 5). This mosaic pattern of partial defoliation results in high canopy cover, litter cover, seed production, species diversity, and, ultimately, a resilient plant community.

Developing Water Sources from Natural Springs

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

Developing springs to provide stock water and incorporating their seasonality into grazing plans is key to being able to fully utilize available rangeland forage (see the *Developing Water Sources for Improving Grazing Distribution and Risk Management* sidebar).

Developing a spring as a water source is unique to both the grazing management unit being considered, as well as the topography, seasonal availability, and need for water across the grazing area. Springs commonly occur along hillsides and in low seep areas where fractured rock and soil allow groundwater to surface and flow. Springs can occur at a point or seep out over a large area. A first consideration in spring development is determining if there is adequate flow for the intended use and if the seasonality of the flow matches the grazing management plan. A simple "fill a bucket" test—timing how long it takes the spring to fill a bucket of known volume—can provide an initial estimate of water flow rate. A spring with a persistent low flow rate can be augmented by water storage in addition to the stock watering tank.

There are generally two spring development designs: one for hillsides and one for seeps. Hillside spring development can creatively take advantage of gravity to collect and then distribute water using storage, pipe and plastic hose. A first step will be to design how to intercept the spring's flow and divert it into the planned point of use that is accessible to the cattle. Spring collection boxes can be as simple as purchasing a spring box and installing the box to collect flow. Alternatively, spring development could entail excavation with a backhoe to install a large collection well if the flow rate supports the design, construction cost and accessibility. What design works best will be site-specific.

Seep development entails enhancing the seep as a pond, to function as a source collection point. Depending on the pond size, the soil characteristics and other factors, this could be achieved a number of ways, ranging from excavating with a shovel to needing a backhoe. Typically, it will be best to protect the developed seep with fencing and then pump or pipe the water into a stock tank, rather than to use the developed seep as a stock pond. The separate stock tank protects the seep from trampling and contamination.

Spring development cost-share programs may be available. Many grazing leases have agreements where the landowner purchases the fixed assets in the spring development design—such as storage and stock tanks—and the lessee provides the spring development skill and labor. The USDA Natural Resource Conservation Service's Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) allow landowners or operators to apply for financial and technical assistance to implement conservation practices. Spring development has particularly strong conservation benefits because of improved water sources for wildlife.

Table 1. Grazing rotation on the Wild Horse CRM, between 2011 and 2018, showing dates that the herd of 150 to 200 cow-calf pairs grazed in each pasture.

Management Unit	2011	2012	2013	2014	2015	2016	2017	2018
Vantage Hwy	4/19-30	5/1-6/10	5/1-15	REST	4/26-5/31		REST	5/1-31
Lower Parke	REST	4/16-30	REST	5/26-6/15	4/16-26		4/15-30	4/16-30
Whiskey Jim	5/1-6/5	REST	5/15-6/20	REST	REST		5/1-20	REST
Upper Parke	REST	REST	REST	REST	6/1-21		5/21-6/15	REST
South Wild Horse*	4/9-19	6/11-7/5	REST	5/1-25	4/1-15	5/7-28; 9/1-15	9/5-30	8/1-20
East Wild Horse*	8/1-9/24	8/1-9/30	8/1-9/5	7/21-8/5	7/21-8/6	8/11-31	7/5-20	6/26-7/10
West Wild Horse*	8/1-9/24	8/1-9/30	8/1-9/5	6/16-7/21	6/21-7/21	REST	7/21-9/4	6/1-25
Wild Horse Crossing*	7/5-7/31	7/6-31	4/15-5/1	8/6-9/5	8/6-31	7/16-8/10	6/16-7/4	7/11-30

* Owned by PSE.

Figure 5. Bluebunch wheatgrass (*Pseudoroegneria spicata*) following grazing, in the fall of 2017. Stingley's grazing management results in most plants being only partially grazed, with only some of the tillers (stems) being clipped. Photo: Darrell Kilgore, fall 2017.

