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FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

HOME ON THE RANGE: MIGHT THE CATTLE PEACEFULLY GRAZE?

Marni Porath

Researchers are looking at how off-stream water sources can improve cattle distribution and decrease cattle effects on streams.

"One of the great dreams of man must be to find someplace between the extremes of nature and civilization where it is possible to live without regret."

Barry Lopez, *Crossing Open Ground*

Images of cattle standing in fish-bearing streams have become a common weapon in the ongoing battle over salmon and their habitat. Heated public debate pits supporters of the long-admired occupation of ranching in the American West against environmental groups who would have the cattle permanently removed, particularly from public lands.

Scientists have been called into the controversy to examine the details of habitat effects along with the options for change. What's the prognosis so far? "Most of the more conclusive studies showing environmental damage by cattle, especially to streams, have come from areas of heavy grazing," says Jim McIver. There the increased sedimentation, reduced vegetation, changed plant communities, and wider, shallower streams present indisputable evidence of damage by cattle.

So far, however, there are not abundant data to show that managed grazing methods are similarly detrimental to the natural environment, he says, and to riparian areas in particular. "What we desperately need is

IN SUMMARY

Grazing and how it impacts the landscape is a concern for public and private land managers. This issue of "Science Findings" examines the issue of cattle and grazing and provides some background, perspective, and research results on various grazing systems. Researchers Jim McIver, of the Forest Service's Blue Mountains Natural Resources Institute, and Mike McInnis, of Oregon State University, share their findings.

Work by collaborators at the University of Idaho and Oregon State University show that the presence of water, salt, and upland forage can attract cattle away from riparian areas and alter their distribution. Cattle being equitably distributed across a landscape can translate into weight gain in young cattle and help to pay for an installed watering system. But, McIver and McInnis found that there are still many unanswered questions regarding the ecological effects of moderate altered grazing.

information on how different levels of grazing intensity affect the same ecological variables. And it turns out getting that information accurately has not been easy." McIver is research coordinator with the Blue Mountains Natural Resources Institute (BMNRI; PNW Research Station).

"We do know how to use our resources and protect them as well," says Mike McInnis, who worked with McIver on a recent assessment of a dispersed cattle grazing strategy. "On the other hand, if we draw a line in the sand, there's not going to be a realistic solution." McInnis is associate professor of rangeland resources at Oregon State University (OSU), stationed in La Grande at Eastern Oregon University.

KEY FINDINGS

- The presence of water, salt, and upland forage can attract cattle away from the riparian area, thereby, significantly altering distribution.
- More equitable distribution of cattle in dispersed grazing systems resulted in more weight gain in young cattle, possibly because of better upland forage, thus paying for the expense of buying and installing the watering system.
- The changed cattle distribution resulted in a slight amelioration of effects on streambank stability but no significant effects on macroinvertebrates or use of forage were observed.
- Research design for effects of cattle grazing is frequently inadequate, particularly in terms of time and spatial scale, and little is known about effects of moderate grazing.

THE APPEAL OF STREAMS

In the interior West of the United States, sensitive riparian areas are unusually important because of the dry climate. They are natural magnets for many species, cattle included: when it's hot and dry, any sensible mammal will go looking for cool and wet. Not only that, the water means there's food there, even in dry times. A recent study out of OSU suggests that over 80 percent of cattle forage comes from just 2 percent of the land: the riparian zone.

In addition, when fish habitat is at stake, when heavy grazing occurs in mountain streams where salmon come to build redds and spawn, the scrutiny from environmental groups, State and Federal agencies, and the general public becomes intense. The demands for action have become insistent. McIver and McInnis agree that cattle management problems in interior West rangelands are more often a problem of distribution and seasonal timing than of abundance.

"We have the technology to minimize the impacts of grazing now. The challenge is to attract cattle away from the streams," says McInnis. Ruminants are evolved to thrive and produce red meat on lands we can't use directly: the grass, shrub, and wood lands we call rangeland, he says. But, whereas only 2 percent of that huge expanse of rangeland (half of North America) is riparian land, it is guaranteed to suffer if we don't protect it. "As a society struggling with how to use our resources, we need to understand how to sustain ourselves at the same time as we are sustaining the resources." A challenge as important as attracting cattle away from streams looms over grazing research: producing clear scientific evidence to clarify alternatives.

