MOSAIC

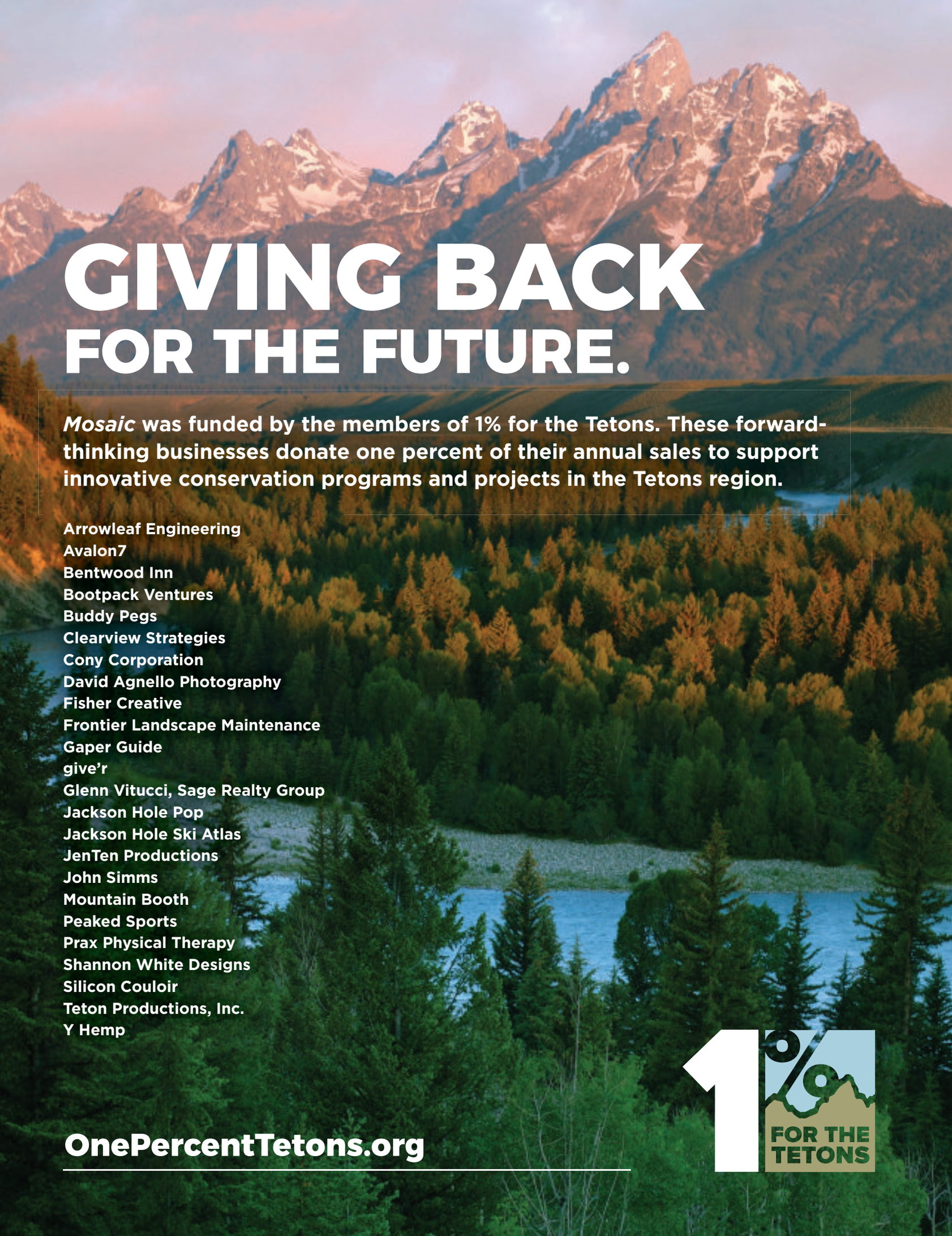
THE STATE OF THE TETONS ECOSYSTEM

PRESERVING AND PROTECTING THE AREA'S ECOSYSTEM

FLORA AND FAUNA, HUMANS AND HABITAT

CONNECTING THE PIECES, CONNECTING THE REGION

2018 edition



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WELCOME TO THE PREMIERE EDITION OF *MOSAIC*.

"Nothing great in the world has been accomplished without passion."
-Georg Wilhelm Friedrich Hegel

JONATHAN SCHECHTER
Executive Director, Charture Institute

In 2012, the Jackson Town Council and Teton County's Board of County Commissioners adopted a joint Comprehensive Land Use Plan. By any standard, the plan's Vision Statement is extraordinary: "Preserve and protect the area's ecosystem in order to ensure a healthy environment, community and economy for current and future generations."

Mosaic's goal is to help bring this vision to life.

Mosaic's genesis lies with Tetons 2020, a group assembled in the spring of 2017 by my Charture Institute. Tetons 2020's members – including Jackson's Mayor and the county commission chair, the heads of all of the region's federal lands agencies, and the leaders of many of its conservation groups – came together to explore how we might help turn the Comp Plan's vision into reality. During our discussions, we realized that, until the community has a baseline assessment of our ecosystem's health, we will never be able to judge how well it is being preserved and protected. *Mosaic* is a first step in that process.

Mosaic is a group of essays written by experts in various aspects of our ecosystem. All the authors are local, a testimony to the depth and talent of the region's environmental community. The essays are written for a lay audience: decision-makers, advocates, and others who care about the region's ecosystem, but who are not scientists. The opinions expressed in each essay are those of the author.

Mosaic is both a title and a metaphor. Metaphorically, each *Mosaic* essay can be viewed as a piece of a larger whole, a mosaic that will fill in with each essay and each successive year's edition. As it does, the community will be able to see an increasingly complete picture of our ecosystem's many components, and how each is faring.

With luck, the picture constructed by this and future *Mosaics* will not only provide a better sense of our ecosystem's health, but catalyze further efforts to understand, preserve, and protect it. As we do, we'll be acting to ensure a healthy environment, community, and economy for current and future generations.

Mosaic would not be possible without the inspiration of Tetons 2020's participants, the intellect and professionalism of its essayists, and the funding provided by the members of 1% for the Tetons, whose donations paid for this publication. To each, my deepest thanks.

Ultimately, though, the catalyzing force behind *Mosaic* is the passion of all those who care so deeply about the Tetons region. That passion shaped the Comp Plan's Vision Statement, and fuels its pursuit.

To our future!

MOSAIC
tetonsmosaic.com

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Our extraordinarily powerful, if not audacious, vision.

by Jonathan Schechter

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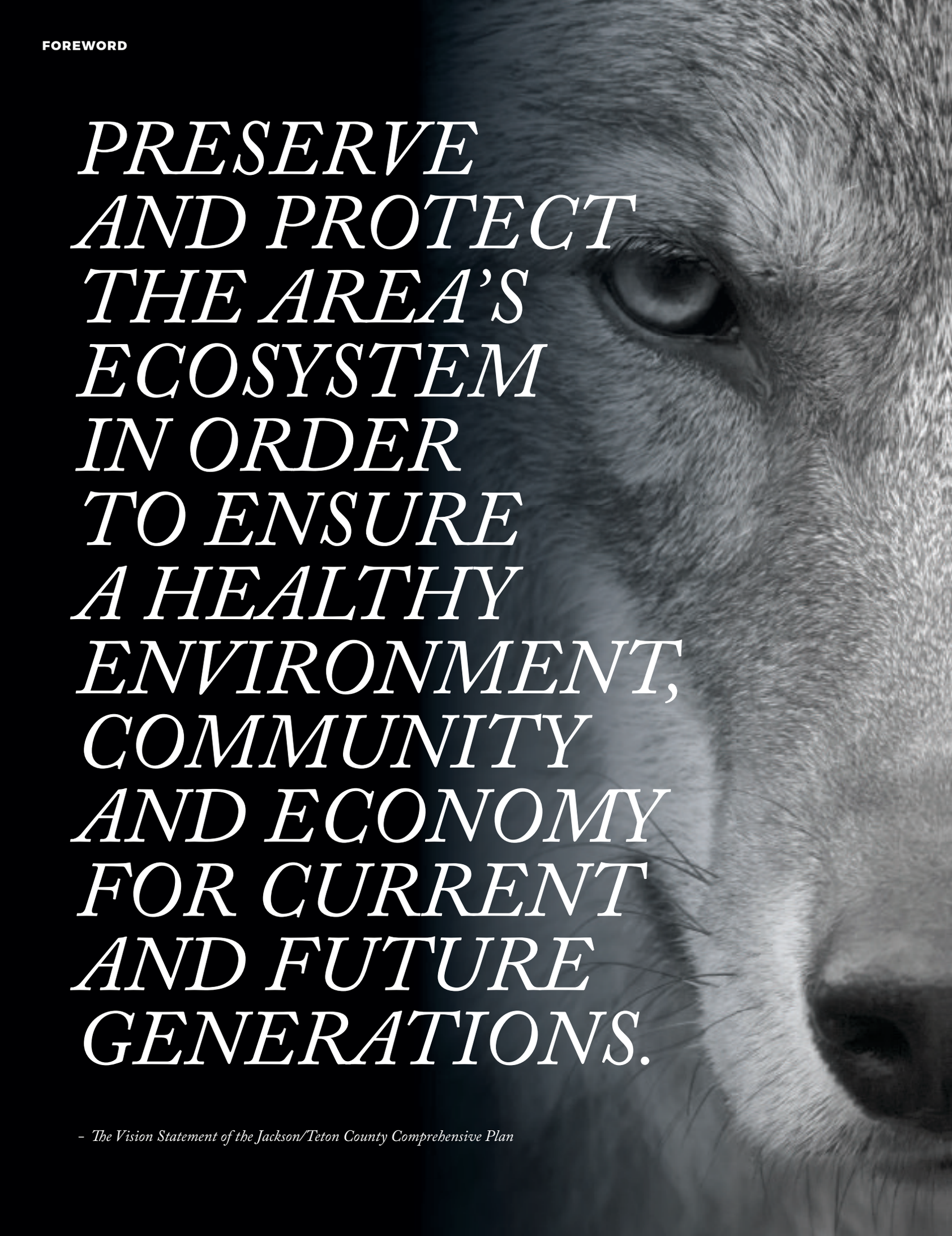

PRESERVE AND PROTECT THE AREA'S ECOSYSTEM IN ORDER TO ENSURE A HEALTHY ENVIRONMENT, COMMUNITY AND ECONOMY FOR CURRENT AND FUTURE GENERATIONS.

– *The Vision Statement of the Jackson/Teton County Comprehensive Plan*

FOREWORD

BY JONATHAN SCHECHTER

The essence of the Comp Plan's Vision is its first six words: "Preserve and protect the area's ecosystem..." The remaining fifteen words are the plan's rationale: "...in order to ensure a healthy environment, community and economy for current and future generations." If we preserve and protect the area's ecosystem, we'll ensure a healthy environment, community, and economy. If we fail, all three will be jeopardized.

POWERFUL, IF NOT AUDACIOUS

For three reasons, the Vision Statement is extraordinarily powerful, if not audacious.

The first reason is its clarity and directness. Globally, the most-successful organizations have vision statements that are both aspirational and operational: Aspirational, in that they motivate stakeholders; operational, in that they provide a clear, binary tool for evaluating the organization's efforts. For Teton County and the Town of Jackson, the Comp Plan' Vision Statement does both. It is aspirational, for it clearly states the community's deep desire to be good stewards of the area's ecosystem. And it is operational, for it provides all interested parties with a very clear standard for assessing any proposed action. Does a proposed action help preserve and protect the area's ecosystem? If yes, then it's worth supporting. If no, then it's not.

The second reason the Vision Statement is extraordinarily powerful is that it says the town and county will prioritize doing something no community with an advanced economy has ever successfully done: preserve and protect its ecosystem.

In the 1760s, business people began to put scientific knowledge to use in the practical, systematic fashion that became known as the Industrial Revolution. Since then, humans have so successfully harnessed the processes and products of the Industrial Revolution that average life expectancy has doubled, and Earth's overall population has increased ten-fold.

The Industrial Revolution-fueled growth in Earth's population is especially striking. To understand why, consider the doubling times of Earth's population over the last 2,000 years. *(Table 1)*

Table 1

Growth of Earth's Population: Doubling Times, and Growth Rates per Century

Year	Population *(millions)*	Doubling time *(years)*	Compounded Growth Rate *(per century)*
1 C.E.	170		
1200	360	1,200	6%
1760 *Start of the Industrial Revolution*	770	560	15%
1890	1,500	130	67%
1960	3,000	70	169%
1998	6,000	38	520%
2018	7,600		226%

In 1 C.E., an estimated 170 million people inhabited Earth. 1,200 years later, the population had doubled, to 360 million.

The next doubling took around 560 years: In 1760, at the start of the Industrial Revolution, Earth's population was an estimated 770 million.

130 years later, in 1890, it had doubled again, to 1.5 billion

70 years later, in 1960, it had doubled again, to 3 billion.

38 years later, in 1998, it had doubled again, to 6 billion.

In the past two decades, the pace of growth has slowed some, but not much: During the last 20 years, Earth has added more people than it did during the 1,900 years between the birth of Christ and the start of the 20th century.

This extraordinary growth in human population is a direct result of our ability to combine science and technology. An unintended consequence of unleashing that power, though, has been that we've altered the basic pre-Industrial Revolution balance that existed between humans and Earth's ecosystems. Before the Industrial Revolution, human behaviors affected ecological health on a local basis, but we did not have the power to fundamentally affect the ecological balance of the broader planet. Now we do, and that balance is increasingly askew.

When combined with the development of modern capitalism, the technologic and related advances of the Industrial Revolution have allowed humans to not just survive, but thrive. As we have done so, though, the cost of our ever-greater ability to extract and harvest Earth's resources has been to alter, disrupt, and harm – in some cases permanently – Earth's environment and its ecological processes. As a result, while humans have thrived over the past 250 years, Earth clearly has not. In particular, I am not aware of any region, state, or nation that has developed an advanced economy (i.e., one based on industry or modern services) without fundamentally harming the health of the ecosystem in which it lies.

Hence the audacity of the Comp Plan's Vision Statement. In unequivocal terms, it says the Jackson Hole community intends to do something humans have never done, something for which there is no blueprint. This is wonderful and magnificent; certainly Quixotic and perhaps a bit crazy. It is also a clear indication of the community's character and values.

LEAVING A LEGACY

So where does this leave us? With a Comp Plan that gives us a clear vision but no blueprint for pursuing it. And a vision that requires us to act beyond our boundaries, no small feat in an ecosystem that spans two states, at least three counties, and a number of different federal, state, and local jurisdictions. In adopting their vision, Jackson Hole's local governments – and by extension the community as a whole – have made an extraordinary commitment to not just our current residents and visitors, but future generations. In that sense, what they – what we – have done is channel the audacity of our forebears, applying to our 21st century circumstances the same boldness that has hallmarked our region for nearly 150 years. In the 19th century, that boldness and audacity manifested itself in the formation of Yellowstone, the world's first national park. In the 20th century, it manifested itself in the expansion of Grand Teton National Park, arguably the greatest public-private partnership in American history. Both occurred in what is now Teton County, Wyoming, and now it's this generation's turn.

"We have committed ourselves to preserving and protecting the ecosystem of the entire area,

Making things more audacious still is the third reason the Comp Plan's vision is so powerful: its stated goal of preserving and protecting the *area's* ecosystem. Not just the ecosystem of the Town of Jackson or Teton County, Wyoming. Instead, we have committed ourselves to preserving and protecting the ecosystem of the entire area, a region spreading far beyond the jurisdiction of either the town or county government. From a scientific perspective, this makes perfect sense, for the region's water, weather, and wildlife recognize no political boundaries. But to effectively pursue its vision, the Comp Plan requires Jackson Hole's local governments to take responsibility for occurrences in areas beyond which they have direct control.

Can we leave a similar legacy? On the positive side, arguably no other place in the world has a better chance to figure out how to develop a system that allows both humans and the environment to simultaneously thrive. Teton County, Wyoming is the wealthiest county in

the wealthiest country in the history of the world. It sits at the center of the largest generally-intact ecosystem in the Lower 48, and one of the healthiest ecosystems in the world. And those drawn to the region – whether as year-round residents, second home owners, or visitors – are among the most highly educated and impassioned people on the planet. Who better to figure it out? And if we can figure it out, then the rest of the world has a model to follow.

But whether we can figure it out is far from a sure thing. For example, consider that, in the six years since the 2012 Comp Plan was adopted, the town and county have made little systematic effort to pursue their vision. The reasons are manifold, but perhaps the most basic is the simple fact that the plan's vision asks us to do something no community in an advanced economy has ever successfully done: preserve and protect an area's ecosystem. How daunting is that?

ASSEMBLING A MOSAIC

As we try to figure it out, one major asset we can draw on is the passion people feel for the region. And not just our residents and visitors, but the scientists drawn to the Tetons. The good news is that, for decades, world-class scientists have done world-class science in our area, developing an ever-greater understanding of the region's landscape, flora, and fauna. The bad news is that much of that science has been done on a piecemeal basis, without much reference to the bigger picture. But drawing on the metaphor of a mosaic, if we can start to assemble the pieces of extant research into a coherent whole, we can take the first steps toward systematically pursuing the Comp Plan's vision.

The sixteen essays that form the core of *Mosaic* are the first step in this process of mosaic-assembly. Each was written by one or two authors who have devoted significant portions of their professional lives to understanding some aspect of the region's ecosystem. Each author was asked to write an essay that, while scientifically sound, was intended for an audience of non-scientists; i.e., the decision-makers and others who want a solid understanding of the region to inform their efforts as they lead the community's pursuit of the Comp Plan's vision.

Trying to describe and evaluate our entire ecosystem is well beyond the scope of *Mosaic*. Instead, this first edition of *Mosaic* focuses on on-going efforts – things we already know and projects in process. In that sense, this first edition is analogous to starting any new mosaic or jigsaw puzzle – to assemble one, you need to start somewhere, usually by grabbing a few pieces you recognize. In this case, the authors of each essay are local researchers, activists, and scholars describing interesting work they've done regarding some important aspect of the area's ecosystem.

a region spreading far beyond the jurisdiction of either the town or county government."

MOSAIC'S CONTENT

Mosaic's essays fall into six basic categories.

1 **FRAMING** Franz Camenzind frames *Mosaic* by defining what an ecosystem is, and how to go about thinking about it.

2 **META-ISSUES** Drilling down a level, the next two essays focus on the meta-issues shaping the region's ecosystem: Corinna Riginos and Trevor Bloom write about the effects of climate change, while Jon Mobeck urges readers to take a landscape-level view of the greater Yellowstone area.

3 **HABITAT AND SPECIES** The signature features of the region's ecosystem are its habitats and the species occupying them. These are the focus of six essays:

Doug McWhirter discusses the critical links between habitat health and wildlife health.

Megan Smith talks about the work she and her colleagues did mapping and assessing habitat throughout Teton County.

Kelly McCloskey focuses on a particular type of local habitat, the sagebrush steppe that forms so much of the valley floor in Grand Teton National Park.

Erica Hansen's focus is on the disproportionate importance of the region's private lands in affecting habitat health.

Erika Edmiston and Mark Daluge look at how invasive species are affecting the local landscape.

Corrinna Riginos and Frances Clark look at the health of several key systems and wildlife species.

4 **WATER** The saying goes that, in the arid western United States, whiskey

is for drinking and water for fighting. Hence the importance of the region's riverine systems to our ecological health. Carlin Girard explores the state of Teton County's water quality, and Dan Leemon that of our riparian habitats.

5 **PEOPLE** During the last seven years, the Greater Yellowstone region has been exceptionally fortunate to have Dan Wenk as Yellowstone National Park's superintendent. One of Superintendent Wenk's most trenchant observations is that, of all the species in the park, the one he and his team know least about is humans.

The importance of this observation is reflected in *Mosaic's* three essays devoted to making public policy, for policy is where humans try to codify their relationship with nature. To shine a light on local efforts, Susan Clark describes how to make and evaluate good public policy, Mark Newcomb discusses the planning tools available to local government, and Tim O'Donoghue looks at local efforts to address the region's growing problem of overtourism.

6 **CASE STUDIES** Two case studies show how all of these concepts tie together into real-world actions: Shawn Hill discusses an effort to rehabilitate Teton Creek as it flows out of the Tetons into Idaho's Teton Valley, and Max Ludington talks about trying to capture the run-off coming down the west side of the Tetons to improve both local agriculture and the Teton Valley's riparian habitats.

These essays only scratch the surface of the thoughtfulness of their authors, much less the depth of the knowledge and work underlying them. Such are the trade-offs that must be made to produce a publication like *Mosaic*. But if it works, then *Mosaic* will leave its readers with a better sense of the Tetons area's ecosystem: its constituent parts, how they are faring, and what challenges lie ahead.

SPONSOR FOCUS

Mosaic was produced by the Charture Institute, a Jackson, WY-based 501(c)3 non-profit. It was funded by 1% for the Tetons, a project of Charture. The advertisements in *Mosaic* feature members of 1% for the Tetons.

Charture's mission is to help human communities and the environments around them co-thrive; i.e. simultaneously thrive. Since its inception in 2001, Charture has developed five interrelated foci:

LEARN The core of all of Charture's work is fact-based, data-driven research and analysis.

TEACH Charture shares its findings through writing, lecturing, and teaching.

INSPIRE In all it does, Charture's goal is to inspire people to act to sustain the places they love.

ACT Charture has helped communities and individuals across the country pursue co-thriving.

FUND To help turn ideas into actions, Charture established 1% for the Tetons to provide critical seed funding for innovative conservation projects in the Tetons region.

To bring all this to life, Charture has developed and runs a number of different efforts.

FOR MORE INFORMATION

about any of these efforts, or to make a tax-deductible donation to support Charture's efforts, please go to the Charture website: charture.org. Alternatively, please call or write Charture's Executive Director, Jonathan Schechter:
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Founded in 2007, 1% for the Tetons is a member-funded organization providing leadership and financial support to innovative conservation projects in the greater Tetons region.

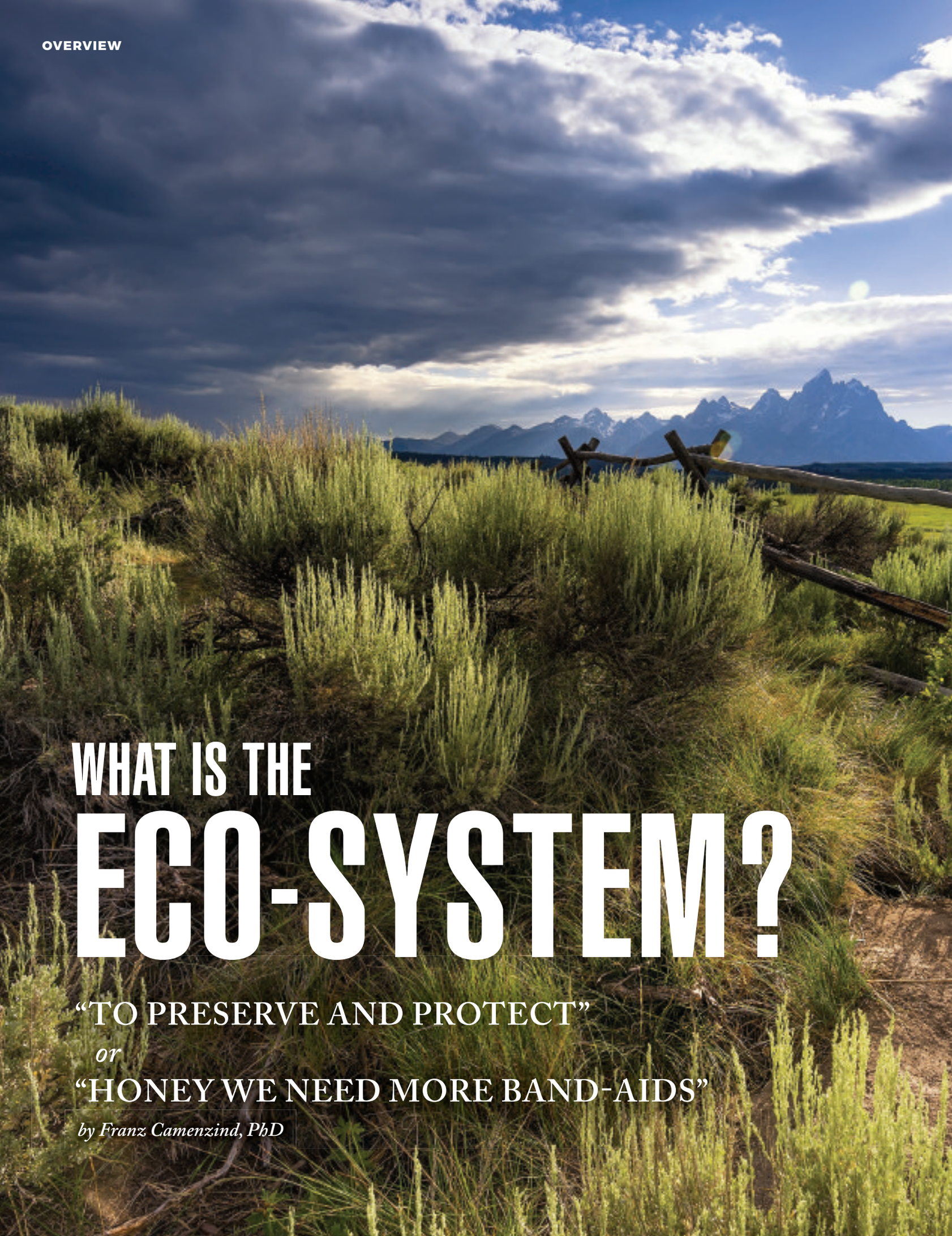
1% for the Tetons members contribute one percent of their annual gross revenue to a funding pool. This money is used to make early-stage grants to cutting edge regional conservation projects. Since its inception, 1% for the Tetons members have collectively contributed more than $800,000 to nearly 100 such projects.

Since 2012, Charture has run a series of annual forums looking at various aspects of the region's future, including its economy, environment, government, healthcare, and philanthropy. Each 22 in 21 session features participants developing actions to address issues raised during the forum.

Since 2011, Charture has provided all of the content for the annual Jackson Hole Compass. Produced in partnership with the Jackson Hole News&Guide, Compass is a compendium of socio-economic and demographic data examining the Tetons region, as well as analysis of the data.

Business is the world's most powerful and nimble economic institution. As a result, it is the only sector capable of bringing about the breadth and depth of change needed to make the world's economy regenerative, and do so as quickly as needed.

Since 2013, Charture has organized and run Healthy Business, Healthy Planet, an effort that brings together leaders of some of the world's most progressive companies to explore how business can be used to make the world a healthier, more equitable place for all.



WHAT IS THE ECO-SYSTEM?

"TO PRESERVE AND PROTECT"
or
"HONEY WE NEED MORE BAND-AIDS"

by Franz Camenzind, PhD

Before launching into any discussion, it helps to have a shared understanding of what we are talking about.

Virtually everyone familiar with the Teton region agrees our environment defines our community. It is the basis of our economy; it guides our physical developments; it provides incomparable recreation opportunities. Our environment shapes our collective way of life, and thus is the foundation of our quality of life. We take great pleasure in its gifts – and it sells very well to our visitors, too. So how can we define and come to understand our environment in a manner that will help us generate plans for preserving and protecting it?

Our environment is our surroundings, but that description is far too broad to focus our efforts to protect the environment. Instead, we need specifics. To do that, we need to examine the components of our environment and understand how they interact with each other. The organic basis for this effort can best be summed up in one word: Ecosystem.

DEFINING TERMS AND COMPONENT PARTS

To begin, let's define terms. The broad definition of "ecosystem" is the complex, functioning, interdependency of all parts. Breaking the term into pieces, here's what the Random House dictionary tells us:

Eco – a combining form representing "ecology"

In turn, "ecology" is a noun meaning "the branch of biology that deals with the relations of organisms to one another and to their physical surroundings."

System – a noun meaning "a set of connected things or parts forming a complex whole; a set of principles or procedures according to which something is *done*" (my emphasis)

Ecosystem – a noun meaning "a biological community of interacting organisms and their physical environment."

I look at the word "ecosystem" as a living, active, working noun. As much as anything, an ecosystem is a dynamic process in which all the parts interact with each other and, consequently, depend upon each other. By logical extension, tinkering with one part may have far-reaching affects upon the ecosystem's ability to function at capacity.

What are those component parts? Those plants and animals; those whatevers? In Teton County we have a full spectrum of component parts ranging from wolves to pikas; from sage-grouse to sandhill cranes and golden eagles. We have white pine, limber pine and lodgepole pine. And aspen and cottonwoods along with shooting stars, monk's hood, sagebrush and mule's ears.

In addition, at last count, Grand Teton National Park is home to four amphibian species and four species of reptiles (one lizard and three snakes - all non-poisonous). Sixteen species of fish live in the county's waters: nine native and seven introduced non-natives. The latest tabulation identifies 341 bird species in the valley. 166 nest here while the remainder are, like so many humans, seasonal visitors just passing through. Sixty-one mammals find refuge in the county, not counting us humans. And there is no way to estimate the number of insects eating, pollinating, buzzing and crawling around the county. Nor can we estimate the gazillions of micro-organisms living within our soil, constantly breaking down and rebuilding their environment from the ground up, creating new from the old, enriching the soils that grow the plants that feed the elk and deer, the moose and buffalo and the cattle that, in turn, feed many of us. This same from-the-ground-up system supports our fisheries, eagles, grizzly bears, mountain lions and weasels. And all these creatures, including us, depend upon the availability and quality of the region's land, water, and air for survival, and on-and-on. In short, it's an ecosystem – a complex, interacting and living noun.

DISRUPTING AND TINKERING

This is but a superficial glimpse of the many-faceted parts, complexities and interdependencies of our region's ecosystem. And as much as we know about our environment, much remains to be learned regarding the many functional nuances and inner workings of our ecosystem, not to mention how our actions – our tinkering – affects its function and long-term sustainability.

The rule of thumb holds that the more diverse an ecosystem's component parts and the more complex their interactions, the more stable the ecosystem is – and thereby the more capable it is of surviving perturbations. In addition, an ecosystem's stability is also a function of the size of the landscape in which it operates. We live near the middle of the Greater Yellowstone Ecosystem's 20-plus million acres, and a great deal of this ecosystem's stability is innately tied to the size of the landscape. Jackson, as a city and Teton County, as a legal entity, comprise the largest human complex so deep within the region's ecosystem. Unfortunately, that privilege also creates the potential for us to be one of the greatest disruptors of our ecosystem, as well as one of the greatest threats to its stability and sustainability.

Historically, the instinct to preserve and protect our surroundings arrived with the first Europeans to set up shop in the region. Understandably, they settled into and developed the most cli-

matically bearable enclaves – the low elevation valleys, including Jackson Hole. Not by chance, these same areas feature the very attributes that so many of our wild co-habitants need for their survival.