Resilience in the Face of Climatic Variability

Stingley ranches in an area with considerable climatic variability. Differences in precipitation and temperature from year to year result in commensurate variability in forage availability (about 15 to 20 percent). Rather than harvesting forage up to the ecological limits of the site, Stingley is managing for high post-grazing residual, low impact on plants and soils, maximum seed production and root reach, and high species richness. This is the equivalent of a large bank account: he does not have to worry much about occasional large "withdrawals" in years when forage

Accessibility and Setup Determine Water Hauling Costs

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

Grazing behavior, forage conditions and potential water sources in the grazing management unit are key factors to consider when deciding where to develop watering sites or whether to haul water to those sites.

Accessibility dictates whether hauling water can be a viable option. Hauling water provides flexibility and can increase forage availability, but adds significant time and labor costs. The major costs associated with hauling water will depend on the vehicle used to do the hauling, the size of tank hauled, and the associated labor. A 1,000 gallon (3,785 L) tank can be towed by a pickup or hauled by a common farm truck, and would supply the daily water needs of about 33 cows in hot summer temperatures. In contrast, a commercial semi-truck hauls up to 9,000 gallons (34,069 L; we used 8,000 gallons, or 30,283 L, in our example), limited by the 80,000 gross weight limit for trucks. In between these extremes, a dedicated water hauling truck can transport 2,500 gallons (9,464 L) each trip. The use of a storage tank ranging from 5,000 to 20,000 gallons (18,927 to 75,708 L) can provide additional flexibility in transportation timing, though it involves additional cost.

The cost of hauling water will be site-specific and dependent on the equipment used, the distance and number of days of water-hauling. We compared the hauling costs of three different set-ups: a semi-truck with an 8,000 gallon (30,283 L) tank, a dedicated water hauling truck with a 2,500 gallon (9,464 L) tank, and a common farm truck with a 1,000 gallon (3,785 L) tank. In all three examples we assumed the truck was driven a round trip of 20 miles (32.2 km) from water source to grazing site. The labor required to fill, drive and empty is detailed in Table 2 and is paid at $15/hour. The cost per trip ranged from $133.05 for the semi-truck to $72.40 for the farm-truck (Table 2), which mirrors the range in truck and tank values assumed. But the amount of water hauled has a large impact on the cost of watering a cow per day. Assuming a cow drinks 20 gallons (75.7 L) per day, the cost of hauling water per cow per day ranges from $0.33 for the semi-truck to $1.45 for the farm-truck (Table 2).

Table 2. Estimated comparative costs of hauling water.

	Semi-Truck 8,000 Gal (30,283 L)	**Water-Truck 2,500 Gal (9,464 L)**	**Farm-Truck 1,000 Gal (3,785 L)**
Distance from water source to watering site—miles (km)	10 (16.1)	10 (16.1)	10 (16.1)
Source water cost—$/gal ($/L) [1]	0 (0)	0 (0)	0 (0)
Hauling truck and tank cost per unit distance—$/mile ($/km) [2]	$4.59 ($2.85)	$3.29 ($2.04)	$2.12 ($1.32)
Labor to fill the water truck tank hours	0.75	0.5	0.5
Labor to drive to and from the watering site—hours	1	1	1
Labor to empty the water truck—hours	1	0.75	0.5

Table 2. Estimated comparative costs of hauling water (*continued*).

	Semi-Truck 8,000 Gal (30,283 L)	**Water-Truck 2,500 Gal (9,464 L)**	**Farm-Truck 1,000 Gal (3,785 L)**
Labor cost per trip (at $15/hour)	$41.25	$33.75	$30.00
Cost per round trip—$/trip	$133.05	$99.55	$72.40
Cost per unit of delivered water—$/gal ($/L)	**$0.017 ($0.004)**	**$0.040 ($0.011)**	**$0.072 ($0.019)**
Cost per cow consuming 20 gallons (75.7 L) per day—$/cow/day	**$0.33**	**$0.80**	**$1.45**

[1] The source of water is from the home ranch and does not have a cash cost.

[2] The hauling truck and tank cost per unit distance (ownership and operating costs) was estimated using the University of Idaho Machinery Cost Analysis program. Value used for the semi-truck was $50,000; for the water truck was $30,000; and for the farm-truck was $12,000.

production may not meet expectations, because of the large size of his reserve (see the *Rangeland Resilience* sidebar).

