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Green Gabions

By Alan Klatt, NMED SWQB - Restoration and Implementation Team Supervisor

Green gabions are an effective and efficient way to incorporate bio-engineering concepts into bank stabilization projects. Gabions are rock-filled wire baskets that are commonly used as retaining walls in landscaping projects, and they are also commonly used in New Mexico to armor and stabilize stream banks. Willow branches can easily grow from cuttings and can quickly transform a mesh of wire and rock into something that more closely resembles a natural stream bank, providing habitat and water quality filtering benefits.

In writing this short article, I quickly reviewed Surface Water Quality Bureau's list of Total Maximum Daily Loads (https://www.env.nm.gov/surface-water-quality/tmdl/), and essentially every TMDL lists stream bank modification, habitat modification, or loss/removal of riparian vegetation as one of the probable pollutant sources contributing to the Clean Water Act Section 303(d) impairment listing. The 303(d) listing signifies one or more designated uses (e.g. aquatic life, wildlife habitat, primary contact, livestock watering), and associated water quality standard, is not supported by current water quality conditions.

Bank stabilization projects will be inevitable as long as rivers continue to flow and meander, as they always have, transporting water and sediment from the mountains to the seas - conflicts between property and infrastructure will also continue to arise. These conflicts do not necessarily need to negatively impact our water resources. It is possible to design with nature, preferably avoiding ga-

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bions altogether as wire mesh is known to injure aquatic life and wildlife, but when gabions are needed, incorporating riparian plantings and installing green gabions will help retain greater stream function and help protect water quality. *Did I mention that bioengineered designs may also be cheaper, require less maintenance, and last longer?*

For additional information on bioengineering and bank stabilization solutions take a look at:

- USDA-NRCS (1996). Engineering Field Handbook, Chapter 16 Streambank and Shoreline Protection.
- USDOI-BOR (2015). Bank Stabilization Design Guidelines, Report No.: SRH-2015-25.

or contact **Alan Klatt**, NMED-SWQB-Restoration and Implementation Team.

Rio Embudo, looking upstream near Dixon, February 20, 2020 with newly planted willow stakes along the base of the gabion wall (left) and September 3, 2021 with fully established willows after two growing seasons (right).

Carbon Sequestration in Montane Wetlands – A Review for New Mexico

By Abe Franklin, Program Manager, Watershed Protection Section

For programs in New Mexico that support riparian and wetlands restoration, the potential benefits of restoration projects towards mitigating climate change through carbon sequestration should be considered along with other costs and benefits. This article provides an introduction to the topic of carbon sequestration in New Mexico montane wetlands, or wetlands similar to ours, associated with restoration efforts, changes in management practices, or protection and provides some comparisons among types of projects and ecosystems.

The first major caveat to be mindful of when evaluating the potential for our wetlands and riparian areas to sequester carbon is that freshwater wetlands can naturally emit carbon dioxide as well as methane and nitrous oxide – more powerful greenhouse gasses than carbon dioxide that may counter benefits of carbon sequestration. Kayranli and others (2010) reviewed carbon storage and fluxes (movement in or out of an ecosystem component) within natural and constructed freshwater wetlands. Wetlands worldwide are almost universally net methane emitters. But wetlands are also net carbon accumulators. Flooded wetlands generally sequester carbon dioxide from the atmosphere but release methane. Oxygen availability and lower temperatures typically reduce methane emissions. Villa and Bernal (2018) provide an encouraging review of wetlands as carbon accumulators – they reviewed 110 studies from around the world – but note that methane emissions hinder the ability of many freshwater wetlands to function as net carbon sinks. In the end, both of these review articles do not support a generalizable conclusion that wetlands or wetland restoration help reduce greenhouse gasses in the atmosphere.

Yarnell and others (2020) measured daily fluxes of carbon dioxide, methane, and nitrous oxide over four years in a montane meadow system in California's Sierra Nevada. Two control plots were examined – one populated by beaver (where use or avoidance by cattle was not mentioned), and one grazed by domestic livestock and without beaver. Two treated plots were examined – one fenced to exclude livestock, and one with constructed beaver dam analogs (BDAs) and livestock exclusion. They provided fluxes for the three gasses separately and in combination, using 100-year warming potential factors of 25 for methane and 298 for nitrous oxide, expressed as carbon dioxide equivalents per square meter (CO_2-C eq/m^2) per unit time. Greenhouse gas emissions or sequestration in the beaver reach were not significantly different from zero. The reach with BDAs and fencing showed net sequestration of about 100 grams CO_2-C eq/m^2 per growing season, while the treatment with only livestock exclusion showed net emissions or storage not significantly different from zero. The grazed plots showed net emissions of about 400 grams CO_2-C eq/m^2 per growing season, about twenty percent of which was attributed to methane. The difference between grazed and fenced treatments resulted in a shift towards net storage of about 430 grams CO_2-C eq/m^2 per growing season. The BDA treatment resulted in a net storage effect of about 70 grams CO_2-C eq/m^2 per growing season. The combined effect of the two treatments was a net storage of about 500 grams CO_2-C eq/m^2 per growing season, with 86% of that effect attributable to the fence preventing grazing, and 14% attributable to the hydrologic effects of the BDAs.