In that context, consider what was likely the first major disruption of the area's ecosystem. Over a century ago, as ranchers converted native meadows into cattle ranches, the elk returning from their summer range found their winter grasses cut and stacked behind fenced enclosures. Consequently, wintering elk began starving to death in catastrophic numbers. Reacting to the carnage, ranchers, community members, private organizations and government agencies came together to form an extensive land-habitat protection plan, which eventually led to the establishment of the 25,000 acre National Elk Refuge.

This first effort to preserve and protect that which we unintentionally broke required a very large "band-aid." Over time, that "band-aid" has morphed into a program where, to feed the elk whose lives we disrupted, we now haul about 2,000 tons of alfalfa pellets into the valley each year, at a cost of over $600,000. Add to this the environmental costs associated with hauling pellets into the valley, and it quickly becomes clear that even "band-aids" are among the items that cost a lot in Jackson Hole.

Unfortunately, concentrating thousands of wintering elk on the refuge also bore other unintended consequences. One of the most important is that it created a perfect petri dish for diseases to thrive, diseases that now threaten our beloved elk population along with the region's ranching industry.

Set in motion over 100 years ago, this remains one of the best examples of how tinkering with environmental systems -- in this case creating wholesale habitat changes and then mitigating the problem by concentrating elk on artificial feed lines – can have unintended, long-term and severe consequences.

"…tinkering with an individual species can have unintended effects on other species, for no one species lives in isolation."

Yes, we are "protecting" the elk component of our ecosystem, but at what financial and environmental cost? Too often, even our best-intended "band-aids" come with complications.

A more recent example of best-intended tinkering yielding unintended consequences occurred over half a century ago with the construction of the Snake River's system of levees. Before the levees, ranch lands and developed property along the river were periodically inundated by the Snake's spring flooding. As a result, constructing levees seemed the logical recourse.

In hindsight, the decision came at an ecological price noticed only decades later, for we now know the levees are responsible for the changing make-up of plant and animal communities both between and outside the levees.

Outside the levies, the absence of periodic flooding is resulting in cottonwood trees not reproducing at a natural rate. As a result, conifer trees are taking over the now-drier habitat, thus changing, and in some manner reducing, the land's value to wildlife, particularly the bird community.

Between the levees, the river's once meandering flows are now constricted, making them faster and more powerful. This added energy may make for more exciting rafting, but it also increases the movement of the riverbed's cobblestones, thus hindering island formation and limiting invertebrate (insect) production. Fewer insects mean less food for the fish and therefore fewer fish for all the species that depend on them for their survival, including ospreys, bald eagles, river otters, great blue herons and kingfishers. And, of course, our fishing guides.

NOWHERE ELSE TO GO

Is this preserving and protecting our environment, our ecosystem? In response, some might argue: "Well, the wildlife will just go somewhere else." Unfortunately, though, that's just not the case, for "somewhere else" simply does not exist.

Here's the problem. Every species has its own particular needs, and if "somewhere else" is already meeting a given species' needs, you can bet it's also already occupied by that species' kin. You can also bet it's already filled to its limits with other critters needing different aspects of those habitats – that's just how nature works. And if that "somewhere else" doesn't fulfill all of a species' needs, then "somewhere else" isn't going to work as a new home for that species, at least not over the long haul.

In short, because nature abhors a vacuum, there are very few, if any, vacant habitats. Further, if there are, it's a very likely a temporary situation.

Central to this point is the concept of carrying capacity. Actually, "concept" is too mild a word – "reality" is far better. There are limits to how much life habitats can support over the long haul.

"…the question becomes whether we humans can control our insatiable desire to transform this place from the native wild into our own pleasuring grounds."

They produce only so much food and contain only so much cover. Only so many critters can survive year after year on any given habitat, a reality that applies equally to Herefords in a pasture and buffalo on the range.

We supplement the valley's remaining elk habitat by hauling in truckloads of "habitat" from Idaho. Similarly, we also bring in the essentials of human habitat, building and expanding transportation networks that convey the food, fuel, clothing, workers, and the like that allow far more humans to live here, and live far more comfortably, than would otherwise be possible. Today, we do our hunting and gathering in the comfort of our grocery stores.

In the end, we can cram only so many elk, mule deer, wolves, bison, or antelope into the region's remaining habitats. Since we're about at that limit, the simple ecological fact is that if, thanks to our actions, that remaining habitat shrinks, so too will our wildlife numbers.

IT'S ALL CONNECTED

Put simply, ecological science tells us that tinkering with an individual species can have unintended effects on other species, for no one species lives in isolation. Consider these examples.

• The reintroduction of wolves has likely contributed to the decline of the coyote population, which in turn has helped increase the numbers of ground squirrels and field mice.

• Fewer coyotes have also likely helped the fox population increase, which in turn can affect the number of ground nesting birds, whose eggs foxes eat.

• More open trashcans and dumpsters have contributed to the increase in ravens, which may contribute to a decrease in sage grouse, raptor and great blue heron reproduction, for ravens love raiding bird nests.

• More golf courses and manicured lawns contribute to the growing Canada

Goose population, as do more "closed to hunting" signs on private lands.

• Growing elk populations in subdivisions lead to more fences. These hinder or block critical wildlife movement corridors, which in turn can lead to neighborhood strife.

Whether restoring missing components or inserting new cogs into the system, our actions have changed the ecosystem's function and its natural carrying capacity. We've "tinkered" with the system to the point where we are now on a perpetual quest for interventions – "band-aids" to fix the consequences of our actions. Perhaps more attention should be placed on limiting "tinkering" in the first place.

From that perspective, the question becomes whether we humans can control our insatiable desire to transform this place from the native wild into our own pleasuring grounds. Our actions have consequences, and wanting to be responsible stewards, we search for ways to mitigate those consequences. Sometimes we're successful, sometimes not. Often mitigation comes at a high financial cost, but inevitably the ultimate cost is borne by the land and its wildlife – the very ecosystem so central to the quality of our own lives.

Simply by being here, we humans assume an integral role in the Greater Yellowstone Ecosystem, a globally unique and dynamic amalgam of land and life. Critically, of all the components of the ecosystem, we are the only ones with the ability to reason.

Should we have allowed development in areas prone to flooding? Should we have taken over winter range critical for our elk population's survival? These and other important decisions are long-since made, but are still worth reviewing when facing future land management decisions. Many of our needs to apply "band-aids" might be avoided if we have more knowledge of and pay better attention to the workings of our ecosystem and the consequences of our actions.

With all this as perspective, here's the decisive question: Shall we continue building more subdivisions, private clubs, highways and tourist accommodations hoping that "band-aids" will both continue to appear and continue to work? And if we do, how does that square with our Comp Plan's Vision to "preserve and protect the area's ecosystem"? Can it square?

History – both our own and that of other places -- suggests we are heading for an inevitable collision between incompatible values: on the one hand, continued expansion of human activity; on the other, preserving and protect our ecosystem. Which will we choose?

As Aldo Leopold, the acknowledged father of wildlife management and early proponent of landscape scale- ecosystem management said: "To keep every cog and wheel is the first precaution of intelligent tinkering."

If we fail to heed these words, we are tacitly admitting that we would rather choose to ignore our Community Vision than fully address the consequences of our actions.

ABOUT THE AUTHOR Franz Camenzind, a longtime resident of Jackson, Wyoming, has a diverse background. Arriving in Jackson in 1970 as a graduate student at the University of Wyoming, his Doctorate research helped pioneer a new understanding for the social structure of coyotes. He conducted regional wildlife inventories including for the proposed Cache Creek gas exploration well (which, thankfully never happened), and the Jackson Lake Dam rehabilitation project. He is an award-winning wildlife cinematographer working for companies ranging from ABC, BBC, the Discovery Channel to The National Geographic, including a project in which he was the first to film pandas in the wild. Camenzind served as executive director of the Jackson Hole Conservation Alliance and he was a founding member of the Greater Yellowstone Coalition.

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KEY TAKEAWAYS

"Ecosystem" is an active, working, living noun.

Because ecosystems are complex, changing one aspect of an ecosystem can and almost certainly will change other aspects, often in unpredictable ways.

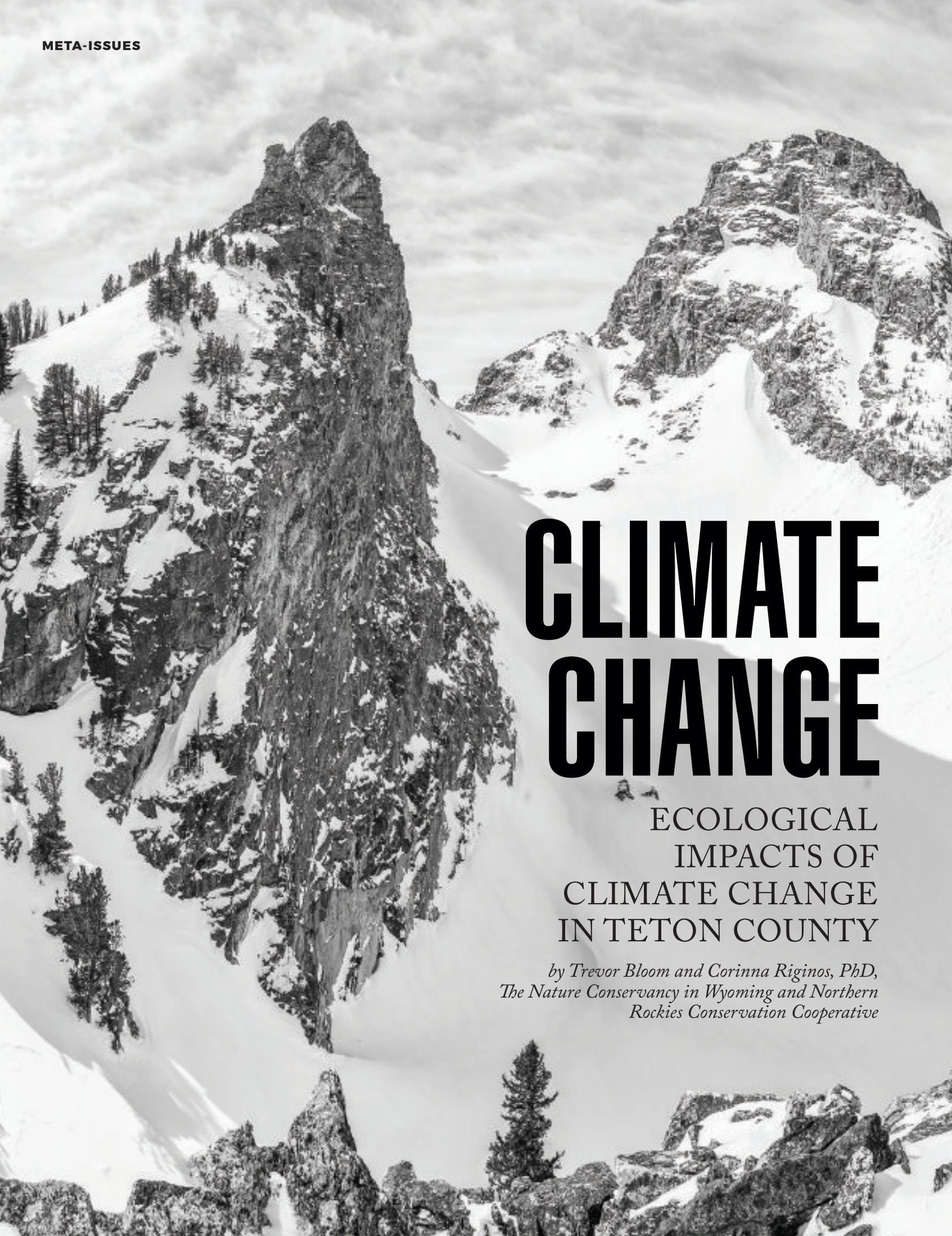
Because the health of the region's ecosystem is inextricably linked to the health of the region's character and economy, we will be well-served to approach any decision affecting the region's land, water, and air with prudence and humility.

Like all environs, Jackson Hole has a wildlife carrying capacity. If we humans, the ultimate environmental "tinkerers," truly want to "preserve and protect the area's ecosystem" and all the wildlife it harbors, we will have to give up some of our indulgences. If not, we will certainly diminish, if not eliminate, the wild we all claim to cherish.

SUGGESTED NEXT STEPS

Ask ourselves whether we have the collective will to do what it takes to "preserve and protect the area's ecosystem."

If the answer is "yes," then identify, prioritize, and implement the steps needed to make that vision a reality.



CLIMATE CHANGE

ECOLOGICAL IMPACTS OF CLIMATE CHANGE IN TETON COUNTY

by Trevor Bloom and Corinna Riginos, PhD, The Nature Conservancy in Wyoming and Northern Rockies Conservation Cooperative

If you ski, snowshoe or snowmobile, you've no doubt noticed the changes. Some places just aren't getting snow like they used to, and snow is disappearing faster in the spring. River levels are dropping sooner in the summer, and July temperatures are hitting record highs. Climate change is affecting everything from sea levels to extreme weather in all parts of the globe – including here in Teton County.

The situation is serious, but we still have time to act, if we don't delay.

AN ERA OF CHANGE

Averaged across all of Teton County, temperatures have risen since the 1970s. For example, Teton County's average minimum temperature has increased more than 3.6 degrees Fahrenheit since the early 1990s. This might not sound like a huge change, but it is actually a startling number — greater than the global average change and, ecologically speaking, a significant increase. Mountain ecosystems such as ours are more affected by climate change than the planet as a whole. This is because the rate of warming is amplified with increased latitude or elevation, through a phenomenon known as "elevation-dependent warming."

One of the greatest contributing factors to elevation-dependent warming is the "snow-albedo feedback." Albedo is the measure of reflectivity of solar radiation. When temperatures rise, more precipitation falls as rain and less as snow. That reduces the overall albedo of the Earth's surface. As a result, more of the sun's radiation is absorbed, increasing surface temperatures, so more rain falls instead of snow, creating a positive feedback loop that magnifies warming.

These ongoing changes in climate are likely to have sweeping impacts on nearly every aspect of the Teton region's ecology, scenery, recreation, and wild character. Below is a brief overview of the changes that have occurred and will likely occur in the future, followed by a snapshot of recent findings contributing to understanding the consequences of climate change for Teton County.

IMPACTS OF CLIMATE CHANGE

Changes that are already occurring:

- At least in part, declines in moose numbers are most likely due to warmer conditions.
- Widespread outbreaks of mountain pine beetle and blister rust have caused large numbers of pine trees to die.
- Snowpack conditions have become less reliable for winter tourism and recreation at the start and end of the season.

Possible future impacts of climate change include:

- Declines and/or local extinctions among cold-dependent species such as moose, pikas, wolverines, and alpine plants such as alpine forget-me-not and spotted saxifrage.
- Declines in native fish, including the Yellowstone cutthroat trout, and the many birds and mammals that eat them.
- Hot, dry conditions conducive to much larger and more frequent forest and shrubland fires. Ecologically, this could lead to large-scale declines in forest cover and increases in invasive cheatgrass and other non-natives. Economically, it could lead to rising costs of fire-fighting.
- Negative impacts to tourism and recreation due to more frequent fires and poor air quality and visibility, reduced snowpack, and fishing closures.

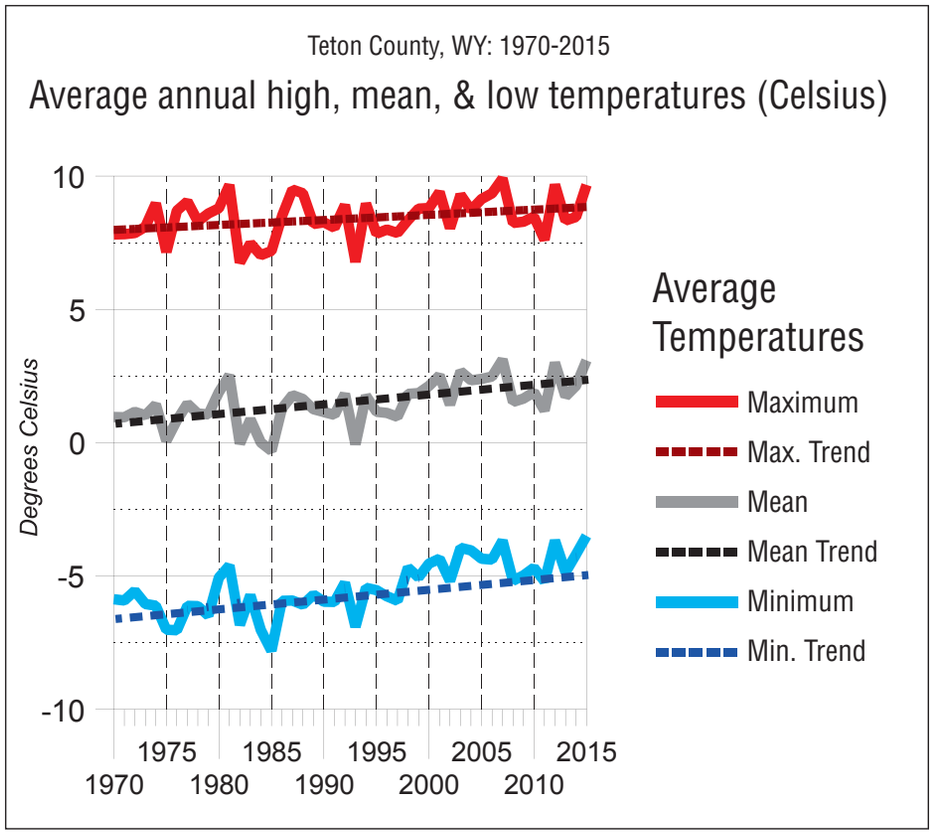
These changes have the potential to affect nearly every species of plant and animal that lives in Teton County, with associated economic impacts[1].

RECENT FINDINGS

Snowpack loss

Scientists at the Yellowstone Center for Resources recently found that total snowpack in Yellowstone has declined park-wide since it was first recorded in 1961. Based on tree-core analysis, they estimate that the decade of the 2000s had the lowest average snowpack in more than 800 years. If this trend con-

[1]For a more comprehensive assessment, please see The Coming Climate: Ecological and Economic Impacts of Climate Change on Teton County by Corinna Riginos, PhD and Mark Newcomb, published by the Charture Institute and 1% for the Tetons.



Daily minimum, mean, and maximum temperatures averaged across Teton County for each year 1970-2015. Data provided by the Yellowstone Center for Resources, National Park Service.

tinues, over-snow travel in the park may be reduced or disappear entirely. In particular, the scientists predict that, by the middle to end of this century, snow coaches and snowmobiles will not have the snowpack necessary to travel from West Yellowstone to Old Faithful.

Closer to home, Teton Pass is also experiencing earlier snowmelt. On average, snow recorded at Phillip's Bench is now melting approximately one week earlier than it did 30 years ago, and extreme early snowmelt is increasingly common. These changes in snowpack could have far-reaching effects on snow-dependent recreation and tourism industries such as skiing and snowmobiling. Despite a good snowpack in the higher elevations, 2018 had extremely low snowpack in the valley. In particular, 2018 was the first year since 1981 when elk in the National Elk Refuge could access the grass under the snow all winter, and the sleigh rides on the refuge operated primarily on rubber tires instead of skis.

Whitebark pine in peril

Whitebark pine, a high-elevation tree species that produces highly-nutritious nuts, is one of the region's species most vulnerable to climate change. Scientists have detected tremendous loss of whitebark pines in the Northern Rockies and the Greater Yellowstone Ecosystem primarily due to increased outbreaks of mountain pine beetle, large wildfires, and increased blister rust. Minimum temperatures limit mountain pine beetle outbreaks; thus as winter temperatures continue to rise in Teton County, we can expect more frequent, intense mountain pine beetle outbreaks and increased whitebark mortality. US Forest Service biologists have found that as of 2016 there are more standing dead whitebark pine trees (51%) than live ones. Evidence suggests that this species will be functionally extinct by the end of the century under current climate trajectories, likely causing far-reaching cascading effects on the ecosystem. Reductions in this important food source are almost certain to drive declines in the numbers of Clark's Nutcrackers, as well as shortages of food for grizzly bears in the critical months before hibernation. This is but one example of how climate change has the potential to cause cascading ecological changes across the region.

Nature's clock

Climate change is also driving shifts in the seasonal timing of ecological events, such as when plants emerge, flower, or set fruit. These shifts are expected to accelerate and affect many species, especially those dependent on plant resources. For example, recent work from the Wyoming Cooperative Fish and Wildlife Research Unit shows that big game migrations are tightly linked to the "waves" of spring green-up that move across the landscape from lower to higher elevations. If the timing of green up-shifts, which some evidence suggests is already happening, it will affect the behavior of grazers such as deer and elk and consequently their predators, cascading throughout the ecosystem.

In the 1970s local biologist, Frank Craighead Jr. began recording the timing of ecological events, a science known as phenology, which he later consolidated into the book: *For Everything There is a Season – The Sequence of Natural Events in the Grand Teton- Yellowstone Area*. More than forty years later, the authors of this essay are now chronicling changes in more than 70 of the plant species studied by Craighead at the same location in Grand Teton National Park. Already, we have witnessed early-season flowers such as yellowbells and sagebrush buttercups emerging 1-3 weeks earlier than in the 1970s.[2]

"On average, snow recorded at Phillip's Bench is now melting approximately one week earlier than it did 30 years ago, and extreme early snowmelt is increasingly common."

Such findings raise fundamental questions. For example, how will wildlife, including pollinators (e.g., bees, hummingbirds, and butterflies) and foragers (e.g., bears, deer, elk, and migrating birds) respond to changes in the timing of when their preferred foods are

[2]As part of our ongoing study, The Nature Conservancy has started a citizen science program called Wildflower Watch. We are looking for volunteers to help us gather additional data that can help land managers take action that will enable plants and animals to adapt to these impacts climate change. For more information or details on how to become a Citizen Scientist, please contact the authors.

Due to increased winter temperatures, by the middle to end of this century, snow coaches and snowmobiles probably won't have the snowpack necessary to travel from West Yellowstone to Old Faithful.

available? Furthermore, if native plants are struggling to adapt, will their weakness allow invasive species such as cheatgrass, musk thistle, and spotted knapweed to gain a competitive advantage?

SLOWING THE PACE

From the perspective of geologic time, Teton County has experienced many climatic shifts, with cycles of glaciations and subsequent warmer periods. Yet a mountain of evidence demonstrates that current changes are occurring at a faster rate than ever before. They are also likely to have far-reaching impacts, both locally and globally.

That noted, climate change does not mean the end of the world. Indeed, there is hope we can maintain most of the ecological and economic integrity of Teton County. But to do so, we must act now.

The place to start is tackling the issue head-on – accepting that climate change is occurring and choosing to act accordingly.

Once we decide to act, each of us can make a difference. We can urge legislators to tackle climate change, make climate change a part of our every-day conversations, and reduce our own use of the fossil fuels that are the root cause of climate change. How? As a start, we can increase home and workplace energy-efficiency, install rooftop solar panels, drive less, reduce air travel, and support industries that are working to reduce emissions rather than increase them.

Many of the possible impacts of climate change we have discussed here don't have to happen, but instead are what we can expect if the world continues on a "business as usual" path of carbon emissions. If the communities of the world work together to aggressively curb the carbon emissions that fuel climate change, we can avoid its worst impacts. The earlier we act, the better we will fare as a community of humans, wildlife, and priceless landscapes. Climate change may be the greatest issue of our generation, and the future of Jackson Hole depends on our actions today.

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Corinna is a conservation scientist with The Nature Conservancy in Wyoming. A former Teton County resident, she is now based in Lander, WY. She received her B.S. in Environmental Science from Brown University and her Ph.D. in Ecology from the University of California, Davis. Corinna's expertise, research, and outreach focus on the impacts of climate change and invasive species on natural ecosystems, the impacts of roads on big game, and rangeland restoration and management. She has published more than 30 peer-reviewed scientific papers and recently authored two Teton County-focused reports: The State of Wildlife in Jackson Hole (with Frances Clarke) and The Coming Climate-Ecological and Economic Impacts of Climate Change on Teton County (with Mark Newcomb).

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KEY TAKEAWAYS

Climate change is clearly affecting Teton County – mean minimum temperatures today are 3.6 degrees Fahrenheit warmer than in the early1990s.

Mountain ecosystems and those in more northerly latitudes – e.g., those in the Tetons and Yellowstone region -- are especially vulnerable to the effects of climate change

Recent research suggests that, if current trends continue, by the end of this century (if not sooner) there will be too little snow in Yellowstone for snow coaches to travel from West Yellowstone to Old Faithful.

SUGGESTED NEXT STEPS

The first step in addressing climate change is accepting it is occurring and choosing to act accordingly.

Take whatever small steps you can to reduce your use – whether directly or indirectly – of the fossil fuels that are driving climate change: 'Tis better to light a single candle than curse the darkness.

Support larger efforts, legislative and otherwise, to address the causes of climate change.

SPONSOR FOCUS

TETONS 2020

Tetons 2020 was initiated and run by the Charture Institute. In the spring of 2017, Charture convened the leaders of local government, the Tetons region's public land agencies, and local conservation organizations. They were asked to collectively consider what steps the greater Tetons community might take to help the Town of Jackson and Teton County move closer to the vision of their joint Comprehensive Land Use Plan: "Preserve and protect the area's ecosystem in order to ensure a healthy environment, community, and economy for current and future generations." *Mosaic* is one result of that effort.

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LANDSCAPE-LEVEL ECOLOGY:

CULTIVATING CONNECTIONS BETWEEN PEOPLE AND LAND

by Jon Mobeck, Jackson Hole Wildlife Foundation

THERE ARE TWO THINGS THAT INTEREST ME: THE RELATION OF PEOPLE TO EACH OTHER, AND THE RELATION OF PEOPLE TO LAND.

- ALDO LEOPOLD

When we think of the health of an ecosystem, we tend to think first of the state of the land and wildlife. Scientifically, we monitor and report on various components that comprise "the land," addressing questions like: How healthy is the stream or the soil? How about the air? What is the population trend for elk?

Doing this, however, often removes humans – removes ourselves – from the picture. Clearly, we are a part of the system: a contributor at best; a taker at worst; a beneficiary either way.

As a result, to properly assess the health of an ecosystem, we need to consider humans' role, in particular how we affect the ecosystem's functioning. This essay will focus on people and our structures, things like the homes we live in and fences we build to mark our territory. How are these affecting the ecosystem? What about our other behaviors? Overall, how well is the ecosystem doing? And how well are we supporting the ecosystem?

To consider such questions, a good place to start is by considering the observation of Aldo Leopold, one of the founders of the field of wildlife ecology. What is the relation of people to each other? What are our relations to land?

THE LANDSCAPE SCALE

Ecologists, conservationists and (increasingly) the general public recognize we need to identify, preserve and actively steward vital wildlife movement corridors and watersheds at the landscape scale. The concept of landscape connectivity is not new. What is new is its growing and widespread acceptance as essential conservation theory.

Just connecting large landscapes is not enough, though. Simultaneously we should also act to connect their human inhabitants, aiming to create and embed a culture that ensures on-going and enduring stewardship.

The foundation of the region's large landscapes is its politically-protected lands; its national parks, forests, and the like. While these public lands are vital to the region's long-term ecological health, because their boundaries are man-made and often arbitrary, the simple reality is that they will always face some degree of political threat. The best way of addressing this threat is for individuals and local communities to become champions for their surrounding public lands, actively valuing and taking part in their long-term preservation.

Since 2000, the population of the Greater Yellowstone Ecosystem (GYE) has grown more than twice as fast as the nation as a whole. As this growth occurs, wildlife populations searching for new habitat/territories may increasingly find conflict with humans. Preserving undeveloped wild lands clearly remains a priority, but supporting long-term wildlife migrations also requires the active cooperation of private landowners and the lands they steward. To complement their efforts, we also need to engage and link together the area's agencies, organizations, governments and communities, all with the goal of making connectivity a guiding principal of living in the GYE.

Why do this? Because preserving large landscapes is necessary if we want to ensure the long-term survival of wildlife. And not just the region's iconic migratory and wide-ranging wildlife, but also the countless species of birds, mammals, amphibians, snakes, plants, trees, flowers and insects which make the Greater Yellowstone region the largest generally-intact ecosystem in the lower 48 states.

OUR PERFORMANCE

If we want to assess our performance in preserving our ecosystem's flora, fauna, and effective connectivity, we can start with the excellent extant data on the wide-ranging movements of many key species throughout the region. Overlaying those migration maps with vital watersheds and habitat zones can help us understand the contours of larger landscapes, and with luck take steps to ensure their long-term preservation.

Other quantitative tools also lend themselves to measuring connectivity, ecosystem health, and, by extension, how well we are doing in pursuing our conservation goals.

For example, assume that a healthy human relationship with a landscape is a relationship that does not harm or otherwise impede that ecosystem's health. By extension, the inverse is true; i.e., if humans increasingly come into conflict with wildlife or degrade habitat, that is "poor performance."

How might we assess that? One key indicator currently being measured is human-animal conflicts. The Wyoming Game & Fish Department maintains a database of such conflicts across the state. In 2017, 107 large carnivore conflicts were reported in the Jackson region, an average of over two per week. Historically, this is about par for our area.

What are such conflicts? One example is when a bear or mountain lion is attracted to a backyard because food was left out. Such a situation is potentially dangerous for humans, and if it occurs repeatedly can become quite dangerous for the animal. Why? Because at best authorities will remove the animal from the area, and at worst will euthanize it. All this because the animal is simply following its instinct to search for food in its habitat.

While our homes and communities can be designed to minimize conflicts with wildlife, many other conflicts occur well out of sight. For example, migrating animals face many barriers within their migration corridors. Fences and roads can sever both migration routes and vital "stopover" areas where animals rest and forage, creating fragmented and isolated habitats that threaten many species' long-term resilience. In the Tetons region, we have made some progress to address this problem by removing or improving fences, as well as educating the public about the impacts of highways on wildlife movement. We are even re-connecting habitats with the introduction of wildlife crossing structures.

By removing or modifying fences that currently present barriers to wildlife movement, landowners, agencies, and private citizens are helping reduce stress on migrating wildlife. In so doing, they are helping ensure the conservation of historic migrations that will sustain populations of elk, pronghorn, moose, bighorn sheep, bison, and mule deer into the future. These efforts also simultaneously support the wide-ranging distribution of large carnivores such as grizzly bears, wolves, mountain lions, wolverines, and other predator species.

Expanding efforts to reduce human-wildlife conflict can also result in a number of complementary benefits, including:

- Improving corridor permeability for wildlife migration,
- Increasing ecological connectivity while connecting people to the natural landscapes they inhabit,
- Addressing regional conservation challenges by replicating and sharing models and resources,
- Building new constituencies of advocates for large landscape conservation,

- Catalyzing and coordinating other regional partnerships, and
- Implementing scientifically-driven actions on the ground.

REASONS FOR OPTIMISM

There has been a surge in public interest in long-distance migrations, giving new purpose and importance to on-the-ground work in migration corridors. While some elements of large landscape conservation are more challenging to address, removing fences and other barriers within migration corridors can not only protect the integrity of migration routes, but reinforce a community's land ethic. A hands-on approach by an engaged and committed community may help ensure the enduring conservation model necessary for long-term protection of the region's ecosystem.