In addition to promoting ecological resilience (which can be defined simply as the inverse of sensitivity), Stingley's management also meets wildlife goals, fostering grazing acceptance by parties ordinarily skeptical of rangeland grazing as a legitimate use of shrub-steppe landscapes.

Benefits

There are a number of factors that make the Stingley Ranch's situation unusual, including the CRM approach and the agreement with PSE and the Washington Department of Fish and Wildlife. These factors have strongly influenced how Stingley manages grazing, have led to some non-traditional challenges, and have also contributed to the benefits that Stingley's grazing management has accrued. These benefits are not solely for cattle production, as they also include wildlife habitat and wildfire risk reduction benefits, in line with the goals of the Wild Horse CRM.

The most immediate benefit is the improved condition of the upland rangeland vegetation. Indications of these improvements that Stingley has observed include greater standing grass biomass (Figure 6) and limited cheatgrass abundance. A more systematic evaluation of the vegetation supports these conclusions (see the *The Grazing Response Index* sidebar). Stingley shared an anecdote from a CRM tour held on PSE rangeland that reflects this improvement: "We went to a spring to the north here and one of the guys asked, 'When will you graze this pasture?' And I said, 'Well, we just moved cows out three days ago.'"

This improved condition of the vegetation (Figure 7) has led to benefits during drought years. For example, in 2015, despite regional drought conditions Stingley was still able to maintain stocking levels on summer rangeland with a combination of healthy grass stands, supplemental protein, and providing water. The condition of the vegetation has also resulted in habitat improvements, such as greater grass cover for ground-nesting birds, and forage production—and water holes—for deer, elk, and birds. The limited cheatgrass abundance also helps reduce wildfire risk, as cheatgrass monocultures carry fires faster and further than the patchy native bunchgrasses.

Rangeland Resilience

***Tipton D. Hudson**, Washington State University Extension*

One common definition of resilience, suitable for rangelands and other ecological systems, is "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to retain the same function, structure, identity, and feedbacks" (Walker et al. 2004). In rangeland management we seek to build social-ecological systems that have high resistance to permanent change; one in which human actors are able and willing to respond in real time to biological feedback and to adjust management, and in which humans are prepared to make transformative changes in management to adapt when conditions change enough that continuing "business-as-usual" is not possible.

Current ecosystem models for rangelands identify relatively stable "states" inside of which predictable assemblages of plant species dominate. In response to excessive or compounded disturbances, the plant community can transition across a threshold into a new, different stable state characterized by different species. These thresholds can be thought of like wind moving soil. At 3 mph, 5 mph, 10 mph, 15 mph (4.8, 8.0, 16.1, 24.1 km/hr) nothing happens, the system remains stable. But at 20 mph (32.2 km/hr) there is sufficient energy to lift soil particles and move them, and the system shifts into a new, different (eroded) stable state. Managing for resilience means managing landscapes such that the current plant community stays well away from these ecological thresholds, so that disturbances are less likely to drive the system beyond that threshold. The Stingleys exemplify this approach in their grazing management. They use multiple practices which are known to promote good rangeland condition:

- Dormant-season grazing as often as practical, which maintains or increases litter cover, maximizes grass vigor and reproductive success, and avoids stressing perennial grasses to protect their competitiveness against undesirable plants, such as invasive annual grasses.
- Very light stocking rates relative to historical forage production.
- Combining short grazing periods (less than 30 days) with long recovery times to minimize plant exposure to grazing animals and ensure species diversity.

High ecological resilience is especially important in cases when operational flexibility is low. For example, if a rancher is unable to make rapid changes in herd size to accommodate reduced forage available in a given year, due to drought for example, stocking conservatively at all times is a sound practice.

Ecological resilience also promotes long-term profitability in several obvious ways:

- High forage yield is conserved with diverse, site-adapted plant populations.
- The duration of active growth is maximized with a diversity of plant species, increasing yield and reducing fire risk.
- Animal health is maintained where animals have access to a wide variety of plant species. The diverse landscape meets nutrient requirements and provides a diversity of plant secondary compounds which maintain animal health when animals are able to be selective.