While this sounds very encouraging, in part because those meadows in the Sierra Nevada may not be very different from New Mexico's montane wetlands, Yarnell and others collected data for only four or five years post-project, and may have documented a primarily short-term increase in biomass, and such increase would be expected to plateau at some point and annual carbon storage might decline.

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Figure 1: A Sierra Nevada Meadow studied by Yarnell and others (2020).

Reed and others (2021) addressed this question somewhat in their article, "*Montane Meadows: A Soil Carbon Sink or Source?*," in which they studied thirteen Sierra Nevada wetlands prior to restoration projects being implemented in some of them. They examined carbon dioxide and methane flux, above and below ground biomass, and soil carbon stocks. Before restoration, they observed that three meadows gained carbon at rates ranging from 371.4 to 847.7 grams per square meter per year, while the other ten meadows lost between 238.7 and 544.5 grams of carbon per square meter per year. Only five of the thirteen meadows were net sources of methane, emitting 0.04 to 4.8 grams of methane per square meter per year, and methane accounted for less than 0.6% of total soil carbon losses. Soils in the other eight meadows were small net sinks of atmospheric methane.

The ten meadows that were net sources of carbon scored lower (i.e., worse) on metrics associated with meadow disturbance. Differences in metrics were significant for root biomass, percent bare ground, depth to groundwater, and percent vegetation made up of obligate and facultative wetland species.

How do wetlands and riparian areas rate in carbon sequestration potential, compared with other ecosystems or parts of the landscape? Reed and others (2021) noted that their measurements from the three meadows that gained carbon exceed sequestration rates measured in evergreen tropical forests and tropical peatlands, two ecosystems considered to have very high carbon sequestration rates. They also compared their meadows with cited results from adjacent forests, which ranged from -0.47 to 153 grams of carbon sequestered per square meter per year, with potential for carbon losses following wildfire, drought, and thinning.

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Wohl (2013) estimated the volume and percent total organic carbon (TOC) in sediments within meadows formed by beavers, within twenty-seven watersheds in Rocky Mountain National Park. The analysis demonstrated that relative to their small proportion of the landscape, these meadows store a large percentage of the carbon in that landscape. Soils in relict beaver meadows averaged 3.3% TOC, and soils in active beaver meadows averaged 12% TOC. Soils in upland forests in the region (which are not as deep as those in meadows) had been estimated in an earlier study to average 7.3% TOC. The results suggest that beaver meadows store 8 to 23% of the soil carbon within the studied landscape, with more storage in areas with active beaver meadows.

Schuman and others (2002) in summarizing relevant field research estimated that improved management of poorly managed western North American grasslands could result in sequestration of around 10 grams per square meter per year. While much lower than some of the numbers cited above for montane meadows, the vast acreage of grasslands in New Mexico suggest that their carbon sequestration potential may be very important. The authors note however that the carbon sequestered in grassland soils will approach a maximum level determined by their new management regime within a few years.

Euliss and others (2006) compared carbon sequestration potential in the prairie pothole region with that of no-till agriculture in the same area, and concluded that “Wetlands can sequester over twice the organic carbon as no-till cropland on only about 17% of the total land area in the region.” They also estimated that wetland restoration has potential to offset 2.4% of the annual fossil carbon dioxide emissions reported for North America in 1990. Admittedly, the prairie pothole region is far from New Mexico, but the results may be partly applicable to New Mexico’s southern high plains playa region or our higher-altitude playas in northeastern and west-central New Mexico.

A little bit closer to home, Li and others (2017) examined carbon sequestration in semi-arid grasslands of the southern high plains in West Texas. They focused on rangelands enrolled in the Conservation Reserve Program (CRP), in which cropland has been restored to grassland. They concluded that soil organic carbon in the first 30 centimeters of restored grassland soil was sequestered at a rate of about 13.29 grams per square meter per year. Measured carbon fluxes indicated that carbon sequestration rates were sustained even after twenty-six years of management under the CRP.

Taken together, the findings summarized in this article demonstrate the importance of healthy montane meadows as significant carbon sinks within their landscapes, and provide some evidence that methane emissions are less of a concern in healthy montane meadows than in other types of wetlands. Reed and others (2021) also highlighted that degraded montane wetlands are *sources* of atmospheric carbon.

What did we miss?