An additional reason for optimism is the rapid growth of citizen science. Citizen science encourages both individual and collective participation in a landscape, engaging and connecting people with both the landscape and each other. It also contributes valuable data to inform local decision-making, while building communities of advocates.

A larger benefit occurs when groups of citizen scientists in geographically separated but ecologically connected communities connect with each other. Those bonds can solidify the systems to support landscape-scale actions. When multiple communities within the GYE collect and share data on all species, our conservation-related efforts will become stronger still as we broaden and more deeply connect the interactions between citizen scientists in different communities.

Better still, engaging the citizens of any community to participate in the collection and analysis of ecosystem-related data not only strengthens a collective land ethic, but can also help further connect ecosystems by transcending political boundaries. This could help with migration corridor protection as "migration sister cities" maintain and share data, allowing all involved to paint a complete picture of how wildlife utilize a regional landscape. These data can then inform future land management decisions while building stronger alliances of conservationists. Recorded observations can also be used to tell larger stories, contributing directly toward greater scientific awareness.

These hands-on efforts inspire optimism by highlighting common values. Communities connecting around wildlife can help to bridge social divides, weaving residents and visitors alike into a supporting fabric that sustains wildlife. In turn, as each community weaves its own piece of fabric, each can be stitched into a larger tapestry spanning the larger landscape that is the region's ecosystem. The more tightly the region's people and landscape are connected in this way, the brighter the future for the entire GYE.

ABOUT THE AUTHOR Jon Mobeck is Executive Director of the Jackson Hole Wildlife Foundation (JHWF), where he works with public agencies, private citizens and other organizations to promote ways for communities to exist compatibly with wildlife. JHWF's hands-on work encourages local participation at many levels, advancing a land ethic that values and acts to preserve landscape permeability, while also engaging citizens in data collection to increase local knowledge and reduce conflicts with wildlife. Prior to directing JHWF, Jon was Director of Partnerships with the WILD Foundation in Boulder, Colorado – an organization dedicated to connecting people, wilderness, and wildlife globally. He contributed to the Jackson Hole conservation community with The Murie Center from 2009-2014, serving as Executive Director at the historic Murie Ranch from 2012-2014.

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KEY TAKEAWAYS

The connectivity between large landscapes is vital to the region's large-scale ecological health.

To advance connectivity, it is critical to educate and actively involve residents about how both they and wildlife use the region's lands, both private and public.

A variety of data-based tools exist for measuring how well residents are living compatibly with the region's wildlife, most notably human-wildlife conflicts.

SUGGESTED NEXT STEPS

Improve structures that unite the GYE's communities; facilitate citizen-led data collection across "migration sister cities" to supplement ongoing scientific research.

Improve corridor permeability through direct fence and roadway barrier mitigation and community-driven private lands stewardship incentives.

Expand and publicize recording and monitoring of all types of human-wildlife conflicts in GYE communities.

WILDLIFE AND HABITAT HEALTH

WILDLIFE HABITAT:
KEEPING THE COGS AND THE WHEELS

by Doug McWhirter, Wyoming Game and Fish Department

Wyoming is blessed with an extraordinary diversity and abundance of wildlife, and it is clear that both Wyoming's citizens and large numbers of its visitors treasure that wildlife. Yet while people may value wildlife, they may not fully appreciate the primary reason for the existence of any wildlife species: habitat.

The definition of habitat is "the natural home or environment of an animal, plant, or other organism." Without it, the animal, plant, or other organism cannot survive. And while some may argue that the keeping of animals in captivity is evidence of their ability to survive without their natural habitat, the only reason they can is because of significant and intensive human input, manipulation, and expense. Right now, nature provides this for free.

Many wildlife species, especially migratory ones, use a variety of habitats. These can be thought of as a series of "options," ones a species uses depending on the circumstances. Having options enables populations to withstand the varying effects of weather (e.g., severe winters and/or pervasive drought), predation, and disease. If these options are reduced, bad things can happen; for example the increased influence of predation if adequate habitat is not available, or the heightened consequences of disease if a species' diverse behaviors and life history strategies are constrained.

"How do we ensure that all of these wildlife habitat options remain available and viable? By keeping all of the pieces of our ecosystems intact."

KEEPING HABITAT INTACT

How do we ensure that all of these wildlife habitat options remain available and viable? By keeping all of the pieces of our ecosystems intact. As Aldo Leopold put it in the essay *Round River*, "to keep every cog and wheel is the first precaution of intelligent tinkering". And if there's one thing humans like to do, it's tinker with ecosystems.

Wildlife management is primarily people management, and when people are involved things get complicated. Although human settlement can create or improve habitat for certain species, the presence of human settlement on the landscape usually means we must accept some adverse impact to wildlife habitat. Of course this impact can and should be minimized, but the simple reality is that some loss is unavoidable.

That noted, we in Wyoming have been lucky. Our wildlife resources have been so abundant and our human population so sparse that we have sometimes fallen into the belief that we can have it all: lots of people (be they

residents or tourists), lots of development, and lots of wildlife. As a result, we have often taken wildlife for granted and, by extension, assumed that wildlife will continue to thrive regardless of our behaviors or habitat-related actions.

The reality is, though, that some management of both people and wildlife is often necessary if wildlife are going to persist in human-dominated landscapes. Sometimes such management can be hands-off. Usually, though, effective management includes actively preserving or improving habitats, minimizing impacts to habitat, recovering or re-establishing populations through translocations, and for at least some species, managing population sizes to align with the capacity of their habitat and/or human desires, acceptance or tolerance.

LAND OWNERSHIP AND HUMAN ACTIVITY

As big and wild as northwest Wyoming is, it is still relatively small in terms of the needs of the wide-ranging and migratory wildlife populations that reside here. These populations routinely travel through a complex mix of land ownership patterns and occupy habitats that fall under various jurisdictions. People are very important in this equation, for we have created and control the legal and value structures related to wildlife and its habitat. Critically, the simple reality is that the human population can grow to the point where the preservation of wildlife habitat becomes increasingly difficult. How do we continue to preserve wildlife habitat in the face of growing populations of residents and tourists? How do we love wildlife without loving it out of existence?

There is a definite upside to the land ownership matrix in Teton County, where 97% of the county is public land and less vulnerable to the challenges residential, commercial, and industrial development create for wildlife habitat. Still, even public lands use patterns affect wildlife and their habitat.

For example, the Tetons region is becoming an increasingly popular place to live and visit. Since 2000, Teton County, Wyoming's population has grown 75 percent faster than the nation's; Teton County, Idaho's population has grown nearly six times faster. Grand Teton National Park has set visitation records for seven of the past ten years, and in 2017 28 percent more people visited Grand Teton than in 2007.

Further north, Yellowstone National Park has set visitation records six out of the last ten years, and 2017 visitation was 31 percent higher than in 2007. A recent survey showed that over 50% of visitors already think Yellowstone is too crowded, and the demand for roads and parking is expected to exceed capacity within the next few years.

The sheer amount of traffic and other human activity created by these levels of visitation can significantly affect wildlife. It also places additional pressure on the region's small and incredibly important amount of private land to support not just the increasing numbers residents and visitors, but also our wildlife.

In addition to the challenge of preserving wildlife habitats in the face of so many people, there is also the danger of creating factions among those who share a love for wildlife, but for different reasons. Hunters, wildlife viewers, recreationists, and other affinities all value wildlife, but increased pressures on wildlife habitat can erode such groups' sense of common ground and shared purpose.

Does this mean we should all have the same attitudes regarding wildlife? Of course not. But as pressures mount, it will become increasingly important to recognize that our shared valuing of wildlife can be the starting point of difficult conversations, during which views may ultimately diverge. Wildlife conservation is something that should bring people together, not divide us. And we should all be grateful we live in a place big enough and wild enough to even allow us to have debates over things that, at a more granular level, may divide us.

"Wildlife management is primarily people management, and when people are involved things get complicated."

A HOPEFUL FUTURE

So is there reason to be hopeful about the future of wildlife and wildlife habitat in Teton County? Yes.

One reason is citizen and visitor support for wildlife. The opportunity to view wildlife is a primary reason people visit Teton County, and wildlife and wildlands are also why many people want to live in the region. Results of a recent survey revealed the percentage of Teton County residents who felt the loss of wildlife habitat was the most important issue affecting Wyoming's fish and wildlife was twice that of any other county in the state. In response to this same concern, local elected officials and the heads of non-governmental organizations have made preserving and improving wildlife habitat a priority.

In particular, the fact that Jackson and Teton County have a comprehen-

sive plan that includes preservation and protection of the area's ecosystem as its vision is extraordinary, even if implementation of that vision is far from complete. Through thoughtful planning and development, the intent is to preserve wildlife habitat as much as possible while still respecting private property rights.

On the non-governmental side, using conservation easements, local land trusts have thus far protected nearly 30% of the private land-based habitats crucial to large ungulates. The creation of the Wyoming Migration Initiative has increased awareness of not just large ungulate migration corridors, but also the resulting need to address wildlife issues across jurisdictional boundaries in a collaborative fashion. Examples of this include such recent work as the Red Desert-to-Hoback mule deer migration route, and the migratory elk patterns in the Absaroka Mountains featured in the "Invisible Boundaries" exhibit at the National Museum of Wildlife Art.

Recognition of the importance of these corridors and the impacts of roadways has been faced head-on by Teton County through the funding of a wildlife crossings assessment, and development of mitigation measures (in collaboration with the Wyoming Department of Transportation and other entities). And helping to make all this possible, Teton County's private philanthropy directed toward wildlife conservation and related causes is simply unmatched.

WHAT IS SUCCESS?

Even with all this effort, though, we must ask ourselves a fundamental question: What is success? What is the goalpost? Our measure of success?

Big picture, the relative health of wildlife habitat in Teton County is currently good, primarily due to the amount of public land, conservation efforts on private lands (including the contribution of working ranches), actions of elected officials, and the desires of the public. And people do care. Clearly.

Can we ever declare victory? The short answer is "no," because the difficulty of preserving wildlife habitat with increasing numbers of people requires continued vigilance, and much more needs to be done. We would also be foolish to lose sight of what has already been lost.

We have been quite successful in many endeavors, and as a result many wildlife populations have thrived. In some cases, though, abundance creates its own set of problems which are often more difficult to address than those created by scarcity.

This brings up the concept of balance. More is not always better, whether talking about ungulates or their predators. Or human beings for that matter. The trick is finding that balance, or creating it where it does not currently exist. And of course the "right" balance will be different for different people – this is where most disagreements begin.

We need to remind ourselves, though, that if we don't preserve wildlife habitat, then all other points of disagreement are irrelevant. As we unavoidably tinker with our ecosystem, we must keep the cogs and wheels of wildlife habitat that support the wildlife of Teton County.

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KEY TAKEAWAYS

The continued diversity and abundance of Wyoming's wildlife depends on it continuing to have easy access to healthy habitat.

As Wyoming's population and tourism grow, maintaining healthy habitat and access to it is becoming increasingly difficult, especially for animals migrating over long distances.

A threat is also posed by the possibility that those who are passionate about wildlife will divide into competing factions, each emphasizing their own interests over those of the fish, birds, and animals they all love.

SUGGESTED NEXT STEPS

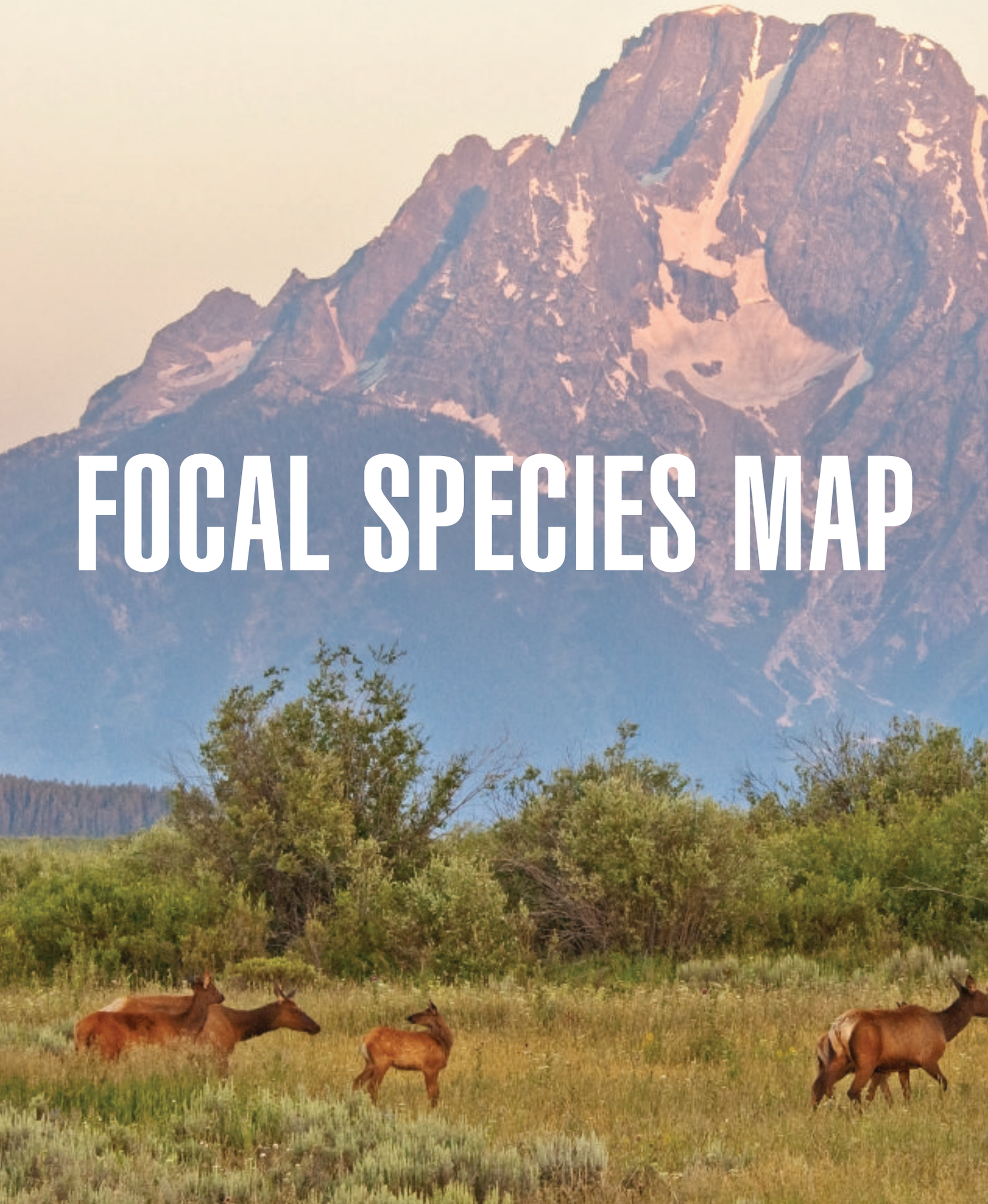
Encourage preservation of seasonal habitats, as well as movement corridors between them.

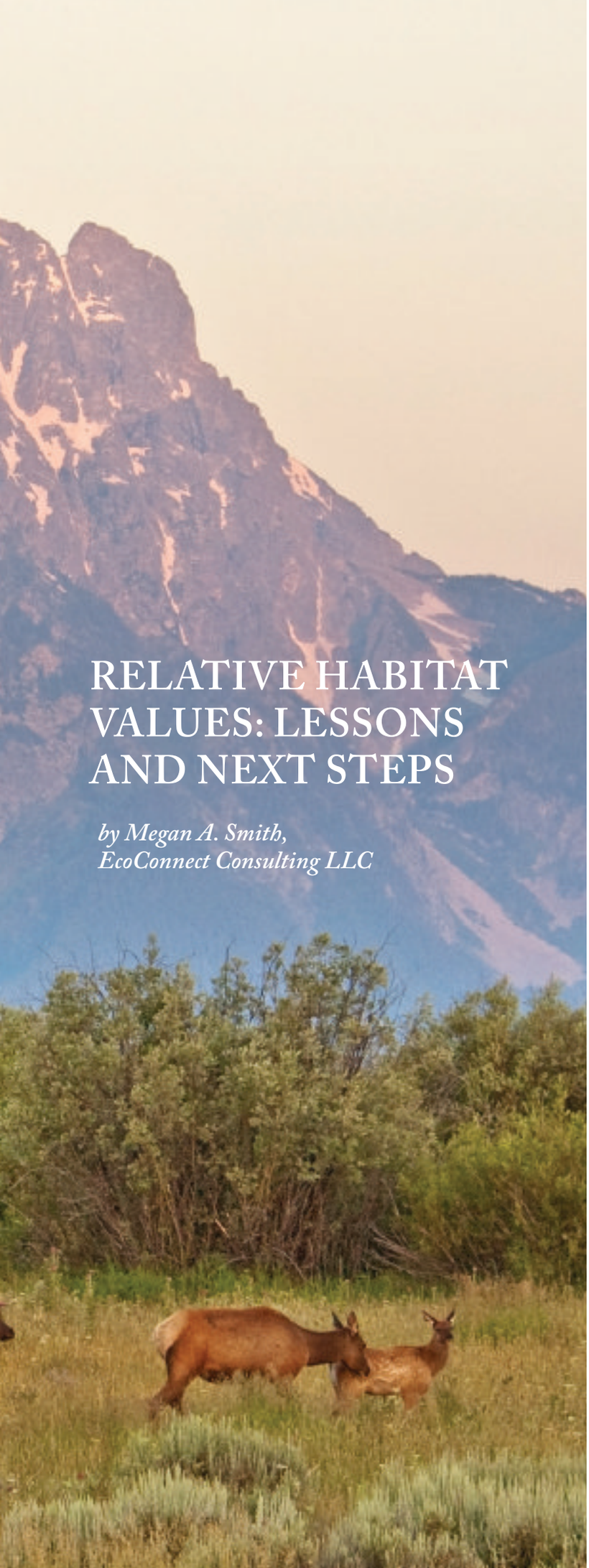
Coordinate conservation efforts among jurisdictions (private, county, state, federal).

Recognize the importance of private lands and keep current agricultural operations intact.

Acknowledge the common value of wildlife, while respecting individual perspectives.

FOCAL SPECIES MAP





RELATIVE HABITAT VALUES: LESSONS AND NEXT STEPS

by Megan A. Smith, EcoConnect Consulting LLC

The vision of the 2012 Jackson/Teton County Comprehensive Plan is to "preserve and protect the area's ecosystem." This is a lofty goal for any community, even one like Teton County where residents and visitors alike care so deeply for the region's wildlife and stunning natural landscape.

To have a chance of achieving the Comp Plan's vision, local government needs to create tools meeting three criteria: based on sound methodology; transparent; and understandable to the community. The 2017 completion of the Focal Species Relative Habitat Values project (FSRHV) marked one important step in this process.

As its name suggests, the FSRHV project assessed Teton County's natural resources based on suitable habitat for sixteen focal species (e.g. elk, moose, Great Gray Owl, and Sage-Grouse). The project then aggregated those assessments and assigned cumulative, relative habitat values across the landscape.

The role this geographic dataset will play in future land planning for Teton County includes providing a framework for natural resource regulations through the creation of a Tiered Natural Resources Overlay (Tiered NRO), a tool called for in the Comprehensive Plan. The FSRHV will also provide a baseline for assessing Teton County's progress toward preserving and protecting the area's ecosystem.

RELATIVE VALUE AND WILDLIFE PERMEABILITY

The FSRHV database assigns a relative habitat value to all land in Teton County based on a cumulative rank. In this assessment, when compared to lower-relative value habitats, high relative value areas may provide habitat for more wildlife species, and/or contain more natural resources, and/or provide habitat for a small number of important species.

What can get lost in this high-value/low value language is a critical point: All habitat is important and has value. What the FSRHV determined was the *relative* value of habitat, based on the cumulative ranking of habitats important to the suite of sixteen focal species[1].

[1]The full report contains more information about how these values were generated – http://tetoncountywy.gov/DocumentCenter/View/3051

Low *relative* habitat value does not mean the habitat is of low *absolute* value or of low quality. To the contrary: All habitat plays a role in ecosystem function and is of importance to some species. Again, in the FSRHV, the focus was on the habitat important to the study's sixteen focal species.

Extending our view beyond those focal species, when viewed as part of the larger whole, the low relative value areas are immensely important to the functioning of the area's overall ecosystem. There are a variety of reasons for this, but perhaps the most important is the role low relative value areas play in providing connectivity between areas of higher relative values.

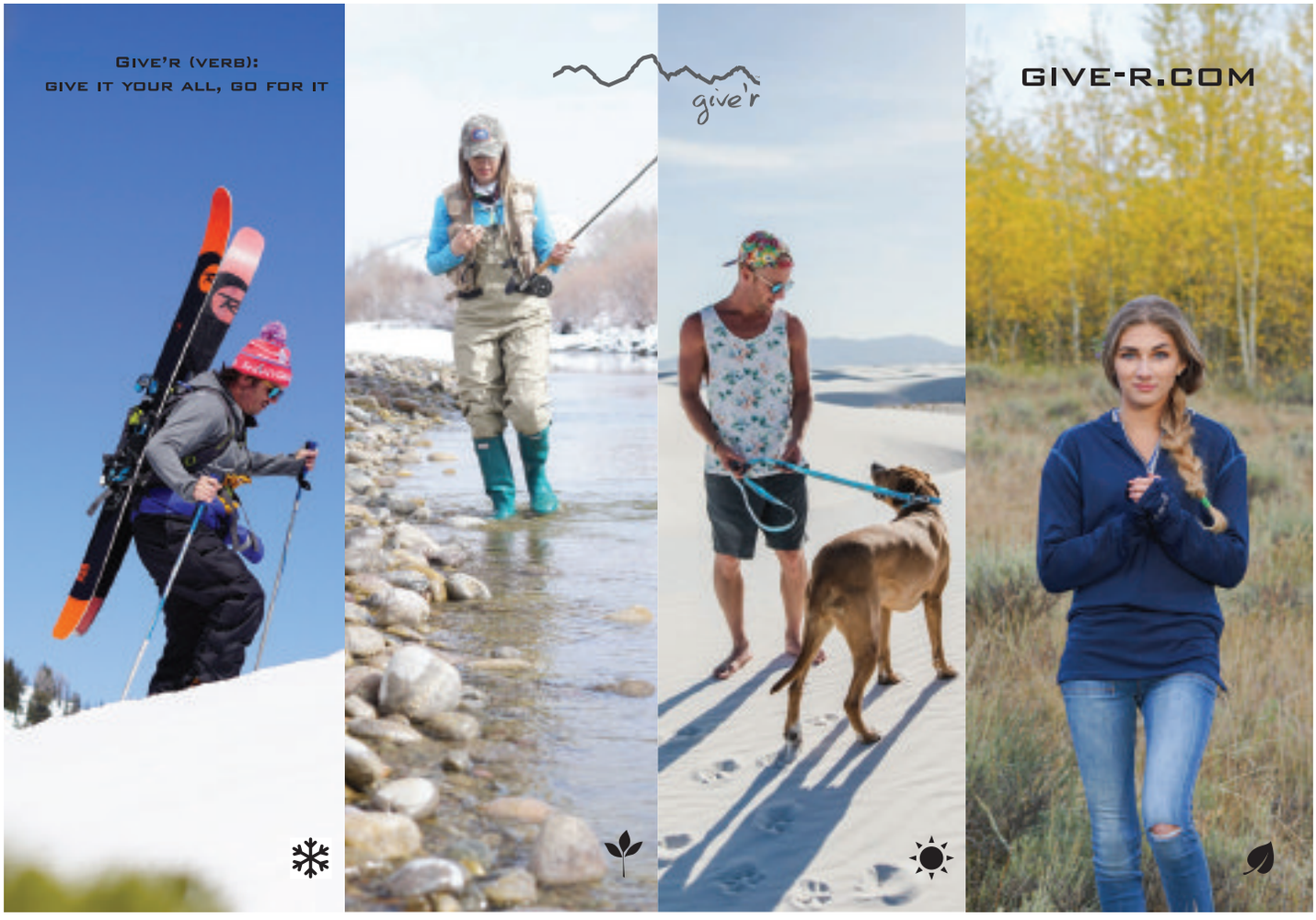
To understand why connectivity is important, consider how all parts of Teton County's built environment are critical to the overall functioning of our human community. Just because more people use a particular street or shop at a particular store doesn't mean other streets or stores are without value. Even a less-busy street is important to the people who live on it, and a less-busy store is important to its owners and regular customers. When compared to a major thoroughfare or supermarket, though, smaller places are *relatively* less important.

So it is with habitat: All the pieces of Teton County's landscape are integral and connected components of the overall system, even if a particular habitat is not important to a given species.

For example, because of its scarcity of natural resources, the relative value of the Town of Jackson's habitat is generally low. Yet it is not uncommon to see ungulate species (primarily mule deer and moose) in town during the winter months. Why? Because the town's snow depth is less and mobility is easier. Indeed, there is a direct correlation between the depth of the county's snowpack and the number of ungulates in town.

To be clear, the paved streets of Jackson are not prime winter habitat for these species. But prior to human development, the entire Jackson Hole valley floor was winter range for ungulates. Now ungulates come into town because, as the snowpack deepens elsewhere in the valley, their ability to move is hampered. Therefore, even though the town is poor ungulate habitat, for a few months each year it becomes quite valuable as a connective corridor between areas of good habitat.

The term for this ability to move through a landscape is "wildlife permeability," and as the FSRHV project made clear, maintaining and improving wildlife permeability is going to be an important factor in preserving and protecting the area's



ecosystem. Why? Because when wildlife cannot easily and efficiently move from one higher value habitat to another, they face increased stress, which in turn hampers their ability to thrive over the long-term.

Improving wildlife permeability does not require heroic measures. While the idea of allowing wildlife to move easily within the built environment often conjures images of large wildlife overpasses such as those near Banff, Canada, the reality is that even small changes to the built landscape can assist wildlife in critical ways. On the least-suitable habitats, simple techniques – whether due to regulatory processes or the actions of goodhearted landowners – can increase and provide for wildlife permeability.

Before going into details, it's important to make clear a critical point: An area of human-built development does not necessarily equate to a low relative value habitat. Do poorly planned areas of dense human development often result in areas of low or lessened wildlife permeability? Absolutely. However, human development does not pre-determine low relative value and/or low wildlife permeability.

That noted, if done improperly, certain types of development-related activity can hurt permeability in a variety of ways. These include:

- Non-wildlife friendly fencing (e.g. enclosure, solid, buck and rail or high fencing);
- Walls over 3.5 feet tall;
- Unleashed pets that chase and harass wildlife; and
- Blockage of line of sight through a densely built area either by dense vegetation or by structural configurations.

These seemingly innocuous realities of everyday life are all hindrances, or in the worst case barriers, to wildlife permeability. The good news is that a variety of simple steps can be taken to improve wildlife permeability, including:

- Removing unnecessary fencing;
- Converting loose, old, and non-friendly fencing into wildlife friendly fencing; and
- Providing line of sight from one portion of a property or neighborhood to the other.

This latter action – providing wildlife a line of sight – is an aspect of landscape design that deserves far more attention than it receives. While far from ideal, even a small, safe passage through an area of human development is much better than a solid barrier of homes, fences, shrubs and playground equipment.

Small changes produce small results, yet when added together, for wildlife permeability the cumulative effects of many small changes are greater than the sum of the parts. This is especially true in densely populated areas. Combined, these small changes can improve wildlife permeability, making things easier for humans and wildlife alike. Working together, neighborhoods can provide greater wildlife permeability regardless of the area's relative habitat value.

"…maintaining and improving wildlife permeability is going to be an important factor in preserving and protecting the area's ecosystem."

NEXT STEPS: INFORMING FUTURE ASSESSMENTS

Teton County continues to be a destination for wildlife viewers, nature lovers and tourists of all types. In order to protect what we love, we need effective natural resource protection-based land development regulations. Given the quality of our wildlife resources, and the importance of wildlife to our economy and character, ideally these regulations would be the best in the country, if not the world. Critical to developing and applying these regulations will be a number of studies and tools related to, and developed from, the FSRHV dataset.

Perhaps the most important tool called for by the Comp Plan is a Tiered NRO, one encompassing all private lands in Teton County. The current NRO is binary. It labels the private lands of Teton County as either in or out of the NRO, and only those within the NRO are subject to NRO-specific natural resource regulations. In contrast, the Tiered NRO will acknowledge that all habitat in Teton County is important, and that the lands with the highest relative values should "receive the highest level of protection and site specific study" (Policy 1.1.b). The regulations associated with a Tiered NRO will then include tiered protection measures and site-specific study (when appropriate) for all private lands. This innovative planning tool is unlike any other in the nation.

"… providing wildlife a line of sight is an aspect of landscape design that deserves far more attention than it receives."

Once the Tiered NRO and associated regulations are in place, the Comp Plan calls for a cumulative impacts study to understand the impacts of growth and development (Policy 1.1.e). This concept, too, is revolutionary.

A key to success of all the community's wildlife-related efforts -- the Comprehensive Plan's vision, the Tiered NRO tool, associated natural resource regulations and the continued quality of our wildlife resources -- and thereby our economy and community character, is to ensure that the areas designated for development are well-aligned with low, relative value habitats and are permeable to wildlife.

For example, the Comprehensive Plan calls for 60% of development to be located in complete neighborhoods and 40% of development in rural areas. Such clustering will not help preserve and protect the area's ecosystem, though, unless both the urban and rural developments are placed in areas that align well with the county's relative habitat values. This basic integration of the needs of wildlife and humans will be critical to determining whether it will be possible for the community to meet the Comprehensive Plan's many wildlife-oriented goals.

The Comprehensive Plan's vision has at its foundation an adaptive growth management strategy that employs both trigger points and as-needed adjustments to implementation strategies. Comparing the county's relative value habitat areas/NRO tiers with areas designated for development is an important first step in a county-wide cumulative impacts study, allowing us to answer questions related to our goals, such as: Are our current and proposed development patterns in line with our relative value habitats? Are our growth management strategies supporting our ecosystem stewardship goals as called for in the Comprehensive Plan, or are adjustments needed?

Teton County is home to outstanding researchers, passionate citizens, a variety of conservation organizations, and an abundance of public lands. Complementing these resources, local government now has both a dataset and innovative planning tools for conducting foundational assessments and on-going analyses of how development is affecting the area's natural resources. As the Tetons area becomes more popular with both residents and tourists, this information and that which will build upon it will prove invaluable local efforts to "preserve and protect the area's ecosystem."

ABOUT THE AUTHOR Megan Smith's company, EcoConnect Consulting, specializes in wildlife, habitat and land planning studies. EcoConnect Consulting was born out of a desire to bridge the gap between what we know about natural systems, wildlife and habitat and the choices made for human development, management and infrastructure. Outside of these pursuits, Megan can be found volunteering throughout our community or adventuring outdoors, enjoying all that Jackson Hole has to offer.

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KEY TAKEAWAYS

In 2017, Teton County and the Town of Jackson commissioned a Focal Species Relative Habitat Values (FSRHV) project. It provides critical baseline data for future planning, forming the basis for developing a Tiered Natural Resource Overlay (Tiered NRO) tool.