Nathan Sayre, a geographer with longtime interests in arid and semi-arid rangeland systems, says that rangelands are more akin to oceans than cropland or forests: they are vast, and variable, and resist micromanagement (Sayre 2017). Meanwhile, human understanding of the complexity of these landscape-scale systems is low. From this perspective, resilience is achieved by harvesting only a part of the available forage. This is not leaving money on the table; it is keeping money in the bank.

Figure 6. The amount of standing grass biomass remaining after Stingley's cattle have grazed the Puget Sound Energy rangelands is an indication of the healthy condition of the rangeland. Photo: Darrell Kilgore.

Figure 7. Healthy native bunchgrasses, low cheatgrass abundance, and little bare soil are indicators of a rangeland plant community in good condition. Photo: Tipton Hudson.

Jennifer Diaz, PSE's Environmental Manager, says the biggest benefit PSE sees is a reduction in flammable biomass. "When the cows are out grazing they're reducing that fuel load that has the potential to increase wildland fires in the area." Current fire research seems to support this observation (Svejcar et al. 2014; Vermeire et al. 2014; Davies et al. 2016). While severe defoliation, especially repeated severe defoliation, can shift the plant community toward invasive annual grasses which are much more flammable than perennials, light to moderate grazing reduces and breaks up the continuity of fine fuels such that it reduces both the severity and the spatial extent of wildfire. In essence, light to moderate grazing limits fire risk but excessive grazing exacerbates it by altering the structure and composition of the plant community.

Additional goals of the improved grazing management that Diaz considers have been achieved include wildlife use, particularly by elk. "We also used grazing as a tool to help improve the rangeland in the facility, to keep the elk away from the local farmers and ranchers that are nearby" (Figure 8). Not insignificant is the commendation Stingley and PSE have received from public agencies for their success in maintaining and improving habitat. This social benefit, though intangible, has clear value for both Stingley and the broader community.

There are other benefits that Stingley describes. He finds that the cattle that are out on the rangeland are healthier than those that graze on irrigated pasture. As Stingley describes it, "The calves, when they come off the hills out here, they're not real fleshy compared to a calf that's in the Valley on green grass. But these calves are healthy and the compensatory growth kicks in. Lots of times at weaning time they'll be bigger than the calves in the Valley."

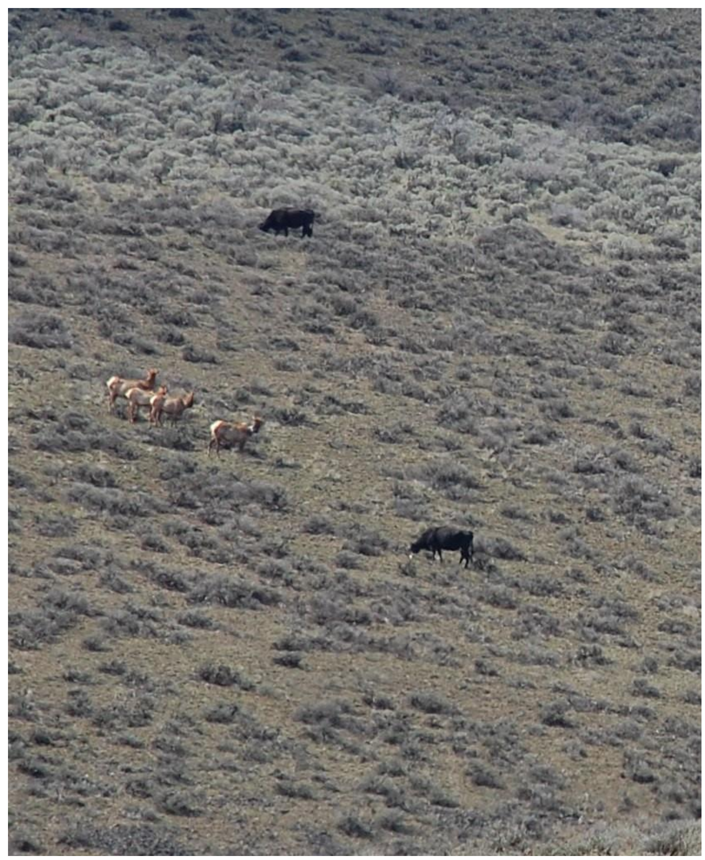


Figure 8. Cattle and elk grazing together in spring. Photo: Tipton Hudson.