TYPES OF EXPERIMENTS

	Watershed (Operational Experiment)	Coupled (Operational + Sediment Experiment)	Hall Ranch (Our Experiment)
Replication/Control	Yes	Yes	Yes
Spatial Scale	Multi-watershed	Single Watershed	Single Watershed
Temporal Scale	10 year	3 year	2 year
Relative Cost	High	Medium	Low
Logistical Difficulty	High	Medium	Low
Probability of Type II Error	Low	Low	High
Ability to Answer Questions on Managed Grazing Systems	High	Medium	Low
Probability of Full Funding	Low	Medium	High

Various experimental approaches can tackle the challenge of understanding environmental effects of managed grazing systems. Multiple watershed and single watershed with controlled/artificial sediment measurement, and single stream experiments each present different strengths and weaknesses.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

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CASE STUDIES VERSUS REPLICATED EXPERIMENTS

Much of the literature focuses on the contentious issue of the impact of livestock on riparian areas, stream systems, and fish habitat. A recent literature review (Larsen and others), however, notes that "Our initial impression of this literature was that there was a great deal of personal opinion and commentary interspersed with a little scientifically valid experimentation." The recurring weaknesses in the literature, according to McIver and others, are inadequate description of grazing management practices or treatments, weak study designs, and lack of pretreatment data. In addition, most studies are nonreplicated experiments, in which there is no repetition of the treatments to increase confidence in the results. "A nonreplicated experiment does not have a lot of power, it's essentially a case study," says McIver. "This doesn't mean it's of no interest. A lot can be learned with a case study, but a replicated experiment is better." Also, as noted, much of the damage focus has come from heavy grazing systems. For example, comparisons of ungrazed exclosure systems, such as fencing, with grazing systems, have shown that rest from grazing often improves riparian and fishery values. This only shows, however, that the prevailing grazing system adversely affected the stream and riparian area. What about the possibility of improving the riparian system while a different system of grazing continues? Unexamined. How do intensity of grazing, frequency of grazing, and season of grazing influence environmental variables? If these questions are not addressed, the experiment can have only an extremely narrow focus. "If you bear in mind also that there are beef cattle grazing in practically every watershed in the interior West, you realize you have to be careful in extrapolating from studies on an individual stream," says McInnis. "And furthermore, no one part of the stream operates in isolation from what's going on upstream, what's being done by the next property owner. How do you design your studies to take that into account?"

MANAGEMENT IMPLICATIONS

- Under appropriate circumstances, fenceless livestock management can be accomplished in an economically feasible manner. In addition, more equitable cattle distribution is highly likely to have beneficial environmental effects on riparian systems. Thus, a fenceless system that is both economically feasible and environmentally sensitive is likely to pay dividends to the livestock manager.
- The complexities of riparian systems makes designing broad-ranging scientific experiments around such vexing issues as cattle grazing and riparian damage challenging. Without careful design, science could too easily contribute to future problems, rather than establish clear cause-and-effect relations.
- The use of incremental adaptive-management principles learning by doing, with science as sideboards and adaptive management as a fine-tuning device, is most likely to offer the best guidance to both public and private land managers.

DEALING WITH DRIFT

As McIver observes, when both your treatment and your variables can drift, you have a problem. To wit, cattle trampling seems to increase instream sediment, a recognized problem for fish habitat. How far, however, will that sediment drift? Is an 800-foot segment (the average length of a treated unit in the McIver-McInnis study) of stream long enough to let a sediment plume settle and thereby study its effects? Will an insect challenged by that sediment plume hunker down, die, or drift itself?

Other problems besetting scientists researching these questions include the complexity of stream ecosystems. Few ecosystems provide researchers with uniform experimental units, but if this problem is resolved by placing all experimental units together along a stream reach, those units are "homogenized" McIver says, thereby reducing your ability to measure specific effects.