The dataset produced by the FSRHV classifies the region's lands on a spectrum of relative values.

All habitat has value, and a low relative value does not indicate no value or non-habitat. Many low relative value habitats serve as connectivity corridors, allowing wildlife and resources to move through and access areas of higher relative value.

SUGGESTED NEXT STEPS

Complete a set of revised natural resource regulations with a Tiered NRO as the foundation.

Assess development designations in light of the newly developed relative habitat values and Tiered NRO.

Initiate a community-wide effort to improve wildlife permeability throughout the built environment through simple, small steps taken by individuals. Cumulatively, these will provide a positive outcome for the region's human and wildlife communities.

SAGEBRUSH STEPPE HABITATS

THE SAGEBRUSH STEPPE ECOSYSTEM – AN ECOLOGICALLY FUNCTIONING COMMUNITY

by Kelly McCloskey, PhD, Grand Teton National Park

In Jackson Hole and much of the Intermountain West, sagebrush steppe communities provide the foreground over which we view the rivers, mountains, and often wildlife of the area. This plant community, where the overstory stands only one meter tall, is one of the most diverse habitats in our region. Yet in Grand Teton National Park alone, more than 15 percent of this habitat has been altered or removed by human influences.

SAGEBRUSH AND JACKSON HOLE'S HISTORY

Homesteaders who settled in Jackson Hole originally cleared sagebrush to provide a place to build homes and create farmyards for livestock. Eventually thousands of acres were cleared and planted to provide forage and hay for cattle.

Cattle ranching proved to be a challenge in the high-altitude environment, though, so even as ranchers turned to hosting 'dudes', the continued settlement of the valley floor in what became the national park meant the removal of additional acres of sagebrush to create visitor facilities in areas ranging from Jackson Lake to the Gros Ventre River. Today, Grand Teton National Park uses other areas in which sagebrush was also

"Park biologists rank Grand Teton National Park's sagebrush-steppe communities as fairly thriving, but in need of both continued monitoring and some management action."

cleared – e.g., former auto camps and former National Forest administrative facilities in areas such as Lupine Meadows and Beaver Creek -- for employee housing and work spaces.

Early settlers may have considered sagebrush an impediment to turning homesteads into productive agricultural acreage. To people who feel the majesty of trees, sagebrush may have been seen as inferior in aesthetics as well as stature. As land uses have evolved, though, there is a growing appreciation for the value of sagebrush communities, not just as habitat but also as a key part of cultural and natural landscapes.

THE IMPORTANCE OF THE SAGEBRUSH STEPPE

The sagebrush steppe is important because it is the most biologically diverse upland community in Grand Teton National Park, richer in plant species than the aspen, cottonwood or conifer forest types of similar elevations. It is also frequented by a myriad of wildlife species. Sage-obligate creatures such as greater sage-grouse, Brewer's sparrow, and pronghorn antelope spend their entire lifecycle in this community. Other animals such as moose, elk, and bison use the habitat seasonally for rutting, calving, and wintering grounds. The community of insects, birds, and small mammals populating the sagebrush steppe is equally diverse, even if rarely seen by many visitors. In addition, sagebrush-grasslands are integral to both the cultural history of Jackson Hole and the web of plant-wildlife-human interactions in Grand Teton National Park.

Grand Teton National Park staff monitor the sagebrush community as well as many of the bird and mammal species that use grassland habitats seasonally or year-round. In these habitats within the park, sage-grouse males perform spring mating rituals in at least 8 leks (i.e., strutting grounds), attracting females who subsequently nest in the surrounding steppe.

Along with surveying bird diversity, biologists count bison and elk summering in the open valleys, and track antelope migrating from the "Path of the Pronghorn's" northern terminus in Grand Teton National Park through the Gros Ventre River drainage to wintering grounds in southwestern Wyoming's Green River Valley. Wolves, restored to the valley since 1998, typically den in or near the valley bottoms, in proximity to the abundant herds of elk which make up the majority of their prey base.

Where it remains inside Grand Teton, the sagebrush steppe ecosystem is predominantly intact and healthy, an ecologically functioning community that, away from roads and trails, is relatively free of invasive species. Biologists regularly document multiple grass, forb, and shrub species within the sagebrush steppe, and in healthy areas there can be up to 50 different plant species within 100-square-meter survey plots. In undisturbed areas, invasive weed species are few, and those represented are often of taller stature, species such as musk thistle and salsify whose seeds are wind-dispersed, often from a considerable distance.

SAGEBRUSH STEPPE AND CHANGING CONDITIONS

Ecologists believe that, despite the historic disturbance and continuing presence of nonnative invasive plants, the ecological function of healthy sagebrush communities will continue. Changing conditions, though (e.g., a warming climate), may favor some species and be less conducive to others.

Park biologists rank Grand Teton National Park's sagebrush-steppe communities as fairly thriving, but in need of both continued monitoring and some management action. In disturbed sites, especially near roadsides and areas heavily used by humans or wildlife (such as bison wallows), invasive species such as musk thistle, Japanese brome, downy brome (or cheatgrass), and bulbous bluegrass are evident and often widespread.

Ecologists are particularly concerned about the spread of cheatgrass over the last decade. Along roadsides and in disturbed areas -- both in the park and elsewhere in the Intermountain West -- cheatgrass brings a two-fold threat:

1. It reproduces rapidly, germinating in the fall and thereby having the ability to grow rapidly in the spring. As it does, it robs slower-growing native species of moisture, nutrients and space.

2. It becomes highly flammable early in the season and carries fire more easily and frequently than plants in native sagebrush communities.

Cheatgrass also invades rapidly post-fire, preventing the re-establishment of native plants.

Lightning-caused fire is relatively frequent in the sagebrush-steppe ecosystem, with or without cheatgrass. Further, as seen with Grand Teton's Blacktail Fire in 2003, fires can explode to cover up to several hundred acres in just a few hours. Even intact sage communities require 15-20 years to regain their former structure and function after a fire, and this recovery time affects habitats for sage-grouse and other species that need mature sagebrush for some components of their lifecycle.

Even more-subtle changes in the landscape result from the earlier snow-free period and warming temperatures that researchers have documented, not just in local sagebrush-grassland communities but throughout the region and beyond.

Phenology is the study of cyclic and seasonal natural phenomena, and it is hard to predict how readily species will adapt to changes in phenology. In studies worldwide, asynchronies are beginning to appear wherein the cycles of plants and their pollinators no longer match. Locally, dozens to hundreds of pollinator species exist in Jackson Hole, and biologists have done limited studies to determine which pollinators and plant species are linked. These studies suggest that, with increasing frequency, Grand Teton National Park's sagebrush plant communities are responding to earlier snowmelt by flowering earlier in the season. This can cause problems for pollinators responsive to temperature or photoperiod, for while both plants and pollinators respond to climate variables, their responses are based on different, independently-varying cues.

Making the problem even more complex is that plant species proximate to each other do not all shift in unison -- some respond primarily to temperature, while others to photoperiod, which does not change with climate or weather. What scientists are beginning

"The sagebrush steppe is…the most biologically diverse upland community in Grand Teton National Park, richer in plant species than the aspen, cottonwood or conifer forest types of similar elevations."

to see in the sagebrush community is a disconnect, where species such as arrowleaf balsamroot emerge and flower earlier in spring due to warm temperatures and reduced snowpacks, then freeze in the flower stage, resulting in reduced or non-existent seed production for the year. When this occurs, the resulting lack of seed production affects future plant production, as well as insects and birds that would normally forage on the balsamroot seeds.

RESTORING AND MAINTAINING GRAND TETON'S SAGEBRUSH STEPPE

For more than a decade, Grand Teton National Park has made considerable efforts to restore sagebrush steppe communities. In the Kelly Hayfields near historic Mormon Row, the park has committed to restoring 4,500 acres of formerly cultivated lands. The process includes removing invasive plant species that have taken hold in the former hayfields, as well as removing the agricultural grasses cultivated by homesteaders. Hayfields restoration work has been supported by Wyoming Game and Fish, Teton Conservation District, the Grand Teton National Park Foundation and other partners. Methods have been developed and shared through collaborations with New Mexico State University, the National Elk Refuge, Bridger-Teton National Forest, and neighbors in Teton County.

National Park Service crews have worked to control invasive populations such as cheatgrass, thistles, and more in each of the Kelly Hayfields units prior to removal of the dominant agricultural grasses. The non-native grasses, predominantly smooth brome and Kentucky bluegrass are then removed using herbicide, and sometimes prescribed fire in areas of dense thatch. Crews hand-collect native plant seeds from undisturbed sagebrush communities, then propagate them to increase the seed quantity. This seed is re-planted in hayfield units of 50-250 acres at a time once the non-native grasses have been removed. Adjusting seed mixes in response to specific conditions is part of the ongoing adaptive management of this project.

To date, more than 1,300 acres of former hayfield are in some state of restoration, a multi-year process. Close monitoring and adaptation should ensure that the park meets its goal of returning these lands to a functioning sagebrush shrubland community, one providing native habitat for sage-grouse, elk, pronghorn, bison, and many other vertebrate and invertebrate species. Park managers expect that hayfields restoration will continue for 15-20 years, as will programs to survey and control cheatgrass and other invasive weed species in Grand Teton National Park.

Over the park's first half-century, land ownership and use has changed. So too has our appreciation for the value and importance of native vegetation. Through its resource stewardship efforts, the National Park Service aims to ensure that the sagebrush steppe vegetative community and the diverse ecological value it provides to wildlife, landscapes rich in history, and visitor enjoyment will be here for generations to come.

ABOUT THE AUTHOR Ecologist Kelly McCloskey has more than 20 years with the National Park Service, including assignments at Yosemite, Rocky Mountain, Grand Canyon, and Kings Canyon National Parks prior to serving as ecologist and former branch chief of vegetation management at Grand Teton National Park. She earned a bachelor's degree in geology-biology at Brown University and an M.S. and Ph.D. at Utah State University in ecology. In addition to sagebrush-steppe communities, her areas of interest include plant community ecology and whitebark pine ecology and restoration.

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KEY TAKEAWAYS

As is true for vast swathes of the Intermountain West, the valley floor areas of Grand Teton National Park are dominated by the sagebrush steppe ecosystem.

Though altered by humans over time, the sagebrush steppe is some of the most biologically diverse and important habitats in Grand Teton National Park.

Efforts are underway to restore 4,500 acres of former hayfields near Mormon Row to a functional native sagebrush steppe ecosystem.

SUGGESTED NEXT STEPS

Promote resilience through invasive plant management and continued ecological restoration of key sagebrush communities (estimated to take 15-20 years).

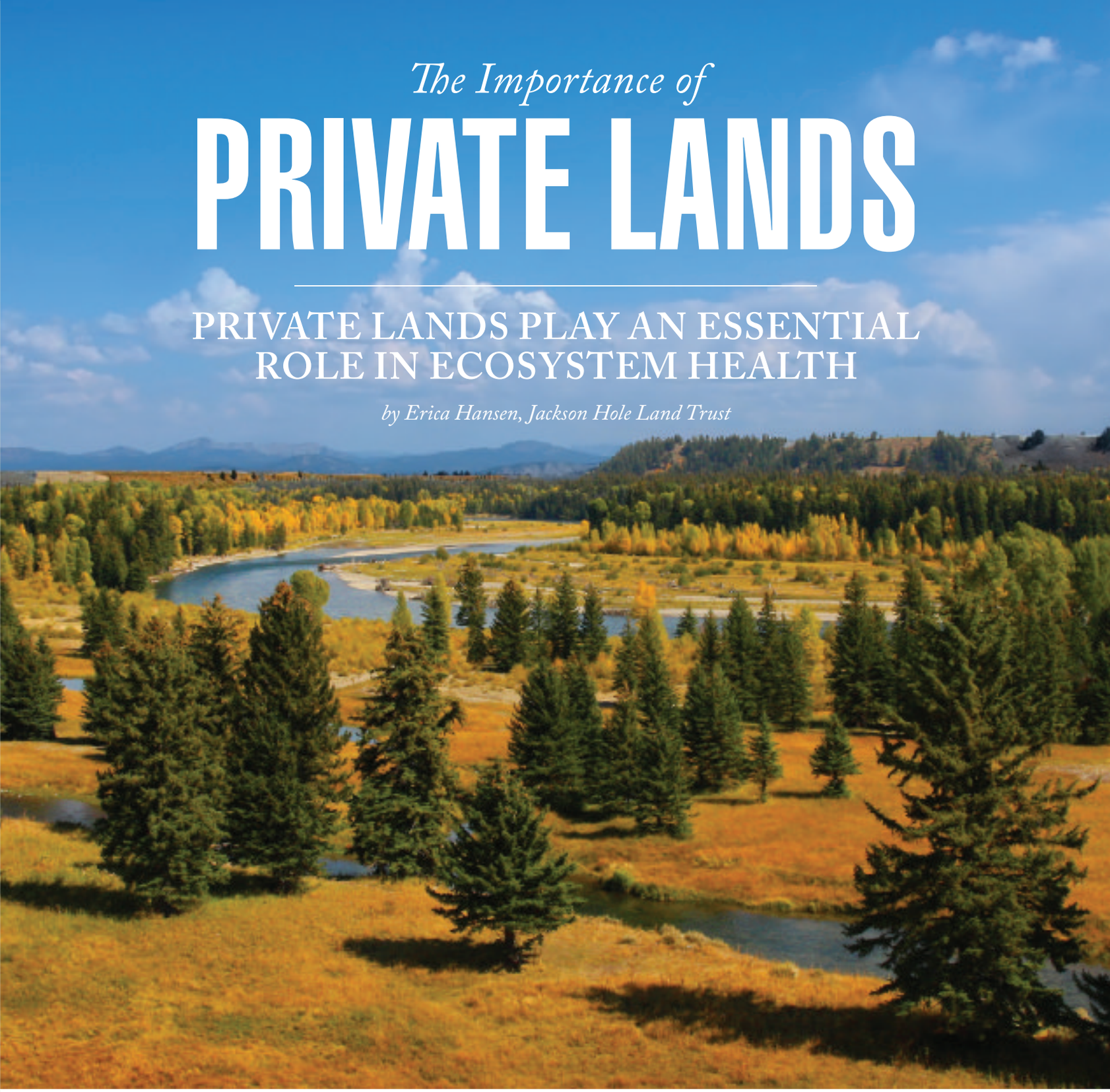
Encourage studies of plant-pollinator relationships.

The Importance of

PRIVATE LANDS

PRIVATE LANDS PLAY AN ESSENTIAL ROLE IN ECOSYSTEM HEALTH

by Erica Hansen, Jackson Hole Land Trust



The Greater Yellowstone Ecosystem, often referred to as the GYE, is one of the largest intact ecosystems on the planet. Although Yellowstone and Grand Teton National Parks form its core, the GYE extends far beyond park boundaries, traversing watersheds, migration corridors, and mountain ranges to encompass millions of acres in northwestern Wyoming, southwestern Montana, and eastern Idaho.

Like a living thing, the GYE has a pulse of sorts, one that varies with seasonal changes in temperature and moisture, and their resulting effects on snowpack and stream flow. The region's wildlife species have finely tuned behaviors synchronized with variations in their surroundings. When snows recede in the spring, animals such as mule deer migrate from low-elevation wintering grounds in the sagebrush steppe to higher-elevation areas where nutritious vegetation persists into the late summer. As food sources diminish in the fall, these animals move back down in elevation to wait out the winter in areas where they can scrape through the

"…wildlife movements, plant communities, and watersheds do not stop at property lines. Instead, they are parts of processes operating on a much larger geographic scale."

shallow snowpack for food. Similarly, greater sage-grouse perform their iconic breeding displays across sagebrush country in the dawn hours of early spring, and then seek moist low-lying habitats with abundant grasses, flowers, and insects to raise healthy chicks. As the chicks grow, they move to windy hillsides where sagebrush remains accessible above the snow throughout the winter. This is a food source few animals can stomach, but sage-grouse are so well suited to their environment that they actually gain weight on a diet of pure sagebrush during the winter months.

LANDSCAPE CONNECTIONS

Less obvious but equally true, across the GYE humans also depend on landscape connections. In particular, the high-elevation snowpack of the northern Rocky Mountains acts as a reservoir for frozen water that is slowly released into streams and rivers as temperatures warm. As it does, the run-off helps communities maintain access to water through dry times of the year when rainfall is scarce.

These ecological ebbs and flows are stitched into the fabric of western Wyoming's heritage, and were present long before humans created the region's first jurisdictional and land management boundaries. Historically, conservation actions have focused on formally designating large tracts of land as parks, wilderness areas, or preserves. These lands play a key role in conservation success, but wildlife movements, plant communities, and watersheds do not stop at property lines. Instead, they are parts of processes operating on a much larger geographic scale.

A map of land ownership in western Wyoming today resembles a patch-

work quilt. Large swathes of land are managed by federal, state, and tribal entities, but in between lies a network of private parcels owned and managed by individual community members. Although the acreage of private lands in the GYE seems small when compared to federal holdings (for example, approximately 3 percent of lands in Teton County, Wyoming are held by private landowners), these properties possess characteristics that make them essential to the function of the ecosystem as a whole.

PRIVATE LANDS IN THE GYE

Private lands in the GYE have a complex history, one that is intertwined with the expansion of the United States. As settlers moved westward in the 1800s, they built new lives in areas well-suited for homesteads and agriculture. Because only some parts of the new western territory met these criteria, much of the higher, drier land remained in federal hands, while lower elevation areas closer to water were transferred into private holdings. This formed the mosaic of land ownership we now see, with concentrations of private properties along river banks and across fertile valley bottoms.

The lush river corridors that first attracted settlers are often referred to as riparian zones. These areas are exceptionally important in Wyoming because, although they make up less than 1.2% of the state's land area[1], they provide year-round or seasonal habitat for over 90% of our wildlife species[2], including 49 of Wyoming's Species of Greatest Conservation Need (SGCN)[3]. For example, many bird species rely on the vegetation structure offered by riparian habitat, a mixture of abundant groundcover, low-lying shrubs, and taller trees that provides a layered, resource-rich environment to nest, forage, and raise young. Such a combination of qualities is less common in the higher altitude forests and arid sagebrush hills found on much of the public land in the GYE.

"Like any living thing, the GYE has a pulse of sorts, one that varies with seasonal changes in temperature and moisture…"

River corridors continue to attract human communities as well -- according to a recent report[4], 69% of all riparian habitat in Wyoming is moderately to highly vulnerable to development. Although the scenic value of these lush "emerald islands" is unparalleled and makes for popular home sites, preserving open, undeveloped space is imperative because wildlife populations need high-quality seasonal habitats and travel routes between them in order to thrive. For example, many private lands

that spread away from rivers along wide valley floors provide brood-rearing habitat for greater sage-grouse and crucial winter refuge for big game animals such as mule deer, elk, pronghorn, and moose.

In addition, many species use river corridors to travel across the landscape, moving from one patch of seasonal habitat to another. Altering large sections of sheltered riparian zones with buildings or barren surfaces such as pavement can make areas so inhospitable for wildlife that they act as roadblocks across these "highways" of wildlife movement, effectively cutting off one part of the landscape from another.

Private lands in the GYE also directly influence both the quality and quantity of water, that lifeblood of the arid west. Wet meadows on working ranches absorb spring runoff like a sponge and release that water slowly,

References

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resulting in grasses that remain green much later in the summer than on surrounding hillsides. For centuries, this extended "green up" period has benefitted a variety of wildlife species adapted to take advantage of it; more recently it has benefitted ranchers who use ecologically sensitive practices such as adaptive management and rotational grazing to raise their cattle.

Riparian lands also provide numerous physical benefits that have far-reaching effects across the GYE. The soil and vegetation lying between rivers and upland slopes act as buffers that filter pollutants and sediment from runoff water before it reaches streams and rivers. The sedges, grasses, and willows that line streambanks shade the water, decreasing water temperatures and creating better habitat for fish and other aquatic species. These plants also provide structure for streambanks, which slows erosion, keeps water clearer, and maintains water channels, which in turn can help protect homes and businesses in low-lying areas from flooding and property loss due to excessive bank scour.

CONSERVING RIPARIAN LANDS

Where privately-held riparian lands continue to provide these environmental benefits is often the direct result of conscious actions taken by conservation-minded owners and managers. In some cases, these individuals are ranchers or otherwise involved in agriculture. In others, they are people simply interested in stewardship of our natural resources. In still others, it is a combination of both agricultural and stewardship interests. Regardless, such individuals generally know their land intimately, offering on-the-ground knowledge of wildlife presence, plant communities, and both the history of the land and how it is changing. Such detailed information is invaluable, for it not only helps inform assessments of landscape trends across both space and time, but also allows for the prioritization of targeted, strategic conservation actions when appropriate. In an era when conservation is becoming both more difficult and more important, preserving intact wildlife habitat and open space on private lands offers a crucial complement to the stewardship efforts taken by federal, state, and local governments.

The relationship between humans and the land has played an integral role in the development of the west, and will continue to shape the region's contours well into the future. Combining the preservation of working farms and ranches with efforts to strategically conserve crucial wildlife habitat and open space on private properties offers significant opportunities for those interested in community-driven, adaptive, and effective management of the region's ecosystems. Though private land constitutes a relatively small amount of the GYE – approximately 30 percent – through thoughtful conservation efforts every landowner in the region can make an outsized contribution to helping ensure our waters stay clean, our wildlife can move freely, we can continue to produce food locally, and the community character of our region is preserved for future generations.

ABOUT THE AUTHOR Erica holds an M.S. in Wildlife Biology from Utah State University, and is the Staff Biologist and Land Steward for the Jackson Hole Land Trust. The Land Trust works in partnership with landowners to preserve and protect wildlife habitat, community spaces, working ranches, and open lands across northwest Wyoming.

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KEY TAKEAWAYS

Private lands constitute a relatively small percentage of the Greater Yellowstone Ecosystem, (GYE), but play an outsized role in the health of the region's ecosystem.

This is because the region's private lands are concentrated in the riparian areas crucial to ecosystem health

As growth pressures increase in the GYE, so too will the conservation-related importance of the region's private lands.

SUGGESTED NEXT STEPS

Initiate landscape-scale planning efforts to identify areas of crucial ecological importance.

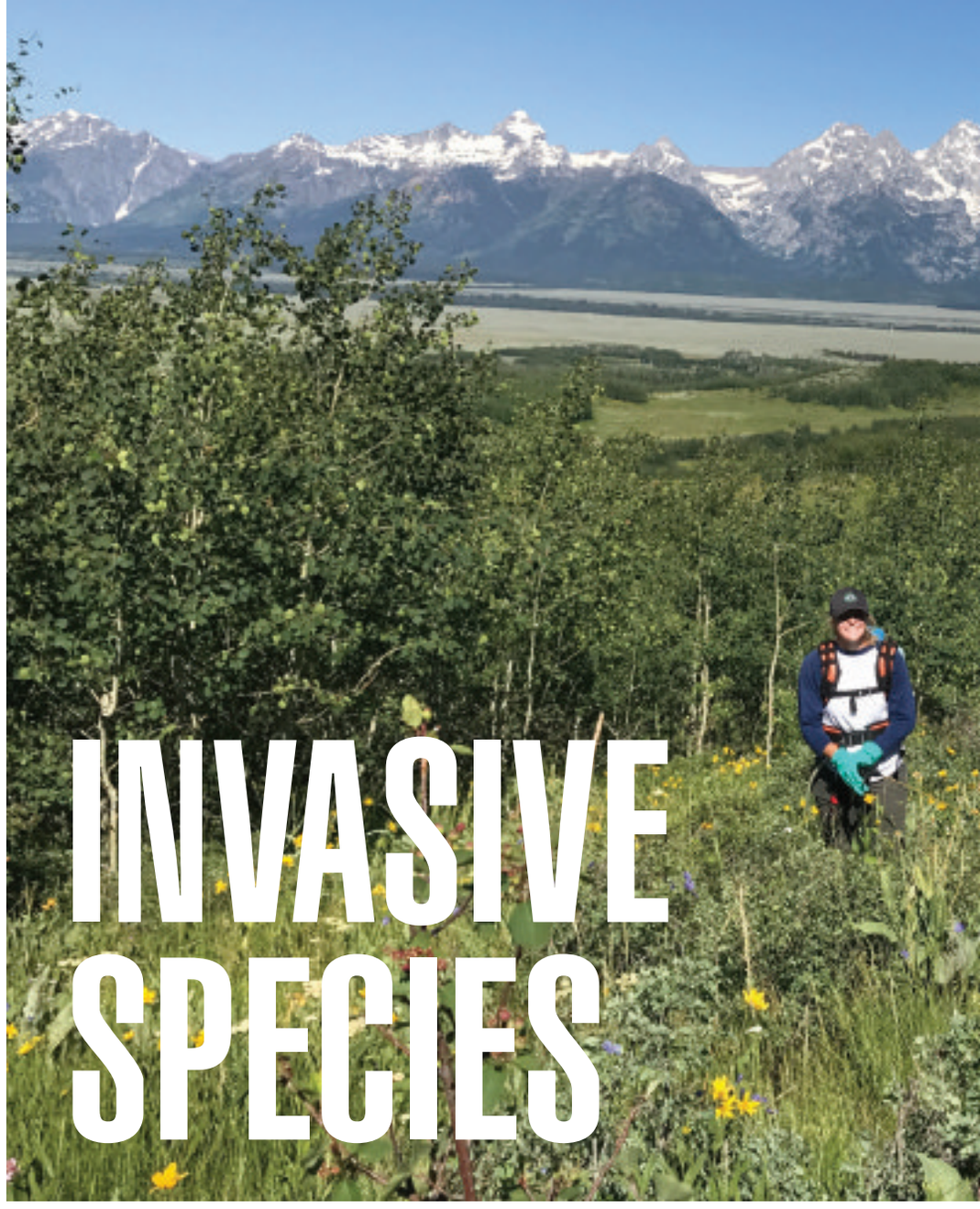
Educate the public about available tools for conservation on private lands such as conservation easements and funding sources.

Engage stakeholders to provide support for landowners facing on-the-ground stewardship challenges.

Perennial pepperweed

Saltcedar (tamarix)

Leafy spurge



INVASIVE SPECIES

PERSPECTIVES ON INVASIVE SPECIES

by Mark Daluge & Erika Edmiston, Teton County Weed & Pest District

This essay is based on three basic points.

First, Teton County lies at the center of the Greater Yellowstone Ecosystem (GYE).

Second, maintaining the health of the GYE is vital to maintaining the health of many high-profile and ecologically important species of its indigenous flora and fauna, including: elk, bison, moose, bighorn sheep, wolf, grizzly bear, sage grouse, Snake River cutthroat trout, trumpeter swan, bald eagle, and Teton golden aster.

Third, invasive species are actively threatening the ecological health of the GYE in general, and Teton County in particular.

INVASIVE SPECIES AND AN OUNCE OF PREVENTION

The federal government defines invasive species as species that are: 1) non-native (or alien) to the ecosystem under consideration; and 2) whose introduction causes or is likely to cause economic or environmental harm, or

harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes).

Nearly three centuries ago, Benjamin Franklin noted that "An ounce of prevention is worth a pound of cure," and that axiom is as true today as it was then. Whether intentional or unintentional, human actions are the primary cause of invasive species introductions. The easiest, cheapest, most effective way to avoid the manifold problems that arise from invasive species is to prevent their introduction in the first place. Preventive techniques can include public education, certified weed-free hay, aquatic invasive species check stations, vector management to minimize impacts of invasive diseases on human and animal health, effective seed laws, equipment washing, quarantine, and early detection of new infestations coupled with rapid response.

Unfortunately, despite these and other prevention techniques, invasive species currently affect many aspects of life in Teton County, including healthy ecosystem function, loss of habitat, and economic, recreational, and human health. In particular, over 24,000 acres of Teton County – roughly one percent of the entire county -- are either currently influenced by invasive species or at risk of being so. Of these "affected acres,", over 1,000 are affected by 28 species deemed as "High Priority" by the Teton County Weed & Pest District (TCWPD), the local agency in charge of invasive species-related issues.

Invasive species are prioritized based on a combination of their relative invasiveness and their potential to harm the ecosystem. In 2017, 181 new high priority species locations were documented in Teton County, covering a total of nearly 70 acres. That same year, 15 new infestations occurred in areas throughout the county deemed "high value"; i.e., places of high ecological importance such as the Snake River corridor and the Bridger-Teton Wilderness areas. Such high value locations are managed utilizing TCWPD's Early Detection Rapid Response technique to ensure that new infestations are detected and treated immediately.

A POUND OF CURE

As with any threat to health, when prevention fails, action must be taken. Similar to human disease, ideally an invasive species infestation can be "cured" (i.e., eliminated from the ecosystem). Much more frequently, though, success instead becomes function of accepting that while we will never completely eliminate the invasive species, with dedicated work over a long period of time, the species can be kept from spreading and doing greater damage.

In the case of Teton County's invasive species, over the years a number of infestations have been successfully kept in check. One example is Dyer's woad (Isatis tinctorial L.), a plant that has severely infested countless acres between Teton County and Logan, Utah. Locally, since 1995 there have been 59 documented infestations, affecting areas ranging in size from several acres to single plants within a management area. Last year, only 18 of those 59 areas had plants present, a reduction of 70 percent.

Two other long-term successes have occurred during the over-15 years long Snake River Project, a Jackson Hole Weed Management Association project to target high priority species on the Snake River. Of the 99 sites where saltcedar (also known as tamarisk, with the Latin name Tamarix ssp.) has been found, in only one did the plant reoccur

"Invasive species are actively threatening the ecological health of the GYE in general, and Teton County in particular."

last season. Similarly, of 437 former detection sites for perennial pepperweed (Lepidium latifolium L.), only 27 had a plant presence last season.

Invasive species can also harm human health. Mosquitoes are indigenous to Teton County; West Nile Virus (WNV) is not. WNV is carried by mosquitoes and was first detected in the U.S. in New York state in 1999. It arrived in Wyoming in 2002 with two cases reported. Neither was neuroinvasive, but the next year, Wyoming reported 92 neuroinvasive cases, 283 non-neuroinvasive cases, and 9 deaths (*source CDC*). Thanks in part to local mosquito abatement efforts, though, during the past 8 years over 500 Teton County mosquito sample pools have been tested for WNV, with only 1 positive test result. No human disease cases have been reported as originating in Teton County.

Not all is success, though. One example is the spread of leafy spurge (Euphorbia esula L.), a plant that has infested over 5 million acres nationwide as of 2005 (USDA) and is difficult to control. Despite active local efforts, in 2017, 122 of Jackson Hole's known 275 leafy spurge locations continued to have plant growth, and 17 new locations were identified, scattered widely across the county.

Another species that has proven to be extremely resilient is whitetop (also known as hoary cress, with the Latin name Cardaria draba). Despite being targeted with a more intense treatment program in 2017, whitetop continued to be present in 90 of the 308 historic locations, with another 48 new locations recorded. Other species which seem to be spreading are St. Johnswort (Hypericum perforatum) and Tall buttercup (Ranuculus acris L.), of which 22 and 33 new locations respectively were recorded.