Challenges

Stingley and his son Ryan described a range of challenges they have faced and continue to face. Some of these challenges are experienced by other ranchers in the area, while others are specific to their agreement under the CRM process. A serious challenge for ranchers looking to expand their operations, or new generation ranchers looking to start their own operations (like Ryan), is the scarcity of available rangeland for spring and summer grazing. Ryan comments, “There are some guys that are my age that are wanting to grow and expand, and you either have to wait for your dad to retire, or somebody else's dad to retire, because the available ground is pretty much all tied up.” However, the Stingleys feel they are better positioned in relation to this challenge than many. Public land available for grazing is scarce, and the future seems to belong to the rancher who can articulate a plan for grazing that furthers the values of the agency rather than solely livestock production goals.

The Grazing Response Index

***Tipton D. Hudson**, Washington State University Extension*

The original Grazing Response Index (GRI), developed by rangelands specialist Roy Roath, aimed to combine easily observed grazing variables into one score that would indicate with some reliability whether grazing influences on a particular site in a given year would have positive or negative effects (Reed et al. 1999).

The Land EKG version of the GRI used by the Stingleys includes consideration of precipitation, and incorporates relevant advances in plant physiology (Land EKG 2009). The Land EKG GRI evaluates four factors: utilization rates, growing season precipitation, plant phenological stage when grazed, and duration of regrowth opportunity. These are combined into a score from -5 to +5.

Factors and Scoring

<u>Post-grazing residual and utilization rate (Table 3)</u>: Removal of roughly half or less of the current year’s growth on perennial grasses in a single grazing event is expected to have a net neutral long-term effect on plant community health. Removing less than half would have a positive effect on the vegetation, while removing more than 55%, particularly when grazed during the active growing season, would have a negative effect.

Table 3. Grazing Response Index (GRI) values for utilization rate.

Use level	**% utilization**	**GRI value**
Rested/light	<40%	+1
Moderate	40–55%	0
Heavy	>55%	-1

<u>Rest and opportunity for regrowth (Table 4)</u>: Overgrazing is defined by a lack of an adequate regrowth period before re-grazing. Severe defoliation with sufficient opportunity for regrowth will not lead to overgrazing. Growing season recovery time is critical for individual plant health and plant community health. Longer recovery time receives a higher score, with the rest period lasting half the growing season expected to have a neutral effect on the vegetation.

Table 4. Grazing Response Index (GRI) values for rest periods.

Rest period before re-grazing	GRI value
All growing season	+2
Most season	+1
Half season	0
Part season	-1
Little to no recovery	-2

Season and phenological stage of grazing (Table 5): The perennial bunchgrasses which dominate much of the semi-arid western United States are largely dependent on seed production for reproduction. Even those species which reproduce vegetatively are significantly stunted by severe defoliation during the bolting period, when they cease producing more leaf material and begin investing in seedhead development. Physiologists refer to this growing phase of internode elongation as the critical period. The critical period spans the beginning of bolting through production of hard seed, or seed set. Grazing on bunchgrasses during the critical period often stops plant growth for the remainder of the year.

Table 5. Grazing Response Index (GRI) values for grass phenological stage.

Grass growth stage when grazed	GRI value
Spring dormancy	+1
Initial growth	+1/0
Vegetative growth / basal leaves	0
Boot through anthesis	-1
Soft dough	0
Hard seed	+1
Dormancy	+1

Growing season precipitation (Table 6): While land and livestock managers cannot control precipitation, the arrival of effective precipitation while plants are actively growing makes a disproportionate difference to biomass production and plant vigor in the Intermountain West and will therefore influence the impact grazing has on forage plants.