Jim McIver

Measurements of change included bank stability and angle, water quality, stream geomorphology, and insect variety and numbers.

"In this scenario, you're unlikely to pick up an effect of your treatment unless it is really profound." An overriding problem of all applied research in this arena is that funding is rarely sufficient to cover the time and space ideally required for finding solid answers. Small sample size and lack of long-term studies do not help clarify links between physical and biological interactions, between land use and environmental effects, the researchers say. These constraints also increase the likelihood of what scientists call a type II error: the finding of no significant difference when a true difference exists.

WRITER'S PROFILE

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EXAMINING DISPERSED GRAZING SYSTEMS

The dispersed grazing system experiment on which McIver and McInnis collaborated encountered several of these experimental design challenges, bringing out some definitive results, as well as raising the inevitable questions.

"There had not previously been any experimental testing of the efficacy of off-stream water systems used to attract cattle away from the stream during heavy-use periods," says McIver. One big-picture intent of their experiment was to bring moderate grazing systems into the discussion. "We wanted to see the results in terms of economics, the behavior of the cattle, and the ecology of the riparian system."

The experiment involved setting up three replicate pastures of each of three treatments: an ungrazed control, an off-stream water system pumping water to troughs in the uplands, and a traditional grazing system in which the only access cattle had to water was from the stream. The treatments were placed along a single 2-mile reach of Milk Creek in northeastern Oregon, on land managed by the Eastern Oregon Agricultural Resource Center, and owned by the OSU Experiment Station. The position of each of the nine experimental units was determined randomly.

The experiment significantly increased the distribution of livestock where off-stream water was provided, making it a behavioral success. Furthermore, by pulling cows and calves into the uplands, where the forage is more nutritious, they gained weight. "This result tells us the dispersed grazing method is also an economic success, even accounting for the cost of the pump," says McInnis.

When it came to answering the environmental effects questions, however, things were not so simple.

THE GREENLINE AS INDICATOR

The study looked at both greenline impacts—those that confined themselves to that area below bank-full but above the scour line—and instream impacts. At the greenline, researchers looked for the presence or absence of cattle, based on hoofprints; the impact of cattle based on vegetation cover; and bank stability based on measures of broken and fallen banks, and angle of banks.

In the units with off-stream water available, 26 percent of the units showed the presence of cattle, compared with 31 percent where the stream provided the only access to water. In addition, where there was no other water source, there was a significant decrease in vegetative cover because of more frequent visits by cattle, according to McInnis. No significant difference occurred in riparian vegetative cover between the ungrazed control and the sites with off-stream water.

Change in bank stability showed a slight decrease after grazing in the dispersed (off-stream water) units, versus a 17-percent change after grazing where the stream was the only water source.

"While this definitely shows that there was less presence of and damage by cattle in the greenline where we provided off-stream water, the next question about the numbers is 'So what?'" says McIver. "Is only 26-percent presence of cattle significant? Is 17-percent change in bank stability insignificant?"

The results suggest that managers can obtain some limited protection of sensitive riparian areas from grazing by offering water in the uplands, according to McInnis. The success of this kind of grazing management, however, also depends on season, topography, vegetation, weather, and behavioral differences.

"Off-stream water to change distribution may not work in early season grazing, due to changes in weather and forage quality," he says. "Pastures with steeper slopes may be less amenable to providing off-stream water, and the relative quality of upstream and riparian forage may be more important in determining livestock distribution patterns. Finally, individual cattle respond in various ways, based on innate and learned behaviors."

BEYOND THE GREENLINE

Greenline effects accurately reflected cattle distribution in this experiment, showing fewer and lesser effects where there were fewer cattle. Instream variables, however, did not, according to McIver. The instream effects he measured included water quality, stream geomorphology, and insect variety and numbers.

"If the significant greenline effects of grazing translate directly into instream effects, then we would expect to find some correspondence between the two when we compare grazed versus ungrazed pastures. Taken as a whole, however, instream variables only suggested a modest grazing effect at best," McIver says.