KEEPING AHEAD OF THE PROBLEM

While what drives the introduction and spread of invasive species is well understood, actual introductions can be left undetected for many years, potentially causing great harm to our ecosystem. As Teton County's population and tourism numbers grow, so too does our vulnerability to the introduc-

tion and spread of invasive species. Further compounding this vulnerability is the increasing ease of access to Teton County, be it by expanded air service, improved roads, and even the increasing amount of goods coming into the region through on-line commerce. Global warming is also a factor, because the resulting changes in temperature, moisture, and the like affect what plants and animals can successfully live and reproduce in a given area of land.

To try to keep ahead of the problem, the region's invasive species management community has begun to promote an outdoor ethic called *"PlayCleanGo – Stop Invasive Species In Your Tracks."* By following proper procedures before and after an outdoors adventure, the spread of invasive species can be minimized. A few guidelines to follow include:

REMOVE plants, animals & mud from boots, gear, pets & vehicle.

CLEAN your gear before entering & leaving any recreation site.

STAY on designated roads & trails.

USE CERTIFIED or local firewood & hay.

In conclusion, from the perspective of invasive species, Teton County's relative health is neither good nor bad, but instead basically in a neutral-but-stable condition. Scattered throughout the county are areas of very healthy, pristine lands, while elsewhere there are areas of heavy invasive plant and animal infestation. The good news is that the region's most aggressive and harmful species have been identified and located, and are being managed with diligence in a collaborative fashion by a combination of local, state, and federal partners. However, whether the region moves in a more positive or negative direction from its current neutral position will be up to the community and its visitors, for their actions are the major variable in the invasive species equation. Remember: PlayCleanGo!

ABOUT THE AUTHORS

Mark is the Assistant Supervisor for the Teton County Weed and Pest District. Arriving to Teton County in 2003, he has been working in the invasive species industry since 2004 via positions with TCWP and a 5-year experiment as Owner of an invasive species control company. Holding a Bachelor of Science degree in Agricultural Business Management from the University of Wisconsin. Mark is currently the President of the North American Invasive Species Management Association, and active in the Weed Free Forage, Early Detection – Rapid Response, and Education committees within the Wyoming Weed and Pest Council. In his free time, he enjoys skiing, whitewater rafting, and enjoying the outdoors with his wife and two children.

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Erika is the Supervisor for the Teton County Weed and Pest District. She began her career with the District as a seasonal employee in 2000, was hired full-time as the Education Coordinator in 2002 and became Supervisor in 2004. She has a Master of Science in Science Education from Montana State University and a Bachelor of Arts in Elementary Education from the University of Wyoming. She is Chair of the Wyoming Weed and Pest Council's Education Committee, a former North American Invasive Species Management Association (NAISMA) Board Member, a State of Wyoming Certified Weed and Pest Control District Supervisor and active PlayCleanGo member. Erika and her husband Eddy are raising their two children Jack and Maslyn on the beautiful Moose Head Ranch where Eddy's family have been ranch managers for over 40 years.

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KEY TAKEAWAYS

Invasive species hold the potential to create great environmental and human health issues, and are costly to address.

Human behavior is the major factor affecting the introduction and spread of invasive species.

Despite active prevention and treatment efforts, over 24,000 acres in Teton County, Wyoming -- roughly one percent of its land -- are affected by invasive species.

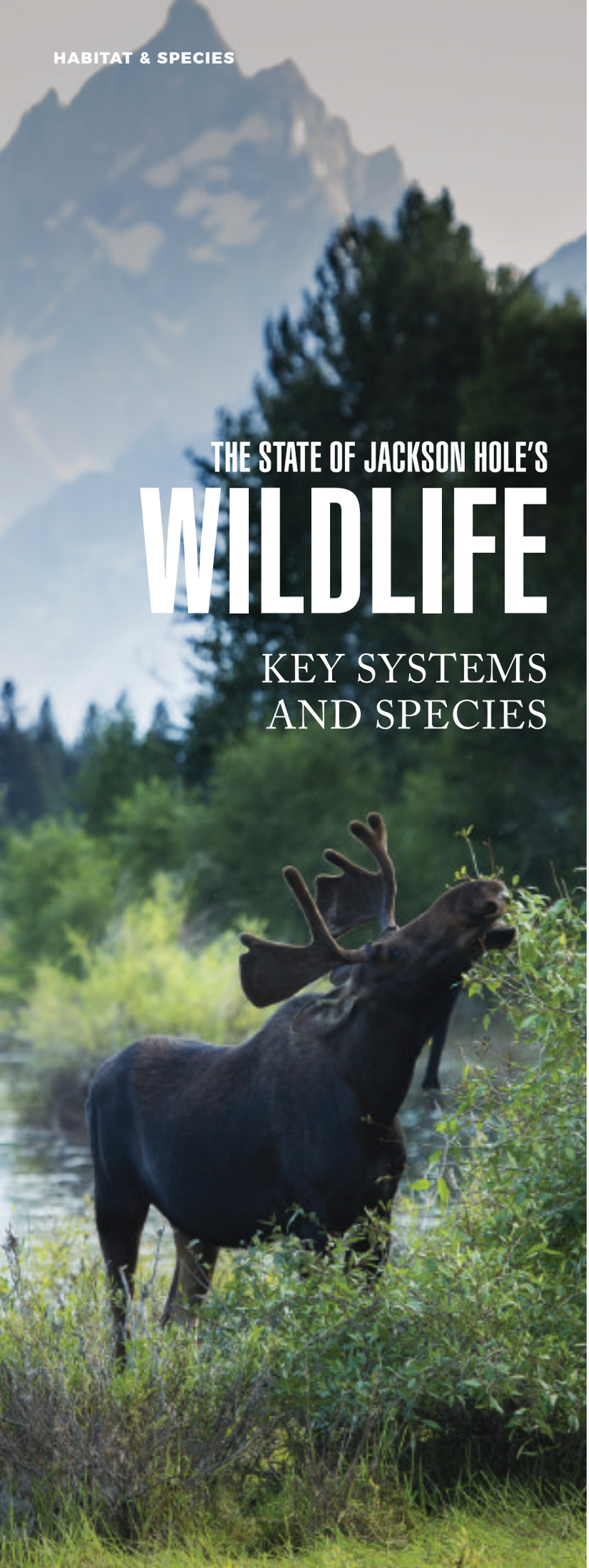
SUGGESTED NEXT STEPS

Practice the outdoor ethic of PlayCleanGo – Stop invasive species in your tracks!

Create invasive species management plans for all development over ¼ of an acre, as required by the Teton County LDRs

Pay attention to plants that look out of place and report them. Curiosity is our friend!

Do your part! Every landowner in Wyoming is required by State Statute to treat noxious weeds on their land.



THE STATE OF JACKSON HOLE'S WILDLIFE

KEY SYSTEMS AND SPECIES

by Corinna Riginos, PhD, and Frances H. Clark

In 2017, the Jackson Hole Conservation Alliance commissioned us to conduct a "State of Wildlife" report. Rather than assess all of the area's species, we chose to focus our study on several key conservation "targets," and the threats to them. In so doing, the hope of both ourselves and the Alliance was to promote efficient and effective conservation efforts backed by sound science.

Taken together, our ten targets encompass the biological diversity of the Jackson Hole area most in need of conservation attention. In other words, we recommend that these are the "things" that collaborative conservation efforts focus on and use as indicators for evaluating the effectivness of their efforts. We selected our conservation targets using an internationally accepted methodology, as well as drawing on the expertise of numerous biologists and managers in the Jackson Hole region. A target could be a species, a habitat, or a process. For each target, we researched the current status and trends relative to historic benchmarks, and identified the major threats to them over the next 50 years.

OVERVIEW OF TARGETS, STATUS, AND THREATS

TARGET:
SNAKE RIVER AND WETLANDS COMPLEX

The headwaters of the Snake River and its associated lakes, streams, wetlands, and tributaries flow through the heart of the Jackson Hole area and create a rich habitat mosaic that supports much of the area's biological diversity.

WITHIN THIS BROAD TARGET, WE HIGHLIGHT FOUR MORE-SPECIFIC TARGETS:

TARGET: HYDROLOGIC PROCESSES

IMPORTANCE:
Hydrological processes are fundamental to riverine and wetland systems. The depth and flow rate of water, the deposition and stability of sediments, and magnitude and frequency of flooding events define the diverse habitat mosaic that is essential for supporting plants and animals.

STATUS AND TREND:
For decades, the Jackson Lake Dam and levees between Moose and Hog Island have altered river flows, reducing flooding and channel meanders along the Snake River and affecting spring creek flows, with significant impacts for fish and wildlife habitat.

GREATEST THREATS:
- Residential development and agriculture cause water withdrawals and nutrient additions.
- Invasive and problematic species on land and water displace native species.
- Dams and levees alter flow dynamics and natural processes.

TARGET: BEAVER

IMPORTANCE:
Beaver are ecosystem engineers that create willow habitat and stable ponds that provide habitat for numerous other species of amphibians, plants, insects, fish, and birds.

STATUS AND TREND:
Beaver abundance in Grand Teton National Park (GTNP) declined by 80% over the past 40 years. Beaver are trapped outside of the park, and the impact of trapping on their population is not known. Several agencies are considering restoring beaver to watersheds to enhance these habitats and ecological services. Beaver are considered a conservation opportunity.

GREATEST THREATS:
- Residential development leads to more trapping of "nuisance" beaver.
- Unknown: The cause of beaver declines in GTNP is unknown but may relate to hydrological changes.

TARGET: COTTONWOOD GALLERIES

IMPORTANCE:
Narrowleaf cottonwood galleries provide vital and unique habitat for a variety of birds and bats. They are essential habitat corridors for many larger terrestrial species and are an excellent indicator of riverine ecosystem integrity.

STATUS AND TREND:
Jackson Lake Dam and levees limit flooding, but flooding is essential for new cottonwoods to germinate and establish. Cottonwood trees are long-lived, but an estimated 30% of this forest type has been degraded since the 1950s in the area between the dam and Moose. This degradation figure is likely greater for the leveed areas south of Grand Teton National Park.

GREATEST THREATS:
- Dams and levees limit flooding and cottonwood establishment.
- Climate change may favor spruce over cottonwoods.
- Invasive and problematic species crowd out native plants.
- Residential and recreational development.

TARGET: SNAKE RIVER CUTTHROAT TROUT

IMPORTANCE:
This subspecies of cutthroat trout is a popular sport fish. It is also an indicator of a healthy riverine and wetland ecosystem that supports many other species.

STATUS AND TREND:
Currently considered common throughout the watershed.

GREATEST THREATS:
- Whirling disease.
- Climate change results in warmer riverine water, which in turn reduces trout populations.
- Changes in hydrological processes and water diversions.

TARGET: SAGEBRUSH AND SAGE-DEPENDENT SPECIES

IMPORTANCE:
The sagebrush plains and grassy buttes of the Jackson Hole valley support a diversity of species not found in other habitats, including the vulnerable Greater Sage-Grouse. Jackson Hole's elevation and high precipitation levels make the sagebrush steppe in this area different from that in other lower, drier parts of the West.

STATUS AND TRENDS:
Many areas of sagebrush are protected within Grand Teton National Park, but many other areas have been converted to other land-uses. It is estimated that 45% of historic sage-grouse habitat has been lost. Sage-grouse numbers have declined by 50-75% since the 1950s.

GREATEST THREATS:
- More frequent fires due to a warming climate.
- Invasive species, especially cheatgrass, promote fire and outcompete native plants.
- Air and vehicle traffic, roads and airports disturb the highly sensitive sage-grouse.

TARGET: UNGULATE MIGRATION (AS A PROCESS)

IMPORTANCE:
Ungulate migration routes, such as the designated Path of the Pronghorn, crisscross the Jackson Hole area. The number, length, and relative intactness of migrations found in the Jackson Hole area are rare on a global scale. Migration is an essential process for maintaining the large herds of ungulates that are a vital part of the GYE.

STATUS AND TRENDS:
Most migration routes have been altered to some extent by human presence. The historic bighorn sheep migration from the top of the Tetons to the valleys has been completely severed. Elk migrations are much shorter than they were pre-settlement. Deer and pronghorn have to navigate many obstacles as they migrate.

GREATEST THREATS:
- Vehicle traffic makes it hard for ungulates to cross roads.
- Fences can be difficult or even impossible for animals to cross.
- Residential and energy development makes it difficult for ungulates to move freely through the landscape.
- Chronic wasting disease is expected to significantly reduce populations of migratory elk and deer.

TARGET: MOOSE

IMPORTANCE:
Moose are one of the most beloved species of wildlife in Jackson Hole. Moose roam among local wetland and stream habitats and up drainages throughout the valley — relying on habitat connectivity across the valley. The local sub-species of moose, the Shiras moose, is found only in the northern Rockies and many of its populations are undergoing precipitous declines.

STATUS AND TRENDS:
Moose numbers have plummeted from around 3,000 or more in the early 1990s to about 500 today. Their reproductive success continues to be low and there is no sign of a population rebound occurring.

GREATEST THREATS:
- Climate change threatens to increase direct thermal stress to these temperature-sensitive animals and exacerbates several other threats.
- Carotid artery worm can severely impair moose, and a warming climate is hastening the spread of this disease.
- Rising traffic volumes are making roads more and more difficult for moose to cross.
- Residential development: Among Jackson Hole's private lands, some of the most in-demand and valuable real estate sits in moose habitat.

TARGET: GOSHAWK AND THE MATURE FOREST MOSAIC

IMPORTANCE:
The Northern Goshawk is a good indicator of large blocks of unfragmented, older-aged conifer forest. This connected forest mosaic is vital habitat for many other species including a variety of owls, songbirds, and small mammals.

STATUS AND TRENDS:
Counting goshawks is difficult and time consuming, and therefore it has been difficult to determine trends. Surveys suggest, however, declines in nesting presence and success in disturbed habitats. New methodologies are enabling more definite conculsions

GREATEST THREATS:
- Increasing frequency and severity of forest fires due to a warming climate.
- Extensive and intensive human recreation in the mid-elevation forests.
- Invasive plants are displacing native species necessary for goshawk prey.

TARGET:
WHITEBARK PINE

IMPORTANCE:
Whitebark pine stands protect the snowpack in the subalpine zone, which in turn feeds streams throughout the growing season. These trees grow where most other trees cannot, and play a unique ecological role by supplying an abundance of nutritious pine "nuts" for red squirrels, grizzly bears, and Clark's Nutcrackers. Whitebark pine and Clark's Nutcrackers have also developed a rare mutualism in which the plant depends upon the bird: When Clark's Nutcrackers stash the seeds that are essential food for their chicks, they are also perfectly planting the seeds that allow the next generation of trees to survive.

STATUS AND TRENDS:
Whitebark pine populations have declined between 40%-90% in the GYE and across its range in the last two decades, mostly due to blister rust and mountain pine beetle infestations. Although these trees are highly threatened, the Jackson Hole area includes some trees and remnant stands that may contain the genetic keys to the future survival of these populations.

GREATEST THREATS:
- White pine blister rust and mountain pine beetle together kill trees of all ages.
- Warming temperatures will favor other species of trees that outcompete whitebark pine.
- More frequent and extensive fires due to a warming climate.

"Of all ecosystems in the lower 48 states, the GYE has the greatest possibility of maintaining its essential functions and species diversity despite climate change."

CROSS-CUTTING THREATS

Many threats are shared across targets. In fact, most of the threats to wildlife in the Jackson Hole area are interrelated, synergistic, and cumulative. Some of the common threats shared by multiple targets are:

- Altered hydrologic dynamics of our rivers, streams, wetlands, and lakes.
- Development of rural areas in the private lands of the JH area.
- Roads and traffic.
- Increases in the amount and variety of recreation.

- Invasive and problematic species and diseases, often exacerbated by climate change.
- Expected changes in the frequency and severity of fires, primarily due to climate change.
- Climate change will produce rising temperatures and changes in precipitation and hydrological processes (i.e., more rain and less snow).

ADDITIONAL THOUGHTS

A wide variety of biologists and managers have contributed significantly to our collective scientific understanding of the local region. As we have compiled this status and threats assessment, several additional lessons have become apparent. These include:

1 Of all ecosystems in the lower 48 states, the GYE has the greatest possibility of maintaining its essential functions and species diversity despite climate change. The topography, large area, and intact landscape are key to resilience to climate change.

2 When compared to other regions, it is clear that animals and habitats respond differently to the conditions found in northwest Wyoming. Therefore, we need to continue to support local research to help sustain our biodiveristy into the future

3 Because the Jackson Hole area includes habitats, species, and connections vital to the GYE as a whole, the residents of Jackson Hole will play a vital strategic role in assuring the future of the GYE.

Finally, there is a long legacy of conservation leadership in the GYE and Jackson Hole. We hope that by focusing attention on a few, key conservation targets and their individual and cross-cutting threats, we can help rally the community as a whole to tackle the conservation challenges that lie ahead.

The full report can be found at: https://jhalliance.org/campaigns/stateofwildlife/

ABOUT THE AUTHORS

Corinna is a conservation scientist with The Nature Conservancy in Wyoming. A former Teton County resident, she is now based in Lander, WY. She received her B.S. in Environmental Science from Brown University and her Ph.D. in Ecology from the University of California, Davis. Corinna's expertise, research, and outreach focus on the impacts of climate change and invasive species on natural ecosystems, the impacts of roads on big game, and rangeland restoration and management. She has published more than 30 peer-reviewed scientific papers and recently authored two Teton County-focused reports: The State of Wildlife in Jackson Hole (with Frances Clark) and The Coming Climate- Ecological and Economic Impacts of Climate Change on Teton County (with Mark Newcomb).

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Frances majored in plant science at the University of New Hampshire, followed by a fellowship at the University of Delaware and an M.A. in Environmental Policy from Tufts University. Professionally, she has been associated for decades with the New England Wildflower Society, starting as an educational program coordinator and eventually serving as the chair of the board of trustees. She has conducted numerous botanical surveys and developed management plans for conservation organizations, as well as taught numerous native plant programs.

As a seven year resident of Jackson Hole, Frances has complemented her passion for plants with a deep appreciation for the region's spectacular wildlife. She currently serves as the Lead Ambassador for the Jackson Hole Wildlife Foundation's Nature Mapping program, and is Program Coordinator for Teton Plants, a chapter of the Wyoming Native Plant Society.

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KEY TAKEAWAYS

The Jackson Hole area covers an essential ecological piece of the GYE, and both on-going research and management specific to our area are essential.

In 2017, the authors examined 10 "targets": species, habitats, and processes most in need of conservation attention in the Jackson Hole area, and which together form a representative sample of the region's collective ecosystem.

The health or well-being of many of these 10 targets has deteriorated or declined in the last few decades.

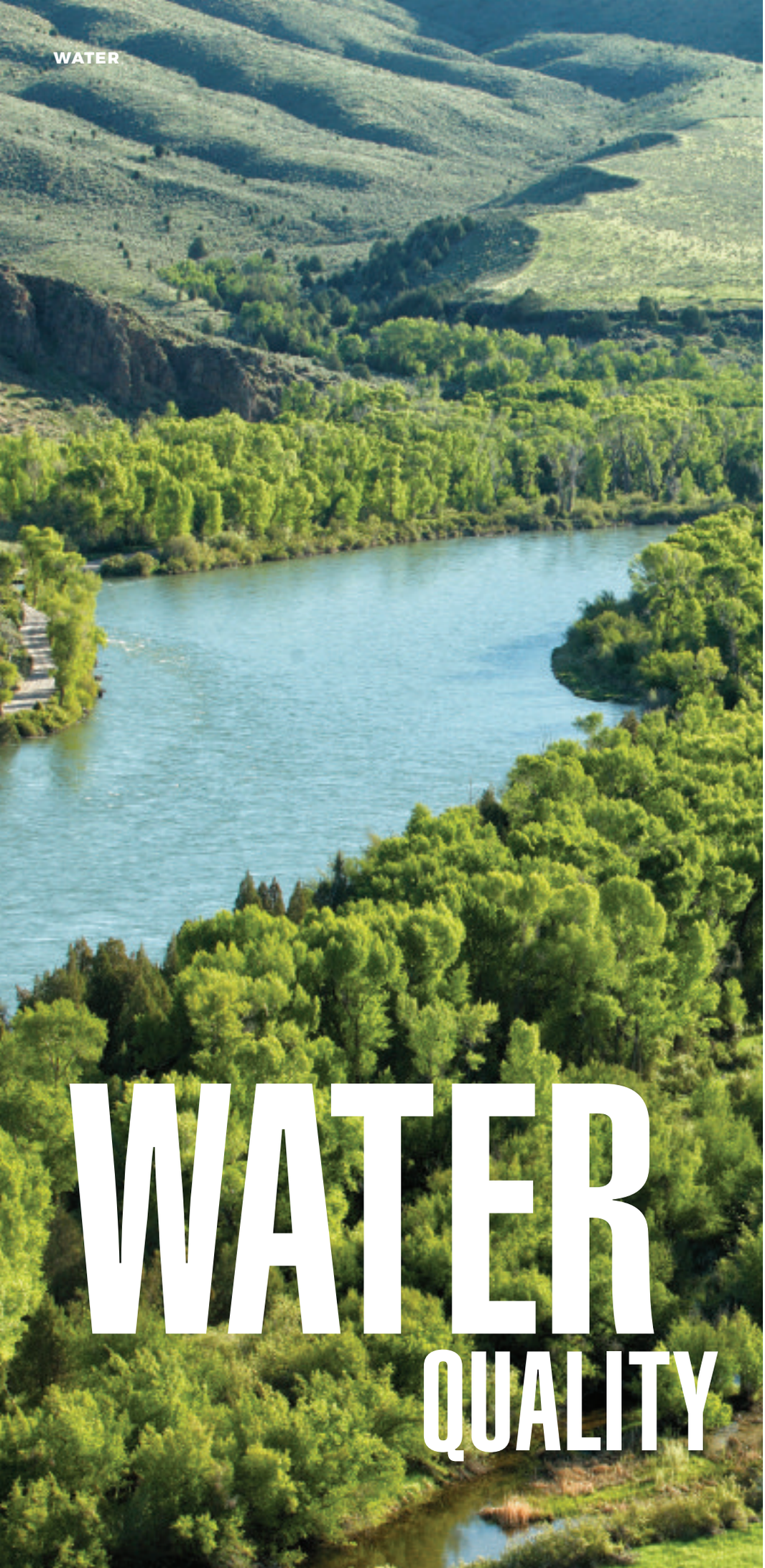
SUGGESTED NEXT STEPS

We all must do our share to conserve the GYE. Needed steps include activating political and financial support both locally and nationally.

To sustain the quality of life in Jackson Hole, the overall community needs to prioritize respecting wildlife and its needs.

Jackson Hole's conservation community must work together to coordinate specific actions:

- Convene working groups of key researchers and managers for each of this study's 10 targets.
- Acknowledge the role each group member can play, and identify specific steps each needs to take.
- Develop public understanding of, and support for, these endeavors.
- Report back annually and collectively to maintain progress and accountability.



WATER QUALITY

PERSPECTIVES ON WATER QUALITY

by Carlin Girard,
Teton Conservation District

In Teton County WY, water is an abundant natural resource. Streams originating in Teton County form the headwaters of many of the largest river systems in the country, including the Columbia, Colorado and even the Mississippi.

Much of the water within Teton County is protected because it originates in the region's national parks, forests and wilderness areas. The reality of abundant water combined with images of pristine high alpine streams and rivers has created a perception that Teton County's water quality is immune from many of the problems facing waterways in the rest of the country. Unfortunately, this perception is at best incomplete, for robust data collection on Teton County's private lands documents the toll human development is taking on our water resources.

The Teton Conservation District (TCD), a local-scale natural resource agency, is actively partnering on and leading a wide array of water-related environmental and human health initiatives. Partners include the United States Geological Survey, Wyoming Department of Environmental Quality (WDEQ), local governments, not-for-profits, and community members. Through its work monitoring local water quality and aquatic ecosystem health, TCD has collected a large body of physical, chemical and biological data indicating that the residents and visitors of Teton County, as well as the infrastructure they rely on, have harmed the region's aquatic ecosystem.

ASSESSING AQUATIC HEALTH

One of the primary biological indicators TCD and its partners use to assess aquatic ecosystem health is aquatic macroinvertebrates; i.e., bugs living in the water. Each of the numerous types of invertebrates found in the region's streams and rivers has adapted to fill the many niches provided by differing stream habitats and available food resources. And they truly are diverse: bug samples collected from both Flat and Fish creeks show that a square meter of local stream bed averages 36 unique macroinvertebrate taxa (genetically unique kinds of macroinvertebrates).

The species assemblage within any square meter of stream is strongly indicative of the environmental health of that site. For example, many aquatic macroinvertebrates have very narrow tolerances for pollutants, to the point where the presence or absence of one species alone can indicate specific types of pollution.

On a larger scale, the complement of aquatic macroinvertebrates in a sample shows the effects of a variety of watershed conditions over time. One of the most common aquatic macroinvertebrate indicators used to evaluate water quality and the health of both ecosystems and watersheds is the diversity within three insect Orders: Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Tricoptera (Caddisflies). Using an acronym formed from the first letters of their Latin names, this metric is commonly referred to as EPT Richness, and is important because EPT species are known to be sensitive to human disturbances such as sediment and chemical contamination.

Within the Town of Jackson, aquatic macroinvertebrate samples have been used to quantify the level of ecological degradation that has occurred from habitat alteration and runoff from developed areas (commonly known as stormwater runoff). This runoff has contributed to above-normal concentrations of suspended sediment in Flat Creek, which in turn has led to decreased diversity of EPT taxa

"…the residents and visitors of Teton County, as well as the infrastructure they rely on, have harmed the region's aquatic ecosystem."

in the creek. Measuring EPT Richness provides a clear indication of the degree to which the sediment load has polluted our water and stream beds, and the results of such measurements has led WDEQ to designate the aquatic life in the reach of Flat Creek in and below the Town of Jackson as 'impaired'. Happily, though, the current trend of increasing EPT richness in Flat Creek suggests the efforts of local partners to reduce stormwater pollution may be working.

An emerging issue on the west side of the Snake River (the Westbank) is nutrient contamination, a type of pollution that is beginning to alter biological communities in Fish Creek. In its unaltered state, Fish Creek's waters contain a relatively low nutrient level. Unfortunately, though, data show that nutrients being introduced into the Fish Creek watershed by residential landscaping, human wastewater, and livestock are working their way into Fish Creek's waters, creating nuisance levels of algae growth.

Why is this a problem? For two reasons. First, each aquatic ecosystem evolves with its own unique nutrient regime. When increasing nutrient levels allow algae to proliferate to unnatural levels in a stream system, the stream's biological communities, including the aquatic insect assemblage, adjust to species tolerant of these altered conditions. Such shifts, in turn, can have cascading and profound effects on aquatic ecosystems, affecting the fish and other components of the larger Fish Creek ecosystem.

The other problem is nutrient enrichment, also known as eutrophication. When prolific algae blooms die, the resulting breakdown process removes oxygen from the water, which in turn can cause fish kills. Nationally, eutrophication first became problematic in ocean estuaries of large river systems, the re-

sult of high concentrations of nutrients collecting in those estuaries after being washed into streams from agriculture, landscaping, and human and animal waste. Eutrophication has quickly become a regional and even local issue, with the Wind River, Henry's Lake and Island Park Reservoir all having experienced large eutrophication-caused fish kills in recent years.

The algae blooms occurring in Fish Creek are a warning flag of things to come in Jackson Hole. Thankfully, these warning are being heeded, and a collaborative stakeholder group has begun to take meaningful actions to reduce nutrient loads entering the valley's waterways.

Ecologically, the resilience of local waterways within Jackson Hole's developable land is at least somewhat bolstered by the high level of connectivity those waterways share with extremely high-quality aquatic ecosystems surrounding them. For example, even though both Fish and Flat creeks are experiencing human-caused water quality issues, both also currently enjoy an intact native fish assemblage, river otters, great blue heron and beavers. The combination of all these creek-dependent species demonstrates a high level of ecosystem health, a phenomenon found throughout Teton County, Wyoming.

THREATS TO OUR AQUATIC ECOSYSTEMS

The overall aquatic ecosystem in Jackson Hole remains robust, especially in contrast to the experiences of many other places. In such places, it is not uncommon for streams to suffer degradation to the point that they no longer respond to extensive, and even mandated, mitigation actions. The streams in Jackson Hole have not reached that point, and at this early stage, improvement remains a worthwhile investment of time and resources.

That noted, the experiences of other places can serve as a warning to those who care about the region's waterways, both because threats remain and because history suggests that, however inadvertently, humans have a propensity to fundamentally compromise the health of their aquatic systems. In Teton County, this means residents, businesses, and public servants must actively work to identify and address such threats, and not just for purposes related to the recreational, aesthetic, and ecosystem services of waterways and riparian areas. Indeed, even though the focus of this essay is on the health of aquatic ecosystems, the simple reality is that water resource issues also affect human health.

For example, the prolific groundwater that flows just beneath our feet, vehicles, and leach fields supports not only our aquatic ecosystem, but also our personal drinking water. And while much of Teton County's drinking water is of high quality, wastewater effluent already contaminates a handful of drinking water wells throughout the county. As a result, in the face of growing resident and tourism numbers, to simply maintain the level of contamination we currently generate will require us to decrease our per capita contaminant load. Improving things will take even more-stringent actions.

The water quality issues facing Teton County are, for the most part, little different than those facing much of the nation. Unfortunately, even the

"As a community, we face a compelling and perhaps unique challenge regarding our water resources and aquatic ecosystems: How do we keep them healthy in the face of a variety of growth-related pressures?"

community's personal and collective prioritization of environmental stewardship has not enabled us to avoid these problems.

STEPS WE CAN TAKE

What to do? A starting place for protecting our water resources is to build awareness and take personal action. For example, local water resource agencies and not-for-profits have just joined forces to form the Jackson Hole Clean Water Coalition, whose initial goal is to help spread the word about lessening our impact on water quality. One tool is the "Trout Friendly Lawns Program," which describes the Best Management Practices any interested resident can use for their landscaping.

Bigger picture, because of its ability to guide development, local government has a great deal of influence over how well we maintain the quality of our waterways and riparian systems. Simply relying on government is not enough, though. As individuals, we all need do our part by taking simple steps to reduce our effects on the region's aquatic systems.

Take, for example, these opportunities for individual engagement:

- landscaping practices;
- the "out of sight, out of mind" approach many take towards human wastewater treatment;
- the food waste, coffee grounds, chemicals, drugs, and the like we put down our drains; and
- how we too often store contaminated snow close to streams.

All of these have cumulative effects on our waterways, but can be affected by actions individuals choose to take.

As a community, we face a compelling and perhaps unique challenge regarding our water resources and aquatic ecosystems: How do we keep them healthy in the face of a variety of growth-related pressures? Unfortunately, as a community, we have far more experience degrading our waterways than restoring them. On the other hand, we have financial resources at our disposal, as well as numerous examples of how other communities have overcome the same challenges we face. Most importantly, we still have water worth protecting.