Table 6. Grazing Response Index (GRI) values for growing season precipitation.

Growing season precipitation	GRI value
Above average	+1
Average	0
Below average	-1

Grazing Response Index Scores on Puget Sound Energy Land (Land EKG Version)

A review of the GRI scores for the entire history of grazing on Puget Sound Energy (PSE) lands under the Wild Horse Coordinated Resource Management (CRM) plan is illuminating (Table 7). Because of the emphasis on changing timing of use, the relatively short duration grazing periods, and the frequency of dormant-season use, average scores range from very high, to, at worst, neutral (zero). This is consistent with quantitative monitoring data showing that rangeland condition is improving or stable from the initiation of grazing under the CRM plan to the present (Tipton D. Hudson, unpublished data).

Table 7. Grazing Response Index (GRI) scores for pastures on Puget Sound Energy land, managed under the Wild Horse Coordinated Resource Management (CRM) plan.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	10-yr average
South Wild Horse	4	4		0	2	3	5	1	3	2	5	2.9
West Wild Horse	4	2	4	2	4	2	4	2	1	5	3	3.0
East Wild Horse	4	2	4	2	4	4	4	4	2	4	4	3.5
Wild Horse Crossing*				4	3	3	1	3	3	3	1	2.6

* Blank cells are missing at least one key piece of data required for an accurate GRI score.

Another challenge—and this was a challenge specific to their efforts to improve the condition and resilience of these arid rangelands—were the large pastures and the uneven distribution of water sources for the cattle. With PSE's financial help, however, the Stingleys now have the water sources and fencing that allows them to overcome this challenge (see the *Managing Grazing to Achieve Multiple Goals* section, above), supporting their efforts to ensure the cattle graze more evenly across the large pastures.

Stingley and his son Ryan highlight two main challenges of grazing under a CRM: complex rotations, and limits to their ability to modify their grazing management in response to improvements in the long-term condition of the vegetation. Ryan describes how this land was historically grazed, starting the cattle in the lower pastures, and moving them up in elevation as spring warmed and the grasses greened up at higher locations: "We started at the bottoms and worked our way to the tops, so the cows stayed in green feed the whole time." Under the CRM, they now sometimes need to move cattle across whole pastures to the one beyond. These moves require herding up to five miles, risk calves getting orphaned if they stay behind, incur additional cost due to needing more herders (herding requirements are already raised by conservative stocking rates), and are challenging because you are herding mature cows, who know the land, through one or more in-between pastures that they cannot stop to graze.

The other CRM-specific challenge is longer term. Over the ten years the Stingleys have been grazing PSE and WDFW lands under the terms of the CRM plan, associated monitoring indicates that the condition of the rangeland has improved. As Ryan describes it, they have been tipping the balance towards the needs of the grass. What is unclear to them is whether there are indications that they can now shift that balance to more equally focus on the needs of their cattle as well as the needs of the vegetation. How to achieve such a shift, while still meeting the wildlife habitat objectives, will need to be resolved in collaboration with the CRM group. Strategies that could be considered include higher stocking rates, increased stocking rates during wet years, or changing the timing of use. The process needed for the Stingleys to resolve this within the framework of the CRM is more involved and lengthier than it would be if they had sole authority over how to manage their grazing.

Looking Forward

Despite the challenges they face, both as ranchers grazing arid rangelands and as collaborators within the CRM, Stingley and his son Ryan are in the ranching business for the long term. As Ryan sees it, “What would make me get out of ranching would be if it ever got to where a guy couldn't run any cows, or you just flat couldn't find anywhere to run them, or the economics of it finally got to the point where you just have to go to town and get a job because of it. As far as getting out of it just because I don't feel like doing it anymore, I don't think that'll ever happen.” They hope that what their grazing management has achieved on this rangeland—improved vegetation condition (Figure 9), resilience to disturbance and possible fire risk reduction, and balancing the needs of cattle and wildlife—can go a long way to convincing those who are looking to achieve these same goals that well-managed cattle grazing can be a way to improve the resilience of these arid, sagebrush-steppe systems.