He notes that it is possible that the level of cattle grazing did not produce significant enough quantities of sediment to change instream habitat, or to cause emigration or death of insects.

"On the other hand, it is possible that greenline alteration did produce significant and biologically meaningful amounts of sediment, but that the experimental design, especially the small time and size scales, was not robust enough to reveal it. We believe that the answer is probably a combination of these two explanations," he says.

A modest grazing effect at best? Effects too subtle to be more than a suggestion? Trends as opposed to powerful statistical changes? Correlational and circumstantial data. These are the descriptors the researchers use to describe the maybe's their experimental results offer.

McIver concludes, "A more robust experimental design, in which large treated units are truly independent, in which substantial pretreatment data are taken, and in which treatments are applied and posttreatment data taken for several years would probably be required to establish definitive links between greenline and instream effects."

AND THE FISH?

At this magnitude, would effects be expected to contribute to declines in native fish populations? It depends, naturally. Might streambanks recover in the course of the year? And did the change in bank breakdown along Milk Creek create enough sediment to cause permanent changes in aquatic habitat quality?

These links are the ones crucial to fish effects, given the abundant evidence for effects of fine sediment on fish: increased turbidity decreases salmonid growth rates, increases emigration from affected areas, reduces the ability of fish to find food, and reduces oxygen levels. Settled sediment on the stream bottom reduces habitat quality for both fish and the invertebrates on which they feed. Fine sediments also suppress survival and growth rates for juvenile salmon, reduce the quality of spawning habitat, and change the composition of invertebrate species communities.

"What we really need is experiments that link cattle grazing intensity, bank breakdown, sediment release, and instream habitat effects," McIver says. "Such studies are essential if we are to understand the thresholds beyond which cattle-induced bank breakdown becomes a problem for sediment yield, macroinvertebrate habitat quality, and fish production."

BUILDING A BETTER DATA TRAP

Both researchers recognize the weaknesses inherent in the experiment design, constrained as it was by funding: nonindependence of treated units, which ranged along a single stream reach; small unit size, averaging 40 acres; and a short timespan of 2 years. The study also had its strengths: replication by three for all treatments, randomly assigned treated units, control over and careful description of treatment intensities and intensive measurement of a critical list of response variables.

The challenge is to attract the funding required to design a more robust experiment. McIver and McInnis have similar preferences in experimental design, each with more complexity in scale and logistics, and thus greater expense. Both believe that moderate grazing needs more, and more intensive, research.

Ten years and many experiments in different watersheds would be a good start, with a before-and-after control-impact study to look at the different variables, which would only work if substantial data were available for the "before" part of the study.

Another possible approach would be a "coupled" experiment, in which greenline effects are first measured in a real stream to establish their range. An artificial stream would then be used to simulate similar levels of sediment production, for example, in order to trace accurately the effects of those levels of sediment on other instream variables. Ideally, several invertebrate species might be identified that are particularly sensitive to increasing sediment.

"And we can support adaptive management through research and extension, in which we encourage operators to compare a variety of practices, and to document the results," he says. "This requires commitment from landowners, managers, researchers, and funders, as we're not going to learn the answers in a single season. But it does replace trial and error with parallel learning."

He has seen good working examples of ranchers becoming better land managers as they get involved in adaptive management, simply because it requires that they continually pay very close attention to matters outside the annual bottom line.

Results, both researchers agree, should be extrapolated with caution. Nevertheless, no funding could possibly support the geographic scale of experiments needed to come up with a cookbook solution to cover all Western U.S. rangelands. The key is to learn information about fundamental processes that can be extrapolated more broadly.

"Science really cannot provide all the information needed to manage every acre. Science can give us the sideboards for broadly acceptable management practices, whether by searching the literature, or doing experiments," says McIver. "Adaptive management then becomes the fine-tuning device."

"All the beasts of the forest are mine: and so are the cattle upon a thousand hills."

Prayer Book 1662

FOR FURTHER READING

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