The aquatic ecosystems on the region's public lands are in very good shape; the ones on its private lands less so, but are still relatively healthy. If we are to maintain the former and stabilize, if not improve, the latter, a community-wide approach will be needed. Thankfully, such efforts are beginning to take place, but all must be involved for these efforts to succeed.

ABOUT THE AUTHOR Carlin Girard has been the Water Resources Specialist at Teton Conservation District since 2014. In this capacity, Carlin works with all things water, whether assisting homeowners experiencing drinking water problems, monitoring stream health, or working with local governments to address their water concerns. Carlin received a Master's of Science from the University of Wyoming, USGS Cooperative Research Unit studying the effects of oil and natural gas development on fisheries, aquatic habitat and water quality in the Labarge Oil and Gas Field in SW Wyoming. Carlin has researched and managed fish and wildlife for state and federal agencies in Wyoming, Oregon and Utah. Carlin moved to Jackson, WY with his smart and beautiful wife, Amy in 2006. Amy, Carlin and their daughter Astoria enjoy being outside in wild places, hunting for fish and wildlife, foraging for wild edibles, and appreciating the complexity and beauty of nature.

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KEY TAKEAWAYS

The waterways and riparian systems on Teton County's public lands are in very good shape; those on its private lands are less so but still relatively healthy.

The kinds of problems affecting water systems in other parts of the country are starting to be seen in Teton County, including algae blooms in streams, urban runoff, and wastewater contamination.

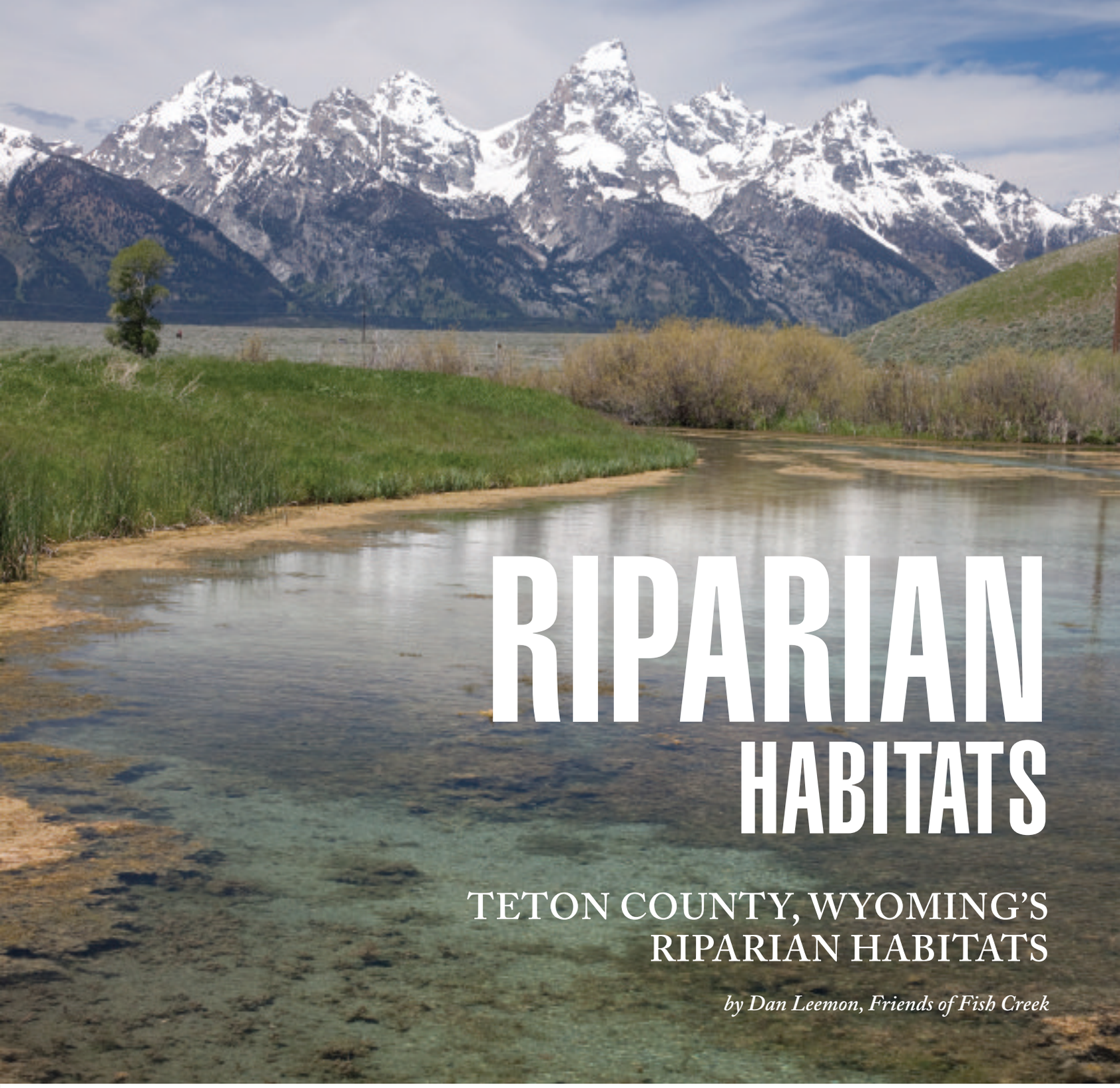
Water resource problems caused by vectors such as landscaping, human waste, and agriculture cannot be addressed by government alone, but instead will require residents being part of a widespread and concerted community effort.

SUGGESTED NEXT STEPS

Increase community awareness and engagement in water resource topics.

Create a Teton County Wastewater plan to provide a long-term vision for human wastewater management.

Support water protection through Town and County government funding and technical support.



RIPARIAN HABITATS

TETON COUNTY, WYOMING'S RIPARIAN HABITATS

by Dan Leemon, Friends of Fish Creek

Riparian areas are the "green strips" of vegetation that follow the paths of rivers and streams. While such areas comprise only a small amount of Teton County, Wyoming's total wildlife habitat, they provide far more benefits to both the ecosystem and society than the percentage suggests.

Scientists consider riparian habitats as transitional zones between the aquatic and terrestrial ecosystems, and they are often more diverse and productive in plant and animal biomass than surrounding uplands. Whether called riparian woodland, riparian forest, riparian buffer zone, or riparian strip (all are used interchangeably), all riparian zones have several characteristics in common, including: high water tables (because of their proximity to aquatic ecosystems); certain soil characteristics; and some vegetation that requires water or conditions that are wetter than normal.

RIPARIAN AREAS' FUNCTIONS

Riparian areas provide three essential, interconnected functions. First, they store and then slowly release surface and subsurface water. Because of this, riparian areas are a critical buffer for the annual runoff of snowmelt and spring rain in Teton County. This storage function also traps sediments that can harm sensitive aquatic ecosystems.

The second essential ecological function of riparian areas is the filtering of contaminants such as the fertilizer commonly found in stormwater runoff. By slowing the stormwater runoff associated with roads, driveways, and other impervious surfaces, riparian soils can provide valuable remediation qualities, directly addressing increasing threats to water quality, especially in the more populous areas of Teton County.

"Eighty percent of all bird species in the Rocky Mountains breed in wetland/riparian habitats, and many fish, amphibians, reptiles, and aquatic insect species rely on riparian habitats at some point in their lifecycles."

The third function is the importance of riparian areas to both terrestrial and aquatic habitats. Eighty percent of all bird species in the Rocky Mountains breed in wetland/riparian habitats, and many fish, amphibians, reptiles, and aquatic insect species rely on riparian habitats at some point in their lifecycles. Riparian areas also provide cover, water, food, and migration routes for a variety of animals, including ungulates.

In an ecologically healthy landscape, streams and their riparian areas form an inseparable unit: the stream corridor. The stream corridor encompasses not only the active river channel but also the ponds and wetlands near its banks and on its floodplain. A stream that has become disconnected from its riparian area accumulates sediment and no longer stores high water during flood season, thus losing critical ecological functions.

That noted, different stream corridors and riparian areas can vary widely from one another. Mountain riparian areas can be considerably different than lowland riparian habitats, and topography, vegetation, available water, soils, and local climate can combine to create unique riparian habitats that can vary over even short distances.

HUMANS AND RIPARIAN AREAS

Riparian areas in Teton County and elsewhere in Wyoming have long been intertwined with human activity. Riparian areas and floodplains have historically provided the most efficient routes of travel through mountainous terrain. Similarly, many communities in Wyoming and other states were founded in the riparian areas of rivers and streams. Locally, ease of access combined with abundant wildlife have made riparian areas the preferred route of travel and development since the first settlers arrived in Jackson Hole.

This long history of human use is also associated with a long history of riparian areas being degraded by activities including road building, logging, grazing, and urban development. Our early lack of understanding of the importance

of riparian areas led to very little protection or monitoring of the resource. It wasn't until the 1970s that any serious effort was made to manage, restore, and monitor riparian areas. Over time, riparian management has slowly shifted toward a multi-resource perspective, especially on public lands. Whether on public or private lands, almost all local stream restoration projects in Teton County now include some riparian restoration component.

PROTECTING AND REHABILITATING RIPARIAN AREAS

As our understanding of the critical ecological functions of riparian areas has improved, federal, state, and local resource management agencies have responded with coordinated management plans to protect and restore riparian areas in Teton County. Because local riparian areas have been altered and degraded over a long period of time, so too will it take a long time to restore them. The National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife Service have developed an interagency watershed management strategy that recognizes the role riparian areas play in healthy watersheds, an approach that includes specific management strategies to sustain and restore these areas. The Wyoming Game and Fish Department's *Wyoming State Wildlife Action Plan* habitat chapter – "Riparian Areas" -- is an excellent source of information about current riparian conservation efforts, threats to the resource, and future management recommendations.

The Teton County/Town of Jackson Comprehensive Plan and Land Development Regulations have had a positive impact on preserving riparian areas, primarily through the use of development setbacks and buffers. The Teton Conservation District has supported and funded numerous stream restoration projects that contained riparian restoration or improvement elements. Funding sources such as the Wyoming Wildlife and Natural Resource Trust Fund, Wyoming Department of Environmental Quality Non-Point Source Program, and the One Fly Foundation have invested millions of dollars into riparian restoration in the Upper Snake River watershed. The Jackson Hole Land Trust has preserved many riparian areas using conservation easements. Numerous non-governmental organizations such as Friends of Fish Creek, Jackson Hole Trout Unlimited, and the Snake River Fund have supported on the ground restoration and provided critical education and outreach to the community on the importance of riparian areas.

Current riparian monitoring efforts focus on those areas in which restoration and related projects are occurring, typically projects designed to improve aquatic habitat. Monitoring the effectiveness of these activities requires measuring the physical and biological responses to the restoration effort of the riparian area, including its vegetation.

Monitoring vegetation change at multiple scales is a well-established discipline with time-tested methods and protocols, and the availability of high-spectral-resolution aircraft imagery has significantly improved the capacity for riparian mapping. The Vegetation Mapping Project completed by Teton County is a valuable tool for assessing net gains and losses of riparian areas over time.

LOOKING AHEAD

Drought, climate change, altered flow regimes, invasive species, and rural development are the primary threats to healthy riparian areas. While protecting riparian areas from these threats may seem like a daunting task, there are many reasons to be optimistic about the future of healthy riparian areas in Teton County.

For starters, local resource managers recognize that the key to preparing riparian systems for threats such as drought and climate change is to make them healthy and resilient now. A riparian area is considered healthy, or properly functioning, when it contains adequate vegetation and proper land form to fulfil all the three interconnected functions: water storage, filtering of contaminants, and providing habitat to a variety of species. To that end, exciting new management techniques are being considered to offset the impact of the Snake River levees on riparian areas of the Snake River.

"Drought, climate change, altered flow regimes, invasive species, and rural development are the primary threats to healthy riparian areas. While protecting riparian areas from these threats may seem like a daunting task, there are many reasons to be optimistic about the future of healthy riparian areas in Teton County."

In addition, local agricultural producers continue to improve irrigation infrastructure and riparian fencing to lessen the effects of cattle grazing on riparian zones. The Teton County Weed & Pest District has developed a comprehensive program for invasive species management that has prevented widespread impacts to local riparian areas. And Teton County's Planning Department is currently updating its land development regulations to further improve protections for Teton Counties riparian areas.

There are many reasons to be encouraged about the current state of riparian areas in Teton County, Wyoming. The headwaters of several of the most important rivers in the United States originate in Teton County, and many of the county's riparian areas are protected because they are in remote areas of our national parks and forests. Riparian areas in the more populated regions of Teton County have suffered from poor land use practices, but as our understanding of the socio-economic benefits of riparian areas has grown, so too have coordinated efforts to protect and preserve these ecosystems for future generations.

ABOUT THE AUTHOR Dan is a watershed management specialist who works with government and nonprofits to develop collaborative solutions to water quality problems. Dan has 20 years of experience in water resources including positions with the Mercury Deposition Network, the Bureau of Land Management in Alturas, California and Buffalo, WY. Dan's local water resource experience includes time as the Water Resources Specialist at the Teton Conservation District and his current position as Executive Director of Friends of Fish Creek. Dan holds a Bachelor of Science degree in Watershed Management/Hydrology from the University of Wisconsin – Stevens Point, College of Natural Resources.

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KEY TAKEAWAYS

Riparian areas serve three critical ecological roles: the storage and release of surface and subsurface water; filtering contaminants; and providing habitat for a wide variety of species.

Historically, human settlements have congregated in riparian areas, compromising the ecological benefits of those areas.

Global warming and increased development will place increasing stress on riparian areas. Improving their resilience begins with making sure they're healthy.

SUGGESTED NEXT STEPS

Improved education and outreach, especially to private landowners, regarding the social and economic benefits of riparian habitats.

Implement a combination of positive incentives and improved regulations to insure complete community involvement in riparian habitat protection.

Continue conducting baseline assessments and on-going monitoring of watershed and riparian habitat conditions.

A GUIDE TO

MAKING POLICY

IN THE COMMON INTEREST

PRINCIPLES FOR SOUND POLICY MAKING

by Susan G. Clark, PhD, Yale University School of Forestry and Environmental Studies, and Northern Rockies Conservation Cooperative

Recent headlines about the area's future have included:

"200 Turn Out for Chat on Snow King's Future."

"No Clear Answer for Elk."

"The Future of Jackson Hole: Will Unchecked Growth, Climate Change Transform the Valley into a Place We Don't Recognize?"

These are the tip of a growing iceberg of interconnected policy challenges facing Jackson Hole. Many residents are convinced we are rapidly losing the valley's distinctive natural and social amenities to development, recreation, and business pressures, and feel we must find better ways to produce rational, practical, and ethical management and policies.

As we strive to improve our management and policy-making, it is vital for citizens, officials, activists, planners, and policy makers to enlarge their understanding of the community's social and environmental dynamics, as well as the common pitfalls of traditional approaches to policy making. And we must do so with civility, not letting an outsized "egosystem" of self-interest overwhelm the region's world-class natural and human environments.

Happily, the policy sciences show we can not only understand policy processes, but build the knowledge and skills we desperately need to participate responsibly, prescriptively, and effectively in our democracy and its underlying processes.

OUR GOALS

The reference point for local land use policies is the vision of the 2012 Comprehensive Plan: "Preserve and protect the area's ecosystem in order to ensure a healthy environment, community, and economy for current and future generations." Unfortunately, both data and our experiences show the health of the area's ecosystem is declining, creating a huge gulf between our vision, what we've achieved so far, and our future trajectory. Yet instead of acknowledging and addressing this discrepancy, we've succumbed to the dominant culture's deeply held beliefs about the supremacy of material progress, wealth, and opportunity. And despite our conceits about how environmentally conscious we are and how much we love our wildlife, in practice these take a back seat to our material and recreational concerns.

All is not lost, though – if we want, we can turn things around. There's no denying that Jackson Hole and the Greater Yellowstone Ecosystem are among the very best places to live and work. Unparalleled really, primarily because of the ecosystem. Thanks to the efforts of people who came before us, the region's tremendous legacy of public lands, biological communities and wildlife give us a back drop for our human community and its remarkable social, intellectual, and financial resources. We are the beneficiaries of this great public good, and our forebears deserve our wholehearted gratitude and respect.

Now it's our turn. Are we going to protect what we have and restore what we've lost? Or will we continue to live in a way that accelerates further decline? If we hope to secure our stated goals, there's a great deal of thinking and work to be done. To do that successfully, the place to start is by developing a genuine "pragmatic hope" that we can, indeed, work through real problems in practical ways to meet our shared goals.

So how to proceed? How should we begin closing the growing gap between what we say we want and what

we actual do? And once the process is underway, how do we see it through?

CHALLENGES

As we struggle to protect our legacy and ensure a healthy future for both nature and ourselves, we face three interconnected types of problems, each increasingly complex.

Type 1 problems are ordinary or technical problems. These include wildlife-car collisions, limited housing, and wildlife fencing. We devote most of our time and attention to these types of problems, in part because we already know how to deal with them. Yet while they are easiest to see, they mask the other types of problems.

Type 2 problems are about the processes of governance and the systems we use to address ordinary problems. Rather than relating to specific issues, Type 2 problems are fundamental and somewhat hidden, focusing on questions like: "Do we have the facts we need?" and "Are our processes open, rational, and effective?" Unless these underlying systems and processes are adequate, successfully addressing Type 1 problems will be challenging at best.

Type 3 problems are even more deep-seated, fundamental, and hard to get a fix on. These "constitutive" or cultural problems result from society's underlying belief systems, social narratives, and institutionalized patterns of behavior; i.e. the aspects of our deep culture most people are barely aware of.

Type 3 problems are grounded in our beliefs about who we think we are as humans, and our relationship to and responsibility for wildlife and nature. For example, Aldo Leopold, the father of wildlife management, was referring to a constitutive problem when he called for new "rules" for humans' relationship with nature: "When we see land as a community to which we belong, we may begin to use it with love and respect." Because we see ourselves as separate from nature, though, we tend to create systems and rules that, in Leopold's words, work against "(preserving) the integrity, stability, and beauty of the biotic community." This is Jackson's basic cultural problem, and if we truly want to preserve and protect the area's ecosystem, we must heed Leopold's (and the Muries') words and come to grips with this foundational constitutive problem.

Addressing these multi-faceted, interwoven problems simultaneously is difficult. As a result, we tend to focus on the surface symptoms; i.e., ordinary problems. For example, humans play a significant role in water and air pollution, wildlife losses, and many other environmental and social problems. Such problems are dutifully identified by in-

terest groups, reported on by the media, and attended to in part by government agencies and elected bodies. Yet underlying all these individual Type 1 problems is the simple fact that, as humans, our behaviors are eroding ecosystem health. As losses pile up, disagreements stemming from Type 2 and 3 problems further erode both natural and social capital, as people become increasingly uncivil, disrespectful, and irrational. From a Type 1 perspective, such problems are often miscalled "politics" and seem intractable. However, what's really occurring are Type 2 and 3 problems, ones that go unrecognized and thus not attended to in any practical fashion.

Locally, adding to the challenge is Jackson Hole's growing population and stratification. We have not just challenging Type 1 problems, but profound and growing governance and cultural challenges as well. Yet the approach we bring to the problem at hand – Type 1 thinking and its related tools – are completely mismatched with the challenges we face. More simply stated: We only have a hammer in our policy toolbelt, so every problem looks a lot like a nail.

How to address the actual intermixed problems we face? Start by honoring the "first rule of holes": When you're in one, stop digging. For example, two decades ago, Sue Lurie and I found that the design of the 1994 comprehensive plan process actually eroded the community's trust in the government, just the opposite of what was intended. Similar efforts in other communities have shown the same thing. We can start systematically learning from our experience about all three problems.

Next step? Let's go to the basics: Policy Making 101.

WHAT IS SOUND POLICY?

Policy making is a human process focused on solving problems. This process usually involves some technical content, and always involves people

"…the design of the 1994 comprehensive plan process actually eroded the community's trust in the government, just the opposite of what was intended."

with varying perspectives and interests in both the problem and its solutions. Policy making wrestles with fundamental problems about how we live, how we find meaning, and how we make important decisions. No one can guarantee the process will "optimize" for the system as a whole, but sound policy is a reliably rational, politically practical, and morally justified social process that determines how the good and bad in life are meted out—that is, who gets what; when they get it, and how.

Sound policy should serve the community's common interests. Common interests—such as a healthy natural environment and flourishing human community—meet the demands of the broad community. They contrast with special interests, which benefit the few at the expense of the majority.

Determining whether a policy process really seeks the common interest is not always easy. Doing so requires appraising not just the overall policy process, but each of its constituent parts: information gathering, debating, deciding, implementing, monitoring, and ending. It also involves assessing how well the parts of the process function in relation to each other.

There are three widely recognized criteria for determining if a policy process serves the common interest:

- Is it inclusive and open to broad participation?
- Does it meet the valid expectations of participants?
- As the policy is implemented and context changes, is the policy responsive and adaptable in achieving its goals?

Any successful policy process will be structured to address all three.

Sound policy builds on our shared interests (e.g., demand for respect), and anyone wanting to develop sound policy must not only identify shared interests to start with, but make sure they become common interests. Locally, we might broadly define our common interest as developing a balanced strategy to maintain and restore ecosystems, wildlife and plants, and worthwhile, non-destructive human enterprises.

"…despite our conceits about how environmentally conscious we are and how much we love our wildlife, in practice these take a back seat to our material and recreational concerns."

ACTIONABLE PRINCIPLES FOR SOUND POLICY

Many policy-related problems occur because the underlying policy-making process was flawed. By devoting time and attention at the beginning to getting the process "right," we can minimize significant problems.

Policy science has developed a practical framework for developing sound policy. Three component pieces are key.

1 Think about these matters in policy making

- Don't over-simplify
- Use diverse expertise
- Ensure all voices are heard
- Be clear about your goals
- Hold leaders accountable
- Consider not only how a new policy will help, but how it might hurt

2 Acknowledge the existence of both "slow threats" and our own shortcomings

Dwight Eisenhower noted that urgent problems are seldom important, and important problems are seldom urgent. The same can be said for many problems facing communities and the environment.

Consider, for instance, sewage spills. These are rapid, acute events that demand urgent responses. Few, however, result in major, long-term threats to a community.

In contrast, most environmental threats consist of small, incremental, barely-noticeable changes that, over time, cumulatively produce large impacts. In Europe, for example, a recent analysis of 88 slow-acting environmental problems—including climate change, species extinction, and forest problems—showed that 84 were caused by policy failures which allowed the problems to keep worsening.

We are experiencing this same phenomenon in Jackson Hole. Can we distinguish the important from the merely urgent? To do so, we'll need to abandon our egosystem, our narrow advocacy, our focus on ordinary problems and our tendency to not just act, but over-react.

What we're up against, of course, is ourselves, our biology. We see fast change, not slow. We understand intentional action that causes harm, but we're not so good at seeing actions not intended to cause harm (e.g., skiing near critical winter wildlife habitat). We can deal with visible and present dangers, but not those drawn out over years or that exist beyond what we can currently comprehend. We are drawn to simplicity and avoid complexity. But these and other human traits are not conducive to solving slow threats or finding our common interest.

3 Be practical and pragmatic while adhering to high principles

For policies to succeed, it's important to provide frequent and continuous feedback with indicators everyone can understand. As technology advances, data collection, analysis, and feedback can become more powerful and easier to use. Technology can also make it easier to visualize challenges and alternative scenarios.

Finally, we must be willing to call out bad actors, but only in ways that do not humiliate people.

Overall, we need increased and persistent engagement by knowledgeable, skilled citizens, organizations, and private and public leaders. These all can help make policy effective, from local to national scales and facilitate finding our common interest.

CONCLUSION

If we choose to do so, we can clarify, secure, and sustain our common interests in Jackson Hole and well beyond, while being practical and following high principles. To do so, though, we need more than good intentions – we need mechanisms for upgrading our policy-making process to the highest standards, especially at governance and constitutive levels.

Let's not delude ourselves: Jackson Hole is not immune to the bigger problems found elsewhere. It's all too easy to imagine we'll always have this beautiful, healthy environment with endless outdoor and lifestyle opportunities, and have them without needing to assume responsibilities or face consequences. While that may once have been possible, today it is magical thinking, no longer tenable given the rapid changes we humans are causing.

Developing sound policy is not about optimism or pessimism, but pragmatic hope. It is a difficult but essential process and, as the last several decades have taught us, far more than muddling through or endless cycles of power plays.

We now have all the concepts and tools we need to create, implement, and evaluate sound policy: a wealth of practical experience, caring residents dedicated to the region's environmental health, and deep scholarship and experience about effective policy making. Combining them, we can structure and guide a process that permits us to work through real problems: effectively, equitably, and in ways that serve our common interests. Let's go to work.

ABOUT THE AUTHOR Susan Clark, PhD, is the Joseph F. Cullman 3rd Professor adjunct of Wildlife Ecology and Policy Sciences at Yale's School of Forestry and Environmental Studies and co-founder of the Northern Rockies Conservation Cooperative.

A decades-long resident of Jackson Hole, her extensive local, regional, and international professional experience is documented in over a dozen books and hundreds of papers. She notes: "I'm deeply concerned about the shortcomings of our policy-making efforts, and want to identify practical, realistic ways to address our challenges. The thoughts in this essay were excerpted from the book I'm working on that explores our understanding of the challenges we face, their causes, and how to upgrade both the processes and content of our decision making. It ends with a call for more farsighted leadership and effective management policy processes."

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KEY TAKEAWAYS

There is a significant body of knowledge and tools for improving policy-making effectiveness.

Policy development involves three intermixed types of problems: technical, governance, and cultural.

We easily see technical problems but have a harder time seeing and understanding the other two.

Addressing the different types of problems requires thinking and tools appropriate to each.

Sound policy integrates reliable knowledge, civic, social, and decision-making processes, problem solving methods, and luck.

SUGGESTED NEXT STEPS

Use proven diagnostic methods to build on successful policy processes and learn from unsuccessful ones.

Actively and systematically learn from past policy making, and use those lessons to inform future processes and policies.

Use actual policy processes as real-time learning opportunities.

Appraise as we go.

PLANNING TOOLS

LOCAL GOVERNMENT'S CONSERVATION TOOLS

by Mark Newcomb, Chair, Teton County, Wyoming Board of County Commissioners

Teton County currently protects and preserves the area's ecosystem primarily through zoning. The County's general zoning authority is set forth in Wyo. Stat. Ann. § 18-5-201, which provides:

"To promote the public health, safety, morals and general welfare of the county, each board of county commissioners may regulate and restrict...the use, condition of use or occupancy of lands for residence, recreation, agriculture, industry, commerce, public use and other purposes in the unincorporated area of the county."

A lengthy community visioning effort to guide future development resulted in the 2012 Comprehensive Plan (Comp Plan), the Vision Statement of which definitively established the importance of the area's ecosystem: "Preserve and protect the area's ecosystem in order to ensure a healthy environment, community and economy for current and future generations."

The county has two basic tools for implementing this vision: zoning, and land development regulations (LDRs). Zoning is akin to the federal or state constitution, and LDRs are akin to laws. In the 2012 Comp Plan, both have been crafted to steer new development out of open rural areas and into or near to areas already built up with denser development. The goal is to cluster development and ensure that open space, wildlife permeability and habitat redundancy predominate in the rural unincorporated county.

EVALUATING SUCCESS

To evaluate how well the community is doing in pursuing the Comp Plan's development-related goals, key metrics have been developed, including: how much development is occurring in rural areas versus in or close to Complete Neigh-

borhoods[1]; how much open space remains; and how much open space is deed-restricted with some sort of conservation easement. Current metrics include:

› As of January 1, 2018, there were 6,272 dwelling units in the rural county and 5,042 dwelling units in the areas targeted for Complete Neighborhoods. The fact that 55 percent of Teton County's development exists in the rural county means the bulk of the community's human impact is on those areas vital to our rural character, natural resources, and the like.

› New rural development regulations implemented in 2015 reduced total future potential development in the county's rural areas from 64% of total new development to 51%, a reduction of 2,300 dwelling units.

› If the majority of future development is to occur in Complete Neighborhoods, it seems likely that zoning requirements and incentives will be needed.

› For reasons related to property rights, it seems likely that at least 40 percent of future development will occur in the rural county. As a result, the town and county gov-

[1]Complete Neighborhoods are previously developed neighborhoods with close access to infrastructure and services. The ecosystem benefits of concentrating future growth in Complete Neighborhoods include: a reduction in traffic by providing people with more options to walk, bike, or take public transit to nearby services; less need for expanded infrastructure in rural areas; and clustered development, which leaves areas of habitat open for wildlife. Existing Complete Neighborhoods include Alta, the Aspens, Hoback Junction, the Town of Jackson, Kelly, Teton Village, and Wilson.

ernments are targeting having 40 percent of future housing growth occur in the rural county, with the remaining 60 percent in the Town of Jackson and other Complete Neighborhood areas.

› While metrics are evaluated annually, overall success in the current mix of zoning requirements and regulations can only be measured over longer periods of time. Between 2011 and 2015, less than 40 percent of new housing development occurred in the rural county. Between 2016 and 2017, though, 47 percent occurred in the rural county.

› Much of the private land in Teton County is developed to a degree that it no longer has significant habitat and ecological value. Of the county's roughly 130,000 acres of private developable land, 42% (82,915 acres) is developed, 29% (23,744) is under permanent conservation easement and 29% (23,907) is undeveloped agricultural land.

› The pace of adding new conservation easements is slowing, begging the question: "What will become of the remaining undeveloped agricultural land that harbors much of the remaining valuable wildlife habitat?"

"The pace of adding new conservation easements is slowing, begging the question: 'What will become of the remaining undeveloped agricultural land that harbors much of the remaining valuable wildlife habitat?'"

WHAT'S PAST IS PROLOGUE

What's past is prologue, and in Teton County's case much of the development pattern in the unincorporated county was established prior to the enactment of the 1994 Comp Plan.

Teton County's first zoning regulations were approved in 1978. Before then, private property rights were construed sufficiently broadly to allow subdivision of almost any lot almost anywhere. That policy led to subdivisions and areas of dispersed development throughout the county, including the lands around Wilson, the Aspens, Teton Village, and the Village Road, and areas both north and south of Jackson. The 1978 regulations still allowed widespread subdivision, but required that all new lots in the unincorporated county be 3 acres or larger in order to protect groundwater. The 1978 regulations also enabled the establishment of the community's first Planned Unit Subdivisions, a tool that created deed-restricted open space in exchange for areas of denser development.

From a conservation perspective, the pattern of development created before the 1994 Comp Plan is highly problematic. Whether adjacent to Grand Teton National Park, scattered along Highway 390, plopped south of town, or injected into habitat rich riparian areas, these widely dispersed pre-1994 developments fragment habitat and open space, impair scenic values, and generate traffic on roads that run through important habitat and movement corridors.

Recognizing these challenges, new zoning regulations were implemented in 1994. These established a 35-acre minimum lot size throughout the rural areas of the unincorporated county, largely creating the underlying framework that guides land-use patterns in today's remaining open tracts of rural land.