Looking towards the future, Ryan feels relatively confident that their current grazing management will help them survive changes the region may see to its climate (see the *Ongoing and Expected Climate Change Impacts in the Pacific Northwest* and the *Impacts of Climate Change on Pacific Northwest Rangelands* sidebars). Equally important, he thinks that their grazing management is likely to continue to be socially acceptable to the community into the future. The interactions that started with the Big Game Management Roundtable and continued through the Wild Horse CRM process have supported the development of positive relationships between stakeholders with different objectives, and has led to broader support for grazing that benefits rangeland health and wildlife habitat. The Stingleys hope that demonstrating that grazing can be compatible with other goals on the Stingley Ranch could help open up additional public lands to grazing. This would improve the likelihood that newer generations—including their children and grandchildren—have the option to maintain this way of life and the quality of life it represents for them.

Figure 9. Healthy rangeland owned by Puget Sound Energy, part of the lands that Stingley grazes. Photo: Tipton Hudson, spring 2017.

Ongoing and Expected Climate Change Impacts in the Pacific Northwest

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

Natural climate variability, including variability driven by El Niño (ENSO) and Pacific Decadal Oscillation (PDO) cycles, dominates the Pacific Northwest’s climate and will remain very important into the future. At the same time, long-term, human-induced climate changes have already occurred and are expected to continue. By mid-century (2036–2065) average temperatures are expected to increase 4.7°F (2.6°C), with the largest increases in the summer (compared to 1976–2005 temperatures, for a high greenhouse emissions scenario, known as RCP 8.5; Vose et al. 2017). Precipitation projections are less certain and expected changes are not large compared to historical variability, though most models indicate a decline in summer precipitation averaging -7 percent (Mote et al. 2013).

Snowpack accumulation is projected to decline, with earlier snowmelt and runoff as the climate warms. With higher temperatures, soils are expected to be drier, at least at the surface and possibly deeper (Wehner et al. 2017). Plant water use efficiency for many plants, however, will likely increase through the “carbon fertilization effect,” as shown in grassland experiments (Polley et al. 2013). Meanwhile, increasing temperatures and drier fuels are expected to lead to higher fire risk, though temperature, soil moisture, relative humidity, wind speed, vegetation (fuel type and density), and both human and natural ignition events are all important aspects of the complex relationship between fire frequency and ecosystems (Wehner et al. 2017).

Impacts of Climate Change on Pacific Northwest Rangelands

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Climate change (described in the *Ongoing and Expected Climate Change Impacts in the Pacific Northwest* sidebar) will have complex impacts on rangelands, affecting the physical environment, environmental stressors, socio-economic factors, and animals, plants, and other rangeland organisms (Chambers and Pellant 2008; Polley et al. 2013; Briske et al. 2015; Neibergs et al. 2018; Reeves et al. 2017). Impacts are expected to be location specific and vary widely across the United States.

In the Pacific Northwest, net primary productivity is likely to increase by mid-century (Figure 10, left image; Reeves et al. 2017). Increases in forage inter-annual variability (Figure 10, right image; Reeves et al. 2017;) in some areas will likely exacerbate challenges for cow-calf operations, as unexpectedly destocking in response to reduced forage production can create economic losses, and increasing herd size in response to higher-than-expected forage production generally takes more than a year (Neibergs et al. 2018). However, in some areas of the Pacific Northwest, variability is likely to decrease.

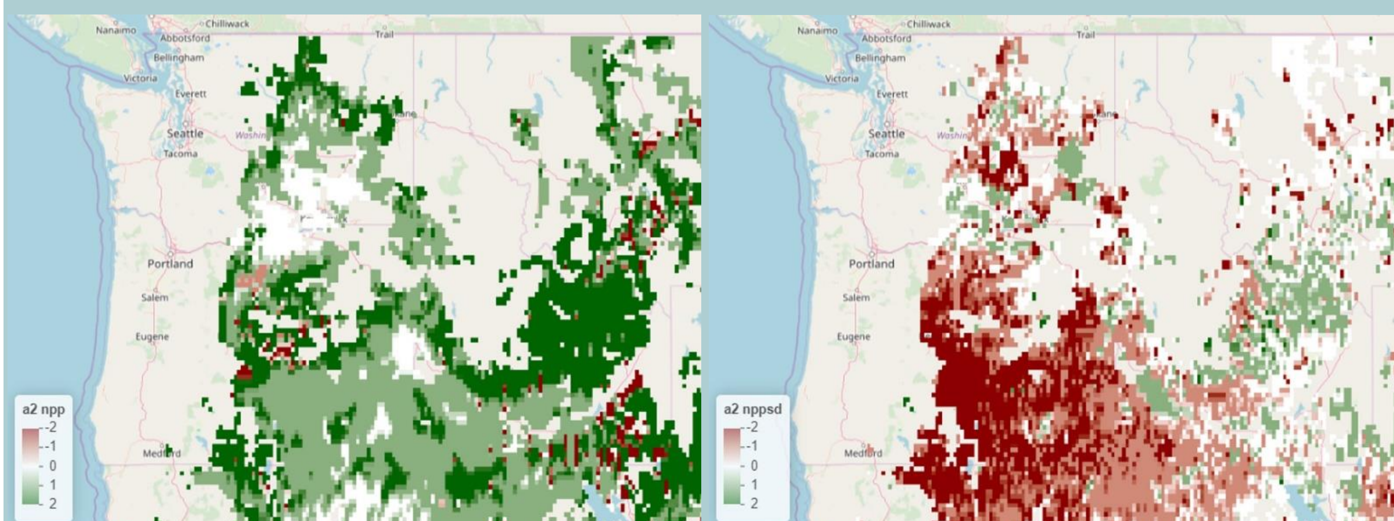

Figure 10. Expected changes in net primary productivity index (positive values represent an increase in NPP) (left image) and expected changes in inter-annual variability (negative values represent an increase in variability) by 2050–2060 (both shown as +2 to -2 index, compared to historical baseline of 2001–2010) (right image). Projections shown were developed using a high greenhouse gas emissions scenario known as A2, and future climate projections from the 3rd Coupled Model Intercomparison Project (CMIP3). Data from Reeves et al. 2017. Visualization by Rajagopalan et al., unpublished.Meanwhile, across the western US, Reeves et al. (2017) projected a move from woody dominance toward grassier vegetation types overall but with considerable spatial heterogeneity (Reeves et al. 2017). However, these projections assumed no fire suppression efforts. It remains to be seen whether fire suppression efforts will actually lessen, perhaps as climate change leads to larger and more intense fire events. Others have suggested that climate does not have a large impact on whether or not woody species dominate, and that grazing history, fire regime, and soil type will continue to be determining factors (Polley et al. 2013).

Rangeland vegetation is also likely to shift in response to climate change's interactions with the potential for threats from cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*) and red brome (*Bromus rubens*) (Chambers and Pellant 2008; Polley et al. 2013). This in turn could reduce forage quality and also contribute to larger and more frequent fires.

Last, results indicated a substantial increase in the number of cattle heat-stress days across the country beginning as early as 2020–2030, including for areas of the Pacific Northwest that do not currently experience much heat stress. Heat stress was calculated based on the temperature-humidity index, which is correlated to physiological heat response. In this region, there are projected to be more than 60 heat stress days annually by mid-century under the A2 scenario, compared to just a few heat stress days per year during the baseline of 2001–2010. In some cases animals may be able to escape heat stress through seeking shade or riparian areas, though this may create different challenges by concentrating grazing pressure in these particular areas.

It is almost certain that ongoing climate change will substantially impact both cattle operations and the complex ecosystems that make up Pacific Northwest rangelands. Impacts in other regions are also likely to be very important for the Pacific Northwest, as these impacts will affect the economics of livestock production across the US. The Southern Plains—with the current highest beef cow inventory—and the Southwest regions are projected to be negatively impacted for most indicators relevant to rangeland livestock production. Relative advantages may thus shift to the Northern Plains and Northwest regions, despite some important challenges in these regions (Polley et al. 2013; Briske et al. 2015; Neibergs et al. 2018).

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