The 1994 regulations also recognized the value of deed-restricted open space; i.e., open space with a permanent guarantee that it remains open space largely free of development. To encourage the creation of such space, the 1994 regulations created a series of tools giving density increases in exchange for conservation deed-restrictions. While these tools helped discourage dispersed small-lot development, the 2015 regulations took things a step further by linking density increases to how close a development is to a Complete Neighborhood.

EFFICACY

How effective have these land use tools been in furthering the community's conservation goals? The short and accurate answer is that it's difficult to say.

On the one hand, the land use tools have achieved a measure of success, and trends are generally going in the right direction. For example, it's safe to say that regulations encour-

aging 1 house per 35 acres of land created better conservation outcomes than allowing 9 houses per 35 acres of land. Similarly, encouraging 9 houses per 35 acres to be located within or adjacent to a Complete Neighborhood is better for the environment than 9 houses per 35 acres located in habitat rich riparian lands. Thus we can surmise that Teton County's environmental health is better today than it would be had no zoning regulations been enacted in 1978, or updated in both 1994 and 2015.

The town and county are continuing efforts to protect the environment through planning and zoning. One project in process is an update to natural resource regulations that will require private property owners to avoid, minimize, and mitigate impacts from development on important habitat (scheduled to be completed in 2018). A Wildlife Crossings Master Plan was recently adopted, and regulations pertaining to artificial ponds are being drafted to protect the integrity of native streams and ponds.

There is much yet to achieve though. The habitat that remains in the unincorporated county appears to be of sufficient quantity and quality to sustain viable wildlife populations, at least for the foreseeable future. But it too faces development pressure.

LOOKING AHEAD

Successful long-term ecosystem stewardship is hard to define and even harder to measure. A place to start is by asking questions that are both difficult and important to answer, including:

› What is the absolute minimum amount of open space that is needed to ensure viable wildlife populations?

› What configuration should open space take in order to ensure habitat resilience and redundancy in perpetuity?

› If we continue to allow development in rural areas, at what point will it fundamentally imperil healthy populations of critical wildlife species? How will we know?

› Are the tools we're using (currently the LDRs) both sufficiently rigorous and sufficiently adaptable to ensure ecosystem stewardship? Or are there better approaches?

Unfortunately, there are not yet definitive answers to these questions. In the meantime, the town and county planning staffs annually gather and evaluate data, a process which allows both staff and elected officials to review progress and adapt their efforts to changing circumstances.

Going forward, elected officials will continue to make policy choices affecting the community's ecosystem stewardship goals. Whether these efforts succeed remains to be seen, but the strong and clear language of the 2012 community vision gives Teton County residents a definitive benchmark against which to judge the actions of their representatives.

ABOUT THE AUTHOR Mark Newcomb currently chairs the Teton County Board of Commissioners. He has a BA in Geology and an MS in Finance and Economics. He was a Planning Commissioner for six years prior to being elected as one of Teton County's five commissioners.

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KEY TAKEAWAYS

Teton County's primary tools for preserving and protecting the area's ecosystem are zoning and land development regulations.

The county has had three different sets of zoning-related regulations: 1978, 1994, and 2015. Each has tried to address the problems of its time while anticipating future issues and recognizing private property rights.

The area's ecosystem is healthier today than it would have been without the regulations. Whether we will continue to have a healthy ecosystem in the future is unclear.

SUGGESTED NEXT STEPS

Complete the Town Zoning Update

Complete the Natural Resource Land Development Regulations updates for the town and county

Implement the Wildlife Crossings Plan

Photo credit: Shutterstock.com

SUSTAINABLE TOURISM

MANAGING VISITORS TO PROMOTE ECOSYSTEM HEALTH

by Tim O'Donoghue, Riverwind Foundation

Barcelona, Reykjavik, Italy's Cinque Terre, the Seychelles, China's Mount Huangshan, Machu Picchu, Mexico's Tulum, Ireland's Cliffs of Moher, Denali, the Yosemite valley, Zion National Park and Springdale. All are high on a list of popular travel and tourism destinations that are increasingly in a state of "overtourism."

So are Jackson Hole and Yellowstone.

"Jackson Hole and Yellowstone are both on (an) overtourism trajectory."

Overtourism occurs when the carrying capacity of a destination, or sites within a destination, is exceeded. The UN World Tourism Organization defines carrying capacity as "the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic, and sociocultural environment and an unacceptable decrease in the quality of visitors' satisfaction."

OVERTOURISM IN THE TETONS

How has overtourism come to be a problem? The root of the answer lies in the confluence of an increasing world population, more powerful information technology, and greater wealth in countries such as China and India. Together, they have combined to create a surge of travelers worldwide. The World Travel & Tourism Council estimates that travel and tourism now accounts for 10.2% of the world gross domestic product and will increase by another percent by 2027. In 2016, 76 million international visitors came to the US, second only to France.

In 2014, Grand Teton National Park welcomed 2.8 million visitors, an all-time record. In 2015, that number increased to 3.1 million. In 2016, it was just shy of 3.3 million; in 2017, it broke the 3.3 million barrier, a total increase of 19 percent between 2014 and 2017. At the northern end of Teton County, Yellowstone National Park's visitation growth during that same period was nearly as strong: 17 percent.

Traditional economic thinking suggests such growth would greatly benefit Town of Jackson, Teton County, and local businesses, and in many ways it has. For example, during the last two local government fiscal years, taxable sales went up 20 percent; in just the last fiscal year, lodging tax collections rose 17 percent. Using such figures to gauge the health of the local tourism economy, it's hard not to conclude that more visitors are better.

However, with this increased visitation has come negative effects such as more traffic congestion, hundreds of annual vehicle-wildlife collisions and human-wildlife incidents, increased waste and littering, degradation of natural sites, and stressed human services and public infrastructure. Our Golden Goose is being increasingly challenged, if not compromised, by our popularity, especially as local, state, and regional marketing efforts aim to bring more visitors here during the summer, the time when we have the least-available capacity for handling larger numbers.

SUSTAINABLE COMMUNITY AND TOURISM RESOLUTION

Recognizing this disconnect, on April 3, 2017, the Jackson Town Council and Teton County Commission unanimously adopted a resolution supporting Jackson Hole becoming a world-leading sustainable community and destination. If Jackson Hole is going to realize this vision, then we must measure our health and success as a community and tourism destination not just with traditional economic indicators, but also with environmental and social indicators aimed at gauging impacts to wildlife, wild lands and natural resources, culture and heritage, infrastructure and services, resident quality of life, and the quality of our visitors' experiences.

A number of existing public and private sector sustainability initiatives support this community vision. These efforts include:

- Decrease the amount of waste going to the landfill;
- Increase access to local, healthy food;
- Decrease energy and water use while increasing the use of green power;
- Increase START bus ridership and active transportation modes such as bicycling and walking;
- Increase the use of alternative fuels and alternative fuel vehicles;
- Increase private land conservation efforts to improve and protect wildlife habitat;
- Decrease wildlife-vehicle collisions and wildlife-human conflicts;
- Improve food and housing security and income equality;
- Strengthen the philanthropic support of community nonprofits; and
- Reduce unemployment and the seasonality of jobs.

These community efforts are integral to the implementation of the policies, principles, and strategies of the Jackson/

Teton County Comprehensive Plan and other community plans. These and other sustainability initiatives will also be important for supporting federal land visitor use management plans for protecting the ecosystem through improved visitor management.

Such efforts are both important and timely, as suggested by recent visitor surveys conducted by Yellowstone National Park. The results of these surveys indicate that visitors see each of the following as moderate or major problems:

- Difficulty finding a parking space (cited by 67% of those surveyed);
- Too many people in the park (57%);
- Other visitors acting unsafe around wildlife (55%);
- Traffic congestion on park roads (55%);
- Traffic congestion at park entrances (41%);
- Not enough overnight accommodations (35%); and
- Other visitors acting unsafe around thermal features (32%).

"A Jackson Hole Sustainable Destination Action Plan will be the result of a process that brings together stakeholders and community members to establish a vision and goals for the future of tourism in Jackson Hole…"

Based on National Park Service visitation growth estimates, Yellowstone expects to exceed its overall vehicular capacity by 2021-2023. When visitors were surveyed about potential transportation management options, voluntary shuttle bus service to popular park locations during peak periods and voluntary park-wide shuttle bus service with parking outside the park during peak periods received support from at least 75% of those surveyed.

National parks are not the only entities facing growth-related challenges; so too are the other federal and state lands surrounding them, as well as the region's gateway communities. This reality makes clear the importance of developing both local and regional plans for managing the particular needs of the rapidly growing number of visitors from other countries and cultures. And perhaps the most important word in the previous sentence is "regional": In order to ensure that tourism continues to work for visitors, residents, and our public lands, tourism strategies and tactics must be coordinated across the greater Yellowstone region.

SUSTAINABLE DESTINATION ACTION PLAN

To address these multi-faceted challenges, key leaders and stakeholders

in Jackson Hole have been discussing the development of a destination management plan focused on sustaining the qualities that visitors enjoy and residents most value: the region's wildlife, wild lands, and community character and culture. A Jackson Hole Sustainable Destination Action Plan will be the result of a process that brings together stakeholders and community members to establish a vision and goals for the future of tourism in Jackson Hole, and then identify and prioritize local and regional collaborative approaches and solutions. This plan will guide our destination tourism stakeholders and overall community in preventing, mitigating, and managing the effects both visitors and residents have on our environmental integrity and natural resources, infrastructure and services, community character and resident quality of life, and visitor experience. The success of implementing this plan will be measured with key performance indicators for environmental stewardship and social responsibility as well as economic health.

Jackson Hole and Yellowstone are both on the same overtourism trajectory as the destinations listed at the beginning of this article. Many of these destinations have created plans to address the threats to the qualities that make them renown. We have a responsibility to ourselves and future generations to protect and sustain our ecosystem. Let's marshal our capabilities to seize this opportunity, strive toward our vision as a world-leading sustainable community and destination, and tell our story to our visitors so that they may be inspired to do the same when they return home.

ABOUT THE AUTHOR As the Executive Director of the Riverwind Foundation, Tim is leading the collaborative stakeholder sustainable community development efforts of Teton County, Wyoming through the Jackson Hole & Yellowstone Sustainable Destination Program. These efforts include leading Teton County's participation as one of six destinations selected worldwide by the Global Sustainable Tourism Council to adopt the world's leading sustainable tourism destination criteria. This program and Jackson Hole were selected by the World Travel & Tourism Council as a Destination Finalist in the 2018 Tourism for Tomorrow Awards, National Geographic as a Destination Leadership Finalist in the 2017 World Legacy Awards, and by Green Destinations as a Top 100 Sustainable Destination in 2016, 2017, and 2018.

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KEY TAKEAWAYS

Overtourism is a clear threat to Jackson Hole and Yellowstone

In 2017, local governments resolved to make Jackson Hole not just a world-class sustainable destination, but community as well.

As a key early step toward meeting that goal and avoiding overtourism, the community has begun working on a Jackson Hole Sustainable Destination Action Plan (JH SDAP).

SUGGESTED NEXT STEPS

Create a JH Strategic Destination Action Plan (SDAP), based on active public engagement

As a basis for the SDAP, determine the region's human carrying capacity, along with associated Key Performance Indicators.

Coordinate the SDAP and underlying process with other community plans, as well as those of the region's federal lands and other communities.

TETON CREEK

THE TETON CREEK CORRIDOR PROJECT: PROTECTING A KEY RESOURCE IN THE GYE

by Shawn Hill, Valley Advocates for Responsible Development

As more people move to the Greater Yellowstone Ecosystem (GYE), development will continue to affect the region's ecological health. For 17 years, Valley Advocates for Responsible Development (Valley Advocates) has advocated for responsible growth management in the Teton Valley of Idaho and Wyoming, working to preserve our corner of the GYE. However, we've found that focusing on future growth alone is not enough to protect our treasured ecosystem. In addition, our regional community must also work to correct the development mistakes of the past.

TETON CREEK CORRIDOR PROJECT

The Teton Creek Corridor Project (TCCP) is an attempt to help address some of Teton Valley's past development mistakes. Begun in 2015, and expected to be completed by 2025, the TCCP is a $14 million effort to protect and enhance the Teton Creek corridor by not only restoring the creek's ecological health, but also fulfilling many of Teton Valley's conservation, recreation, and land use planning goals. Specific project goals include:

- Improve native plant communities;
- Increase winter elk habitat;
- Restore year-round stream flows; Enhance Yellowstone cutthroat trout fisheries;
- Restore degraded sections of the stream channel;
- Reduce development impacts; and
- Construct a 4-mile recreational pathway to allow the public to experience and appreciate this tremendous ecological resource.

The genesis of the TCCP goes back to the mid-2000's, when Teton Valley experienced an explosive development boom that severely affected some of its most ecologically-rich areas. Teton Creek was particularly beleaguered, with new resort and residential development ravaging riparian lands, dismantling the creek's hydrology, and severely degrading fisheries and wildlife habitat.

After the Great Recession, development along the creek all but ceased, and the Teton Valley community made progress in adopting new growth control and environmental protection measures. But the damage from the pre-recession boom endures.

In response, four Driggs-based conservation non-profits—Valley Advocates, Friends of the Teton River (FTR), the Teton Regional Land Trust (TRLT), and Teton Valley Trails & Pathways (TVTAP)—formed the Teton Creek Partnership (TCP), and hired Legacy Works Group to facilitate the project's implementation. Seed money was provided through a generous grant from the LOR Foundation.

In addition, the partnership is continuing to raise funds from private, public, and nonprofit partners to complete the project.

TETON CREEK AND THE TETON VALLEY

Teton Creek is an active migration corridor, connecting the mountainous habitat of Grand Teton National Park and the Caribou-Targhee National Forest with the vast wetlands on the east bank of the Teton River. As it flows through Teton Valley, the Teton River corridor contains more than 5,000 acres of big game, wetland, and prime bird habitat. Numerous big game species use the corridor as winter range, including a local elk herd. Moose, deer, and large raptors are commonly seen within the corridor, and bears utilize the riparian habitat seasonally. Through extensive fish surveys, FTR has identified Teton Creek itself as one of the most important spawning tributaries for Yellowstone cutthroat trout, a native species classified as "Greatest Conservation Need" by the Idaho Department of Fish & Game.

Teton Valley is growing rapidly, due to both spill-over from Jackson Hole and a burgeoning second home market. Between 2000-2017, Teton County, Idaho was the 23rd-fastest growing county in America, with its population growing six times faster than the nation as a whole. As it grows, post-recession development in the Teton Creek area is placing increased pressure on the corridor's conservation-related qualities. Coming out of the Tetons, the creek parallels a haphazard development corridor between Driggs and Grand Targhee, and most of the creek's 10-mile reach flows through private lands subject to development speculation. Complicating things further, previous development has altered the stream channel, moving massive amounts of sediment that destabilized the creek and put much of Driggs at risk for flooding. Other development-related encroachment into the corridor has fragmented sensitive migration habitat. In addition, the conversion of farmland to home sites continues to deplete the area's shrinking supply of the agricultural lands that tend to be more compatible with conservation than residential development.

On top of all of this is basic economics. The combination of general development pressures and the attractiveness of the Teton Creek corridor has pushed land values to a level where large-scale conservation is cost-prohibitive for much of the corridor.

Recognizing all these pressures, the TCP formed to combine its members' complementary skills with those of other interested parties to develop and execute a plan for conserving this key resource.

"The Teton Creek Corridor Project is acting in support of a vision that has been repeatedly laid out by the Teton Valley community."

The focus of the TCCP is the section of Teton Creek from Highway 33 upstream to Stateline Road, and ultimately into Teton Canyon and Grand Teton National Park. The effort has two goals: to maintain and enhance the public's ability to access and enjoy the corridor; and simultaneously maintain and enhance its ecological integrity. Specific anticipated project outcomes include:

- Protecting and enhancing the riparian corridor;
- Protecting agricultural lands;
- Maintaining and improving native plant communities;
- Improving winter elk habitat;
- Restoring degraded sections of stream channel to reduce flood risk to Driggs and improve stream habitat;
- Making development along the corridor more in line with community goals; and
- Building an initial 2.5-mile recreational pathway that will connect with a regional pathway system.

The TCCP will also strengthen habitat conservation by protecting riparian habitat against loss to the creek, and by developing water use plans that keep agriculture viable while increasing the availability of instream flows.

THE COMMUNITY'S VISION

The first step in pursuing these aims was for the four local nonprofits to develop formal governance and funding structures. Following this came the development of a comprehensive strategy and timeline, with each organization tasked with leading aspects of the project that fit within their specific mission. Importantly, the vision and goals of the TCCP as a whole are the product of collaborative work by the partner organizations.

The TCCP is acting in support of a vision that has been repeatedly laid out by the Teton Valley community. Teton Creek has been identified as a key resource for protection by numerous community-planning processes, including the Teton County Comprehensive Plan. Moreover, both the Teton Valley Economic Development Plan and the Teton Valley Recreation and Public Access Master Plan support the establishment of a pathway through this area. The partners have used these and other planning efforts as guiding documents to establish project goals and understand the community vision. Recognizing the importance of having community input throughout the entire process, the partners also developed an outreach strategy to engage local residents and local governments. The input, insight, and participation of the local community have been key to the project's success.

The TCCP was designed to build on the strengths and past successes of the partner organizations. The planned pathway will tie into the existing Teton Valley trails system that TVTAP has supported and expanded throughout the valley. Habitat protections will extend and enhance the 1,100 acres of conservation easements TRLT has already protected along Teton Creek upstream and downstream of this project. FTR has already restored roughly 6,100 feet of degraded streambed along Teton Creek at a cost of roughly $2.85 million, and this project ties into those previous successes by removing the ongoing threats presented by the remaining head cut. Valley Advocates has drawn upon its relationships with both local government and existing and planned developments to ensure coordination between the project's goals and the efforts of the public and private sectors.

To date, the project's key accomplishments include:

- Acquired 172 of the approximate 800-acre project area, land which will be protected and managed according to an approved plan;
- An additional 178 acres is protected under conservation easement;
- 162.3 acres of prime wildlife habitat protected, including 19.4 acres of wetlands;
- 115 acres of farmland protected;
- 2.6 cfs of water rights secured, roughly 10 percent of the 25 cfs needed to restore the Yellowstone Cutthroat Trout lifecycle period and provide irrigation for farming;
- 2.5 miles of connected pathway easements secured across 4 separate properties for a planned 4 mile pathway connecting Driggs to public lands in Wyoming. This pathway is further envisioned as a spur

from a regional pathway system extending from West Yellowstone, MT to Jenny Lake in Grand Teton National Park.

THE IMPORTANCE OF COLLABORATION

Many of these outcomes were only possible through collaborative work. For example, while TVTAP has worked on numerous pathways in Teton Valley, the organization is not structured to hold pathway easements. For this project, TRLT was able to acquire pathway easements targeted by TVTAP, before transferring them over to Teton County.

Similarly, FTR relies on landowner permission to carry out vital stream restoration work. Through TRLT's project acquisitions, FTR gained access to restore some of the most impaired sections of Teton Creek. Finally, Valley Advocates' experience working with developers allowed the collaborative to approach subdivisions within the creek corridor about reconfiguring development to advance conservation and pathway goals.

Each of the TCCP partners recognizes a simple fact: Through collaboration, we not only have been able to produce outcomes that otherwise could not be achieved alone, but have produced outcomes that more fully address the community's vision for Teton Creek. We believe our collaborative approach is a model that can be replicated by other communities throughout the GYE that face similar challenges balancing conservation with development.

Based on the initial success of the project, the TCCP partners are looking to implement the future phases of the project between now and 2025. In 2018, we have begun restoring riparian habitat along the creek corridor, restoring winter elk habitat and upland vegetation, and initiating construction of the first phase of the pathway directly adjacent to Driggs. In future years, our plan calls for us to continue to prioritize conservation of key habitat, expand stream restoration through all sections of the creek that pose flood risk to the City of Driggs, and expand recreational access for local residents. We anticipate a completion date in 2025, and at this time hope to have the most of creek corridor between Highway 33 and the Wyoming State Line protected, enhanced, and accessible to the public. Most importantly, we hope to have an example of – and catalyst for – other transformative projects in the GYE.

"Most importantly, we hope to have an example of – and catalyst for – other transformative projects in the GYE."

ABOUT THE AUTHOR Shawn is the Executive Director of Valley Advocates for Responsible Development and a fifth-generation Teton Valley resident. He earned his BS in Urban Planning from the University of Utah and MPA from the University of Wyoming. He has been a town planner in various Rocky Mountain communities, including Jackson, and is the organizer of the Mountain and Resort Town Planners Summit.

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KEY TAKEAWAYS

Collaborations offer great promise in addressing complex conservation issues.

In Idaho's Teton Valley, four conservation-oriented non-profits have combined to develop the Teton Creek Corridor Project (TCCP), an effort to help conserve and restore the Teton Creek and surrounding lands, as well as improve public access.

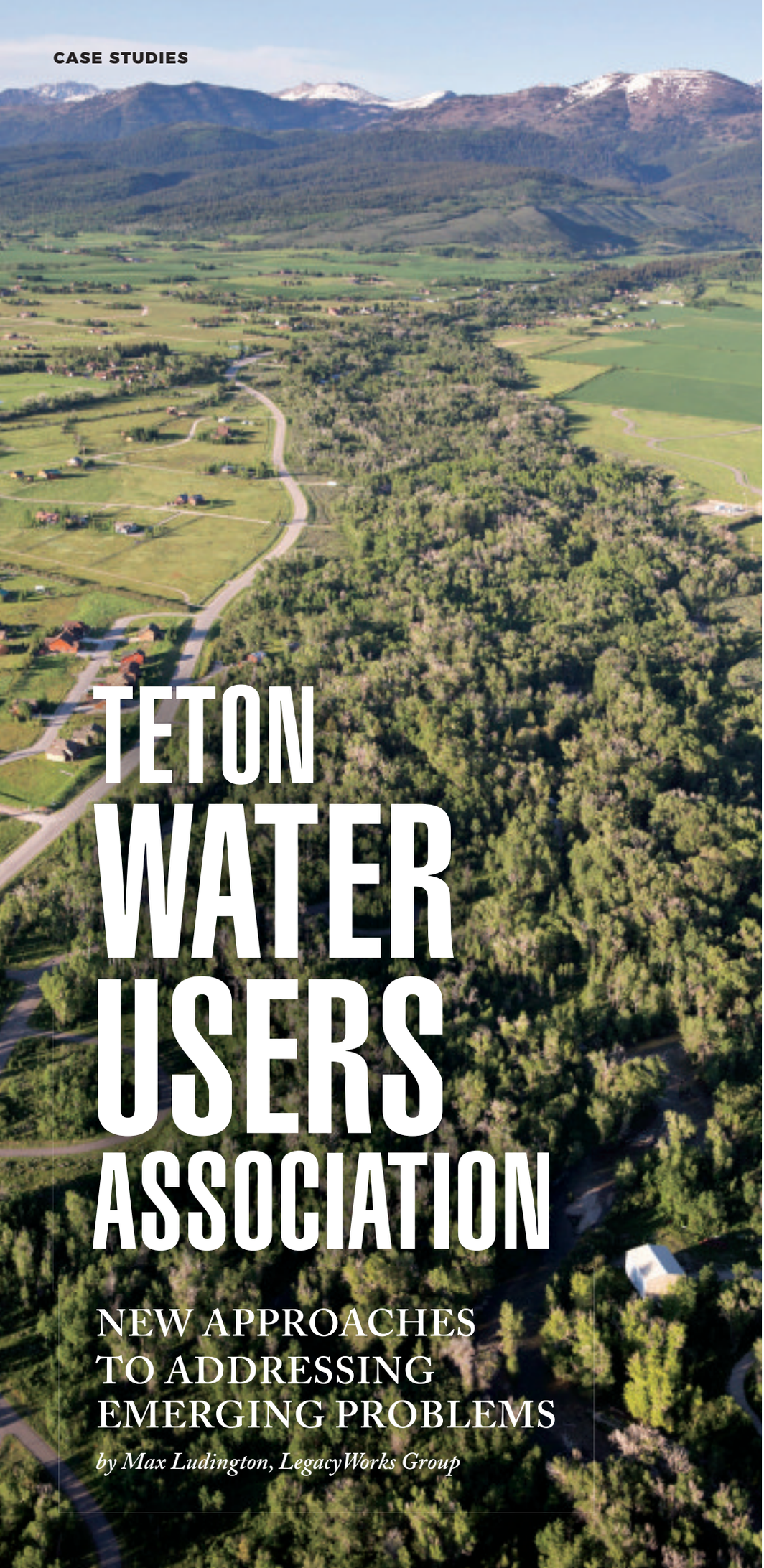
The project has aligned government, property owners, and developers with the community's desires for the area, and its success offers a model for other areas of the GYE and beyond.

SUGGESTED NEXT STEPS

Raise funds to complete remainder of the project.

Engage public for pathway, park, and conservation plan details.

Identify other potential efforts in the GYE that could emulate the TCCP model.



TETON WATER USERS ASSOCIATION

NEW APPROACHES TO ADDRESSING EMERGING PROBLEMS

by Max Ludington, LegacyWorks Group

"What direction does water flow?"

Anyone who has watched snow melt off the mountains every year knows the obvious answer: "Downhill." Yet those who've made water their life's work often give a different reply: "Water flows towards money."

If you doubt that answer, look at any one of the many infrastructure projects around the United States that pump water uphill, at times over entire mountain ranges, to places where water is needed and people are willing to pay for it. Or for a more local context, look at any of the agricultural pumps that move water out of our waterways to make it available for agricultural use.

Why mention this? Because we can no longer take for granted water availability in the Greater Yellowstone Ecosystem (GYE). As climate change alters our weather patterns and human demand for water increases, water availability throughout the ecosystem is changing, affecting both people and wildlife. Economics drives both the management and availability of water. If we are to devise durable solutions to water availability for the GYE, we must think about both natural ecosystems and the economics of water. One way to do this is by considering a new effort in Idaho's Teton Valley: the Teton Water Users Association (TWUA).

TETON WATER USERS ASSOCIATION

TWUA is a first-of-its-kind partnership attempting to combine science, economics, and the ingenuity of local farmers to address decreasing water availability. Partners include farmers, local irrigators, and a variety of local governments, state agencies, and local and regional non-profits. A partial list of those partners includes: Teton Soil and Water Conservation District, Teton County Farm Bureau, Friends of the Teton River, Henry's Fork Foundation, Teton Regional Land Trust, Teton County, ID, the City of Driggs, and LegacyWorks Group.

What makes this group of collaborators distinctive, if not unique, is its mix of agricultural and environmental interests, all working together to address water issues. It's been said about the American West that whiskey is for drinking and water is for fighting over. While that may hold true in general, it's simply not the case with TWUA. In the face of a shared challenge, these groups have decided to work together.

TWUA was created in response to the same types of changes in water availability being seen throughout the GYE. In the case of Teton County, Idaho, in recent decades the valley's aquifer has been declining at precipitous rates: on average by roughly 25 feet, and up to 55 feet in some localized areas.

This decline has affected the entire Teton Valley community. For example, around the county agricultural and residential wells have gone dry. For farmers the problems created by increasingly short water years have been exacerbated by earlier calls for water from the downstream holders of senior water rights. And for outdoor enthusiasts, aquifer-dependent flows into the Teton River are declining late-season, affecting fishing, wetland habitat and overall riparian health.

"Scarce summer water is worth more than abundant spring water… TWUA's goal is to convert spring water into summer water, in so doing creating value."

CHANGES IN WATER AVAILABILITY

The reasons for the change in water availability are varied, but three key factors seem to be driving it.

First is a change in snowpack. Traditionally, snowpack has functioned as a free reservoir, holding water that arrives as snow until farmers and their crops need it in the summer. As Earth's temperatures rise, though, more of the Tetons' spring moisture is coming as rain, leading to earlier runoffs – over time, the date for peak runoff has crept ever-earlier in the season. The end result is that less water is available in the summer, when both agricultural and ecosystem demands for that water are at their highest.

Simply put, as the planet warms, any community dependent on snow run-off is losing one of its key water storage systems. That's certainly the case in the Teton Valley.

The second cause is an increased demand for water. This is being driven by both local residential and downstream agricultural uses. The proliferation of homes in Teton Valley has resulted in more and more residential wells, which draw out groundwater without replacing it. At the same time, many of the senior water rights in the Teton River system lie downstream in the Eastern Snake River Plain around Idaho Falls and Rexburg. As those users deal with increased demand for water, one solution has been to make earlier calls for water in headwater basins like Teton Valley.

The third cause, and also the root of a potential solution, is a change in agricultural water use.

To make their operations more efficient, most of Teton Valley's farmers have switched from flood irrigation to sprinkler systems. These systems offer a variety of benefits, including reduced water use, improved crop production, and decreased labor costs.

From the perspectives of both water conservation and food production, this switch has been a boon: per capita water demand has decreased throughout the valley, and farmers are producing greater yields than were possible through flood irrigation. However, a major unforeseen consequence of the shift is that the extra water used in flood irrigation no longer seeps into the ground. As a result, Teton Valley's aquifers have lost a recharging mechanism, which in turn reduces the amount of water emerging from those aquifers later in the summer, water that eventually works its way into local riparian systems. As a result, stream gauge data from the last century reveals a significant decline in late season flows in the Teton River, a decline directly corresponding to the increased use of sprinkler irrigation.

While some might see this loss of aquifer recharge as a lamentable side effect of modernization, TWUA sees a potential solution. This is because these declines have made crystal clear that

how farmers manage their water affects the functioning of the region's hydrologic regime.

Specifically, the decades of flood irrigation in Teton Valley showed that local farmers have the ability increase aquifer recharge, and in so doing slow the rate at which water leaves the valley. There are good reasons this doesn't happen any longer, but is it possible to bring back some of that recharge?

SUMMER WATER IS MORE VALUABLE THAN SPRING WATER

To address this question, TWUA has proposed a solution based on a simple economic concept: Scarce summer water is worth more than abundant spring water. Building on this idea, TWUA's goal is to convert spring water into summer water, in so doing creating value. Here's how it works.

The seepage into the ground that occurs during irrigation is known as incidental recharge, and it currently accounts for roughly 40% of total aquifer recharge in Teton Valley. While we lack the data to know what this figure was when flood irrigation was the primary means of irrigating crops, modeling suggests it was much higher. Combine flood irrigation with Teton Valley's highly porous soils, and the result is significant incidental recharge, something that also occurs when water runs down unlined, leaky canals or out into rocky soils.

Once in the aquifer, recharge water slows down, delaying its delivery into local streams by an estimated 1-3 months, depending on location. In essence, the aquifer acts like an underground reservoir, holding abundant spring water until summer, when water is scarce.

From an economic standpoint, the aquifer stores cheap spring runoff and turns it into valuable summer water. As this occurs, the additional water availability can give downstream farmers a couple of extra weeks of irrigation water during a time of year when every day of water can make or break a crop season.

In addition, water stored in this underground reservoir has significant ecosystem benefits, including feeding wetlands, putting cold water into streams during summer months when water temperature is a major concern, and boosting the water table.

CONVERTING SPRING WATER INTO SUMMER WATER

So how can Teton Valley farmers manage their water in a way that optimizes both irrigation efficiency and aquifer recharge? For all of its ecosystem benefits and water storage capac-

ity, going back to flood irrigation from sprinkler systems simply doesn't make sense for a modern farmer – it's just not economically feasible to give up the efficient, productive watering of center pivot irrigation systems.

Instead, what TWUA has been working on is not a wholesale change, but rather combining seasonal flood irrigation with sprinkler systems. In essence, the idea is to ask farmers to engage in the old irrigation practices that lead to high rates of aquifer recharge during the spring months when water is abundant, and use pivot irrigation when it's not.

How does it work? For farmers with rocky pastureland that can handle early season flood irrigation, we're encouraging them to flood irrigate it (a practice which, not insignificantly, can also lead to better farming results on marginal ground). Then, as soon as water starts to become scarce, farmers can go right back to sprinkler irrigation. Put simply, what we're encouraging farmers to do is use as much water as they can when it's abundant, and be as efficient as possible with it's scarce.

How does this new water management regime create value? As in most of the western US, in Idaho water rights are based on a system of prior appropriation. That means that those who filed the first water rights get their water first. Since the headwater basins like Teton Valley were typically settled after those on the Snake River Plain, Teton Valley claims on water rights are considered junior, with farmers and residents getting their water allotments only after senior water rights are met. The more water flowing out of Teton Valley late in the season, the higher the likelihood that senior rights will be met, and the more likely it becomes that Teton Valley farmers will be able to continue diverting water. This program is designed to boost late season flows, making more water available for all farmers, while also putting more water into the ecosystem.

In spring 2018, TWUA launched a two-year pilot program, working with a few Teton Valley irrigators to manage their water rights to increase incidental recharge. If the monitoring data indicate the effort is improving both stream and aquifer health, the plan is to expand the program in 2020 and beyond.

TWUA's fundamental goal is to change the timing of water flowing out of Teton Valley. That is no small task, and success will require a coordinated effort from all of TWUA's members. To date, TWUA has succeeded in the critical first steps of developing not only the knowledge needed to pursue the project, but the mutual trust between the many parties necessary to carry it out. Should it succeed, this approach has great potential to be applied in agriculture-heavy headwater basins throughout the GYE, as well as broadly across the West.

As the planet warms, the effects of climate change are only going to become more apparent. If our communities are to cope, and ideally to continue to thrive, we will need to develop new, innovative, cost-effective approaches to our challenges. As the Teton Valley sees its snowpack diminish and in so doing loses its natural water storage system, the challenge is to develop new, cost effective storage replacements. TWUA believes groundwater recharge is just that.

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KEY TAKEAWAYS

Agriculture in Idaho's Teton Valley and areas further downstream depend on snowpack to serve as a natural water storage system.

Climate change is causing snow to melt earlier, making it harder for farmers to obtain water when most needed in late summer. The earlier run-off is also harming the region's riparian health.

Agricultural interests hold and manage the vast majority of water rights in Teton Valley. Farmers have the means and legal right to manage water in ways that lead to more late season water availability.

By incenting Teton Valley's farmers to flood irrigate their fields when water is abundant, the area's aquifers can be turned into an alternative, natural, and cost-effective water storage mechanism.

SUGGESTED NEXT STEPS

Generate statistically significant improvements in Teton River baseflows through pilot program.

Secure funding to grow the program.

Scale the effort to serve other headwater basins in the West.

AFTERWORD

EMBRACING AN EXTREME CHALLENGE

by Jonathan Schechter

THEMES

Four major themes run through *Mosaic's* essays: climate change, habitat, people, and connectivity.

Climate change

Earth's rapid warming will likely have profound consequences for the Tetons area's ecosystem. Whether flora or fauna, terrestrial or aquatic; everything connected to the region's ecosystem will be affected by climate change, including our residents and visitors.

It's clear that human activity is causing climate change. Far less clear is if humans – whether locally, nationally, or globally – will act quickly and forcefully enough to meaningfully address the resulting problems, much less their cause.

Somewhere in-between these poles of certainty and uncertainty is our understanding of exactly how climate change will affect the region's ecosystem. In their essay, Corinna Riginos and Trevor Bloom explain that some consequences of climate change seem reasonably certain: e.g., more rain and less snow, drier conditions leading to more fires, and more invasive species. Other possibilities are at best educated guesses. What we can be sure of, though, is that few of the potential consequences of climate change will be positive. Why? Because the planet is warming far faster than most species can adapt in response.

For millennia, the flora and fauna of the Tetons area's ecosystem have evolved in ways that allow them to thrive in a climate marked by, long, cold, snow-filled winters. As climate change disrupts this foundational cycle, so too will it disrupt the ecosystem's health.

Our human population is also closely tied into this cycle of snow and

"Whether flora or fauna, terrestrial or aquatic; everything connected to the area's ecosystem will be affected by climate change, including our residents and visitors."

cold, and the changes resulting from climate change will affect everything from our snow-based recreational economy to our firefighting budgets. As a result, it seems likely that rising global temperatures will place increasing pressure on, and add increased volatility to, the local economy and all those who depend on it.

Habitat

The local economy can never be healthier than the region's environment, and the environment can never be healthier than the habitats that comprise the region's ecosystems. Happily, there is much good news about local habitats.

For starters, as Doug McWhirter, Megan Smith, Kelly McCloskey, Erica Hansen, Carlin Girard, and Dan Leemon discuss in their essays, overall the region's habitats are in reasonably good shape. Much of this has to do with our vast tracts of public land, but those alone can't ensure healthy habitats and connectivity. Also critical to habitat health is how the region's private lands have been developed and managed.

Migrating animals are especially sensitive to private land stewardship, for the region's migratory routes predate its land ownership patterns by thousands of years. Jon Mobeck points out that as the region becomes increasingly aware of this reality, there is a growing appreciation for the need to take a landscape-level view of habitat, and to ensure connectivity across long migratory routes.

In addition, growing awareness of the importance of habitat has led to increased study of the ecological value of the region's lands, as well as additional resources being put into the conservation of healthy habitat and the restoration of damaged lands.

Threats exist though. As both the region's population and visitation grow, so too does the potential of developing private lands in ways that compromise wildlife habitat and connectivity. In addition, as Erika Edmiston and Mark Daluge observe, because people are the primary vector for introducing invasive species, growing numbers of residents and tourists increase the chances that invasive species will compromise habitat health.

Climate change also holds great potential to cause significant problems for the region's habitats. As conditions become warmer and drier, some habitats will become less favorable, while others

will become increasingly important. As this happens, animals will need access to the new, more favorable habitat.

How animals and property owners will adjust to these changes is unclear. What does seem clear is that if humans are to help animals adjust to the new habitat realities, it will require all those involved – land and wildlife managers, property owners, government officials, and the like – to be increasingly flexible and collaborative.

People

As Doug McWhirter puts it, "Wildlife management is primarily people management."

Residents of the Tetons area clearly have the resources to successfully pursue the Comp Plan's vision. We also have the passion needed to animate the effort. Far less clear, though, is whether we can break out of the silos that limit our ability to do something no community has ever done before: preserve and protect our ecosystem.

There is reason to be hopeful. As Franz Camenzind, Susan Clark, and Mark Newcomb discuss, both the region's residents and institutions increasingly recognize that successfully addressing the challenges facing the area's ecosystem requires multi-disciplinary, cross-jurisdictional approaches, ones spanning economic sectors and moving beyond long-held suspicions and antagonisms. Such efforts require time to build trust and make sure all voices are heard. They also require imagination, because many of the problems we face today stem from the unintended consequences of traditional approaches. And they require courage, because doing new things is never easy and often scary.

But as highlighted by Tim O'Donoghue, Shawn Hill, and Max Ludington, the region has already initiated a number of efforts involving diverse groups tackling incredibly thorny problems. Better still, many of these efforts are succeeding.

With luck, with each successive effort, the community will become better at addressing our complex challenges. With even more luck, we'll come to believe that even challenges as daunting as preserving and protecting the area's ecosystem can be successfully addressed.

Connectivity

Binding together all of *Mosaic's* essays is a shared theme of connectivity. Franz Camenzind began *Mosaic* by emphasizing that our region is "...a set of connected things or parts forming a complex whole..." Max Ludington ends it by discussing how an unlikely collection of interest groups is working together in a new, unprecedented way to address a new, unprecedented problem. In-between, central to many other essays is the idea that all of our region's systems are deeply entwined with one another.

The overarching theme of Corinna Riginos's and Frances Clark's essay is that understanding the health of our ecosystem requires understanding both habitats and species. Whether considering climate, landscape-level habitats and migration corridors, riverine systems, or the multitude of species dependent upon even apparently low-quality habitat, no component of our region's ecosystem stands alone. Similarly, the consequences of our decisions often have far-reaching and unintended consequences.

All this is clear. Far less clear is how we will respond. We have both the opportunity and resources needed to develop a new approach to how humans interact with their environment. What we lack is a blueprint for doing so.

Unfortunately, history is not in our favor. This reality is made more daunting by the tendency to take for granted the things we currently have. As Susan Clark put it:

> "It's all too easy to imagine we'll always have this beautiful, healthy environment with endless outdoor and lifestyle opportunities, and have them without needing to assume responsibilities or face consequences. While that may once have been possible, today it is magical thinking, no longer tenable given the rapid changes we humans are causing."

The opportunity at hand is to leave a conservation legacy as meaningful as those left by our forebears: Yellowstone's founders; John D. Rockefeller's expansion of Grand Teton National Park; the Muries' role in the creation of the Arctic National Wildlife Refuge. Each faced the same fundamental lack-of-blueprint challenge we face, yet each persevered through uncertainty and setbacks to eventually succeed.

"We have both the opportunity and resources needed to develop a new approach to how humans interact with their environment. What we lack is a blueprint for doing so."

If we hope to emulate these efforts, some initial steps suggest themselves. First, though, they need to be placed within a framework.

NEXT STEPS: FRAMEWORK

Do you drive a car? Use a cell phone or computer or the internet? How about a refrigerator, washing machine, or other home appliance?

Have you taken any medicine recently? Had a diagnostic test? Flown in a plane? Eaten food you haven't raised or hunted? Watched a movie or television show?

Essentially every good and service used by contemporary society is the result of what humans have learned using the scientific method. For the last few centuries, when scientists have become curious about something, they've used the scientific method to explore the issue. If they find an answer, their research adds to the canon of what we know – and, critically, do not know – about our world and how it operates.

Sometimes those results are turned into goods and services, such as those listed above. But even if it has no obvious practical use, the knowledge developed through scientific inquiry informs and makes our lives richer. As the columnist George Will put it: "... it is a paradox of prosperity that nations only reap practical innovations from science by regarding them as afterthoughts, coming long after basic science."

Why mention this? Because the if we are to successfully preserve and protect the area's ecosystem, the first step we have to take is to acknowledge a fundamental reality: The primary reason our ecosystem's health is at risk is because technology gives humans the power to alter the ecosystem far faster than plants and animals can adapt.

Photo credit: Shutterstock.com

The same scientific method that undergirds this ecosystem-altering power also tells us climate change is real, and that it is perhaps the greatest threat to the Comp Plan's vision. It also tells us that Darwinian adaptation and evolution are real, and occur much more slowly than our technology advances.

As a result, if you use any modern technology, it is at best logically inconsistent to reject the realities of climate change or evolution – all share the same intellectual foundation. No cherry-picking please.

Small-c conservative

That Jackson Hole wants to preserve and protect the area's ecosystem is a reflection of an essential part of Jackson Hole's character: Philosophically, we are a small-c conservative place. Linguistically, "conservative" and "conservation" share the same root: "conserve," or "to protect (something, especially an environmentally or culturally important place or thing) from harm or destruction."

In contrast, it is profoundly non-conservative – profoundly radical, if you will – to support actions that compromise the ecosystem's health. Just as it's profoundly non-conservative to deny realities so clearly proven by the scientific method.

Part-and-parcel of being small-c conservative is being clear-eyed about the realities of a situation. And the foundation of being clear-eyed about the Comp Plan's Vision Statement is understanding why it is needed in the first place.

Why do Teton County and the Town of Jackson want to preserve and protect the area's ecosystem? As the Vision Statement notes, "...to ensure a healthy environment, community, and economy for current and future generations." But why the concern? Won't things take care of themselves? Unfortunately, 250 years of post-Industrial Revolution history argue otherwise. Specifically, they argue that unless we take dynamic and significant efforts to preserve and protect the area's ecosystem, it will almost certainly end up fundamentally harmed. And if that happens, our community and economy will also end up fundamentally harmed.

Table 1

Town of Jackson, Teton County, and Joint Boards, Commissions, etc.

(Sources: Town & County websites)

Town of Jackson

1. Board of Examiners
2. Design Review Committee
3. Planning Commission/ Board of Adjustment
4. Public Art Task Force
5. Teton County Community Juvenile Services Board

Teton County

1. Alta Solid Waste District Committee
2. Historic Preservation Board
3. Planning Commission
4. Teton District Board of Health
5. Weed & Pest Board

Joint Town/County

1. Affordable Housing Supply Advisory Board
2. Airport Board
3. Comprehensive Plan Citizen Advisory Groups:
   - Stakeholder Advisory Group
   - Technical Advisory Group
   - Data task forces
4. Energy Conservation Works Board
5. Integrated Solid Waste & Recycling Board
6. Jackson Teton County Housing Authority
7. Museum Board
8. Natural Resource Technical Advisory Board
9. Parks & Recreation Board
10. Pathways Task Force
11. Regional Housing Authority Board
12. START Board
13. Teton County Library Board
14. Teton County Fair Board
15. Travel & Tourism Joint Powers Board

In short, if we are to buck history, we cannot take our ecosystem's health for granted. Instead, we need to develop a deep understanding of each of our ecosystem's components, and how each works within the larger system. We'll then need to put that understanding to use in a significant and sustained fashion. In that context, to quarrel about the realities of climate change or evolution only diverts time and energy from a task that requires all the resources we can muster.

To emphasize the positive, we already know a lot about how our ecosystem and how it works. Indeed, *Mosaic* is a testimony to how much hard work and good science has been done – and is being done – to understand the region. Ditto to help preserve and protect the ecosystem. But as *Mosaic's* title and underlying conceit suggest, most of this effort has been done in a piecemeal fashion – there has been little coordinated effort to develop a clear and comprehensive understanding of the ecosystem's dynamics, much less how to systematically apply that understanding to regional conservation efforts. Absent such efforts, it will be much harder to buck 250 years of history.

To catalyze such efforts, eight actions suggest themselves.

NEXT STEPS: EIGHT ACTIONS

1 *Create a Joint Town of Jackson/ Teton County Ecosystem Board*

Between them, the Town of Jackson and Teton County have 25 different boards, commissions, and the like (Table 1). Only one comes close to being a "vision commission": the Natural Resources Technical Advisory Board, whose on-line minutes suggest it hasn't met since January 2017.

That local government has no board focused on the Comp Plan's vision is a paradox. So is the fact that the town and county employ a combined eleven land use planners, yet no staff ecologist, wildlife biologist, or the like. Creating an Ecosystem Board, supported by dedicated staff, would send a strong signal of local government's commitment to the Comp Plan's Vision Statement.

2 *Conduct a Baseline Assessment of Ecosystem's Health*

We cannot accurately or effectively evaluate how well we are preserving and protecting the area's ecosystem without a baseline understanding of its health. *Mosaic* is a step in that direction, but ultimately a formal assessment is needed. Ditto a process for keeping the assessment up-to-date.

3 *Develop a Strategic Plan*

To be truly successful, any effort to preserve and protect the area's ecosystem has to be approached systematically, with resources directed within the framework of a strategic plan. Building on the baseline assessment of the area's ecosystem, a "Preserve and Protect Strategic Plan" will identify and prioritize both research needs and action steps.

4 *Develop a Dedicated Funding Source*

Appointing a board, doing studies, and developing a strategic plan are all necessary, but not sufficient. Like any worthwhile endeavor, stewardship takes resources.

An organization's budget is the clearest indicator of its priorities. As Table 1 suggests, right now the Town of Jackson and Teton County put human and financial resources into dozens of efforts, including affordable housing, energy conservation, pathways, and the county fair. All of them play important roles in our community, yet none is mentioned in the Comp Plan's vision.

To be clear, some public money does go into stewardship each

year. Combined, entities like Teton Conservation District and Teton County Weed & Pest spend hundreds of thousands of public dollars on their missions. Additional monies are also spent on individual conservation efforts.

What's missing, though, is an overall framework for those efforts, as well as the funds necessary to to support that framework. If we are going to make a serious stab at bucking 250 years of history, local government's investment cannot be meager or conventional. Instead, we will need to devote a lot of resources to the effort, both human and financial.

We'll also need to take risks. Act in ways that challenge conventional wisdom. Forge unconventional partnerships. And accept that not all efforts will succeed. Bucking history is not for the faint-hearted.

Nor is it cheap. Little in Jackson Hole is. As Earth's environment comes under increasing strain, our region's environmental health – our fundamental asset – is becoming both increasingly rare and increasingly popular. Viewed from a supply and demand perspective, this is a critical factor in the region's ever-escalating property prices.

An argument can be made that the Comp Plan's vision is essentially a way of protecting our collective investment in local real estate – if our ecosystem becomes compromised, so too will the region's property values.

How much is our property worth? In 2016, the Teton County, Wyoming Assessor estimated the combined value of all of the county's residential land and improvements was $10.8 billion. In 2018 it was $13.5 billion, a growth of 25 percent in two years.

How much of that value is due to the health of our ecosystem? Impossible to say, for Teton County is attractive for a variety of reasons, including Wyoming's trust and income tax laws. But since those benefits are available to all Wyoming residents, how do we explain that, despite having only five percent of Wyoming's homes, Teton County accounts for 25 percent of the state's total assessed residential property values? Or that the value of Teton County's residential property is greater than that of Wyoming's two most populous counties combined (Laramie and Natrona), despite having just one-sixth their total number of homes?

"Humans can modify and adapt to ecosystems in ways no other species can, allowing our numbers to far exceed any given ecosystem's 'natural' carrying capacity. Non-human species enjoy no such advantage."

Clearly the region's environment has something to do with Teton County's property values. To make a quick-and-dirty stab at it, let's say the environment accounts for ten percent of those values. If so, then the value of the environment embedded in Teton County's real estate is $1.35 billion.

Taking it a step further, let's say that efforts to preserve and protect the area's ecosystem are crudely analogous to an insurance policy. If the annual cost of a good homeowner's policy is around 0.5 percent of the improvements (not the land itself), we should be putting around $45 million/year into our stewardship efforts. Which is about eleven times more than we currently spend to support the START bus. Or to promote Jackson Hole through the lodging tax.

$45 million is crazy high, though, so let's say we spend as much each year on the Comp Plan's vision as we spend on lodging tax-related promotions; i.e., around $4 million. Where might that money come from?

One obvious possibility is to dedicate a portion of the county's sales tax revenues to preserving and protecting the area's ecosystem. That way, both residents and tourists would be supporting local stewardship.

Based on FY 2018 figures, one-quarter of one percent of Teton County's taxable sales would produce around $3.8 million per year for preservation and protection. That's close to the lodging tax number. It's also about the amount the Teton Village Association receives each year through its two percent resort district tax.

If these tax-funded stewardship efforts work out well, more public money might be used in the future. Regardless of the amount spent, though, it will be important to leverage local public money by attracting additional funding, whether from private, non-profit, state or federal sources.

5 *Fund the Steps Identified in the Strategic Plan*

Broadly speaking, the money designated in Step 4 should be viewed as an investment in the long-term health of the area's ecosystem, and with it the health of the community and economy. More prosaically, the Step 4 funds would support the Ecosystem Board's strategic plan, with expenditures targeted at research, conservation projects, and public-private partnerships with local non-profits and businesses.

Critically, to truly address the Comp Plan's vision, some portion of the expenditures would have to support work done outside Teton County, Wyoming.

6 *Form Partnerships: Learning, Teaching, Actions*

From a macro perspective, the greatest threat to the Tetons region is homogenization; i.e., becoming viewed as just-not-that-different from other places. Due to a combination of technological advancements and economic pressures, homogenization has long-since washed over America's suburbs, and the barriers insulating the Tetons region from those forces are rapidly eroding.

Only three qualities about any area cannot be readily replicated: landscape; flora and fauna; and character. The character of the Tetons region has been shaped by its landscape, flora, and fauna, and a key part of that character is a reverence for extreme independence and self-reliance. While both are admirable qualities, we need to ask whether they will continue to serve us well as we attempt to do something no other community has ever done, i.e., preserve and protect our ecosystem. The fact that we are even worrying about preserving and protecting our ecosystem suggests that our tradition of self-reliance isn't working. Instead, we need assistance; in particular three different types of partnerships: Learning, Teaching, Actions.

Learning partnerships

The foundation of any successful effort is deep understanding. If we are to successfully preserve and protect the area's ecosystem, one message cutting across the *Mosaic* essays is the need to develop a deep understanding of not just our ecosystem, but how it affects, and is affected by, the people who live in and visit it.

Realistically, developing this understanding is going to require a huge amount of resources and expertise, far beyond those Jackson Hole can, by itself, bring to bear on the subject. Hence we need to forge partnerships with those who have a complementary interest in learning about our region; i.e., academic institutions with not just first-rate research abilities, but a commitment to using them holistically.

Such partnerships should start small. If successful, the goal will be to grow them into efforts that provide the kinds of longitudinal and cross-disciplinary information residents need to better understand the region, and decision-makers need to help guide its future.

"As the town and county attempt something no other community has consciously set out to do, other communities will be eager to learn from us."

Teaching partnerships

From the perspective of a business owner, the residents of the Tetons are potential customers. Ditto the millions of people who visit the region each year.

From the perspective of the Comp Plan's vision, the region's residents and visitors are potential partners. To be effective partners, though, residents and tourists need to understand what the community needs from them. Similarly, local government needs to understand the needs of its residents and visitors, and how those needs intersect with the Comp Plan's vision. In short, there needs to be an active and concerted educational effort.

Because the Town of Jackson and Teton County created the Comp Plan's vision, local government needs to lead the effort to teach and engage residents and visitors. That noted, local government likely doesn't have the skills to devise and run a comprehensive education and outreach effort. What local government can do, though, is set

a goal, use its bully pulpit to convene those needed to achieve that goal, and help fund whatever plans emerge.

There is one final facet to teaching – sharing our experiences with other communities. As the town and county attempt something no other community has consciously set out to do, other communities will be eager to learn from us. And if our efforts succeed, Jackson Hole can become a role model for other regions to emulate. Further, as with any teaching effort, the more we share with others, the more we will learn in return.

Actions partnerships

Arguably, the most audacious quality of the Comp Plan's vision is its regional scope; i.e., looking to preserve and protect the ecosystem in areas over which local government has no authority.

To have any chance of succeeding beyond its jurisdictional boundaries, the Jackson and Teton County governments will have to actively pursue partnerships throughout the region – not just with governmental agencies, but with businesses and non-profits whose actions affect the ecosystem's health.

Here again, our local governments can use their convening power to bring together potential partners. Other regional players will be incented to participate because what Jackson Hole does affects them, and it will be in their self-interest to help shape how Jackson Hole approaches its future.

Of similar significance is that every other local government in the region has less money than the Town Jackson and Teton County, and their constituents have less wealth. If Jackson Hole's governments can parlay their financial resources into helping the region's players address their concerns, this will create a strong incentive for everyone involved to forge stronger regional ties.

7 *Acknowledge Evolutionary Processes*

The essence of the Comp Plan's Vision Statement is its first six words: "Preserve and protect the area's ecosystem..." If we are to be serious about that vision, though, its final two words may be the most critical: "... future generations."

Taking a shorter-term view, we have an ecosystem worth preserving and protecting because of our forebears' conservation efforts. Taking a longer view, those efforts were worth pursuing only because local flora and fauna evolved to thrive in the region's cold, harsh climate and terrain. Therefore, if we are serious about stewarding the area's ecosystem for future generations, we need to ensure we understand those evolutionary processes, and act in ways that complement them.

A critical part of supporting these evolutionary processes is recognizing that, biologically speaking, humans have no business living in a place as inhospitable as Jackson Hole. Yet here we are, in growing numbers and living very well. How is this possible? Because uniquely among all species, to adapt to new conditions, humans don't have to exclusively rely on Darwinian evolution. Instead, our increasingly sophisticated ability to develop and distribute goods and services has allowed us to behaviorally adapt to this cold, remote region.

From a Darwinian perspective, our technology and economy give humans a profound adaptive advantage, one enjoyed by no other species. Specifically, it has freed us from the yoke of Darwinian evolution, in which adaptation is driven by long-term natural selection acting on genetic traits. As a result, the threats to the ecosystem outlined in *Mosaic* do not pose any existential threats to the region's human population – if the climate warms or invasive species arrive in droves, our technology will likely allow those living in or visiting the region to quickly and successfully adapt.

Not so the region's non-human species. Why? Because the threats outlined in *Mosaic's* essays are manifesting themselves far more rapidly than most species can adapt and evolve.

It's taken millennia for local species to successfully adapt to the environment of the Tetons region. Humans are now changing that environment far more rapidly than evolutionary processes can respond. Unless we acknowledge and act on that reality, there is little chance we will leave a healthy, functioning ecosystem for future generations.

8 *Determine Human Carrying Capacity*

In their *Mosaic* essays, several authors either directly or implicitly discussed Jackson Hole's carrying capacity, for both wildlife and humans.

One of Franz Camenzind's points was how, by bringing in food from outside the valley, we have altered Jackson Hole's carrying capacity for both humans and elk. Get rid of those imports, and the region's carrying capacity shrinks dramatically, especially for its human residents and visitors.

Building on this point, a strong case can be made that the fruits of the Industrial Revolution have created a carrying capacity disconnect between species. Humans can modify and adapt to ecosystems in ways no other species can, allowing our numbers to far exceed any given ecosystem's "natural" carrying capacity. Non-human species enjoy no such advantage. For them, adaptation is still linked to generational spans and random genetic mutations.

From this perspective, what the Comp Plan's vision essentially asks us to do is preserve and protect not just the region's landscape, flora, and fauna, but the evolutionary processes that have allowed our ecosystem to develop and flourish. As part of that effort, we need to figure out how many people the region can support – both residents and tourists – while still allowing those processes to occur. Otherwise, we cannot be sure we will meet our goal of preserving and protecting our ecosystem for future generations.

FINAL THOUGHTS

"From everyone who has been given much, much will be demanded; and from the one who has been entrusted with much, much more will be asked."

– Luke 12:48 (New International Version)

Thanks to our forebears, those of us lucky enough to live in the Tetons region have been given much; specifically, an incomparable conservation legacy. We have been entrusted with even more: to build upon that legacy.

By adopting the Comp Plan's Vision Statement, we have chosen to build upon that legacy by preserving and protecting the area's ecosystem, a task that has never been accomplished by any community, region, or nation with an advanced economy. This doesn't mean it's impossible. Instead, it's just something that's never been tried. Just like no one had ever tried to create a national park before Yellowstone's founders did. Or greatly expand a national park by buying adjacent private lands, as John D. Rockefeller did. Or protect over 19 million acres in Alaska, as the Muries helped bring about.

If *Mosaic* is ultimately viewed as a success, it will not be because of the details it shared about the topics it covers – in 16 essays and 96 pages, *Mosaic* cannot pretend to fully explore any of these subjects. Instead, *Mosaic* will be viewed as a success because it helped catalyze the community's pursuit of the Comp Plan's vision, that bold, audacious, challenging, and inspirational 21 word sentence.

By adopting that vision, the current generation of Jackson Hole residents has taken its first step toward leaving a legacy as meaningful and appropriate to our times as our forebears' legacies were to theirs. That we have such an opportunity is extraordinary, a gift enjoyed by few people in few places at few times in history.

The path ahead may seem extreme, but extreme is in keeping with the landscape we embrace, the climate we endure, and the beauty that surrounds us. In short, doing extreme things is an extension of our culture, and it's that culture that knits us together into one community spanning two states and at least three counties.

In adopting the Comp Plan's vision, we've created an extreme challenge for ourselves. Here's hoping we embrace it.

GET INVOLVED.

1% FOR THE TETONS

Mosaic was funded by the members of 1% for the Tetons, a group of businesses passionately dedicated to the long-term sustainability of the Tetons region.

In ten years, 1% for the Tetons' member businesses have granted over $800,000 in critical seed funding to nearly 100 innovative sustainability projects throughout the Tetons region.

Please help 1% for the Tetons's efforts by becoming a member business, making a tax-deductible donation, and supporting the member businesses of 1% for the Tetons.

To join, donate, or learn more about 1% for the Tetons,
please visit OnePercentTetons.org, or phone (307) 733-8687.

Join or donate today.

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1% for the Tetons is a project of the Charture Institute, a Jackson, WY-based 501(c)3 non-profit organization.

LEARN. TEACH. INSPIRE. ACT. FUND.

Charture is a Jackson Hole-based not-for-profit think tank. Charture's mission is to help communities and the environments around them co-thrive; i.e., to simultaneously thrive.

To help communities co-thrive, Charture has developed a variety of projects and programs, including: 1% for the Tetons, 22 in 21, Co-Thrive.Earth, Healthy Business, Healthy Planet, the Jackson Hole Compass, Tetons 2020, and Mosaic.

charture.org
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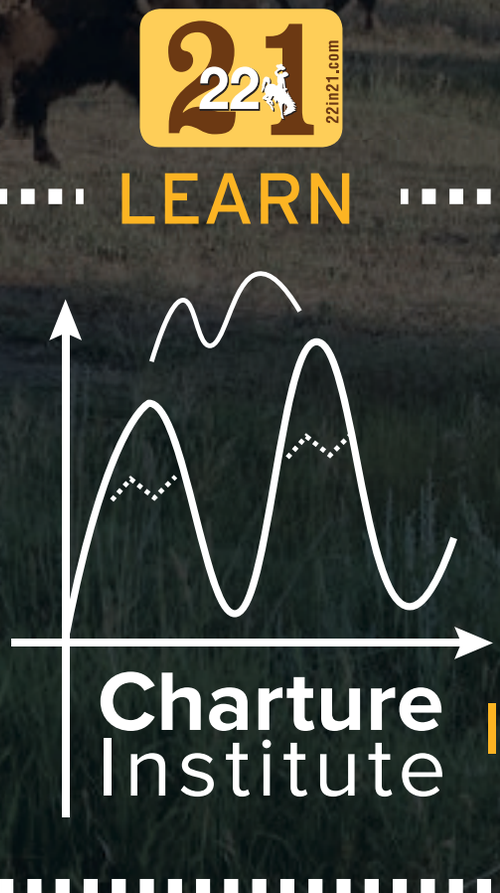

1% FOR THE TETONS

JACKSON HOLE Compass

HBHP
HEALTHY BUSINESS
HEALTHY PLANET

MOSAIC