The editors hope that this article has provided some useful and inspiring information, but we recognize that major aspects of carbon sequestration in riparian areas and wetlands may have been omitted. We could have included information on (or noted lack of information) on carbon sequestration potential of cottonwood bosque. We could have added information on the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* and *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands,* key documents (with associated software) used in carbon accounting and credit programs. And we could have added information on our own state’s climate mitigation efforts (https://www.climateaction.nm.gov). We invite additional articles on these topics, or comments and corrections on this article, for future issues of *Clearing the Waters.*

UPDATE FROM THE MONITORING, ASSESSMENT AND STANDARDS SECTION

Monitoring Team News

In 2021, the monitoring team sampled in the Jemez (42 monitoring stations), Lower Pecos (53 stations), Rio Puerco, Rio San Jose and Little Colorado (30 stations) watersheds. They completed approximately 90 to 95% of the work that was planned for the 2021 sampling year. Field sampling plans can be seen on the SWQB website; https://www.env.nm.gov/surface-water-quality/water-quality-monitoring/.

Probabilistic Monitoring is the collection of data from randomly selected stations to provide an unbiased regional or statewide characterization of water resources with a known degree of statistical confidence. Probabilistic Monitoring data has many applications, including:

- Enabling broad regional assessments of overall ambient conditions.
- Establishing baseline water quality conditions.
- Identifying problem areas for follow-up monitoring.

During the index period, the Monitoring Team completed sampling at all 30 stations for the 2021 MASS Probabilistic Monitoring Survey. Dry streams, low lake levels, vehicle issues, COVID pandemic, staffing, and difficulties in procuring supplies provided challenges to completing the field work.

Probabilistic monitoring by SWQB staff Kris Barrios and Eliza Martinez on San Antonio Creek below the hot springs.

Water Quality Standards Team News

The SWQB participated as Petitioner in hearing proceedings for the State's Triennial Review (TR) of the Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC). The hearing was the culmination of a multi-year endeavor to propose amendments to the State's *Standards for Interstate and Intrastate Surface Waters*. It spanned five days (July 13-16, and 21, 2021). Links to TR testimony and exhibits are posted on the Water Quality Control Commission (WQCC) webpage. The WQCC has

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scheduled deliberation of the TR during a public meeting to be held March 1-3, 2022. For more information visit the WQCC web page; https://www.env.nm.gov/water-quality-control-commission/wqcc-14-05-r/.

The Standards Team has also been working with several outside parties pursuing proposed amendments to the standards. Some of the proposed amendments are to designated uses for particular classified waters, site-specific criteria, and several waterbody nominations for designation as an Outstanding National Resource Water.

Our Quality Assurance Officer has updated the SWQB's "Quality Assurance Project Plan for Water Quality Management Programs" (QAPP) and submitted it to EPA for review and approval. In addition, several Standard Operating Procedures (SOPs) associated with work done through the Bureau's programs have been updated recently. The Bureau's most recent updated SOPs and QAPP are on line at https://www.env.nm.gov/surface-water-quality/monitoring-assessment-and-standards-section/.

TMDL/Assessment Team News

The Comprehensive Assessment and Listing Methodology (CALM) explains how the SWQB evaluates existing and readily available surface water quality data and other information to determine whether or not surface water quality standards are being attained. The CALM is revised every other year. SWQB received five sets of public comments on the CALM, which were incorporated as appropriate, and the Final CALM is now available online at https://www.env.nm.gov/surface-water-quality/calm/.

The public comment period closed January 14 on the *2022-2024 Clean Water Act §303(d)/305(b) Integrated Report*. We received 12 water quality datasets from stakeholder groups and assessed the stakeholder data plus SWQB data from the 2019-2020 Gila/San Francisco/Mimbres, Lower Rio Grande, and Upper Pecos watersheds. SWQB is currently responding to comments. The Water Quality Control Commission (WQCC) has scheduled consideration of the approval of the Integrated List at its March 8, 2022 meeting.

Total Maximum Daily Loads (TMDLs) were presented to the WQCC for Bluewater Lake (plant nutrients impairment) and the Jemez River watershed (various impairments) on August 10. Both TMDLs were approved by the WQCC. The final TMDL reports can be accessed from the SWQB website at https://www.env.nm.gov/surface-water-quality/tmdl/.

A report including new TMDLs for the Upper Rio Grande basin will be released for public comment during spring of 2022. TMDLs can lead to new or revised National Pollutant Discharge Elimination System permit limits, and inform stakeholders and watershed planning and restoration efforts.

A peer-reviewed article describing New Mexico's biologic condition gradient model for benthic macroinvertebrates and fish communities in southwestern rivers was published in *River Research and Applications* (http://doi.org/10.1002/rra.3929). The Bureau intends to use this model as a tool to assess the attainment of the state's narrative water quality standard for biological integrity in larger rivers such as the Rio Grande.

EVENTS & ANNOUNCEMENTS

February

February 23rd - 25th - Silver City. Natural History of the Gila Symposium IX - Sharing the natural beauty, research, and resources of New Mexico since 2006. The Natural History of the Gila Symposium's mission is to provide a venue for researchers, land managers, conservationists, and educators to meet and share information and ideas gathered from the Gila Region including watersheds and neighboring areas extending into southwestern New Mexico, southeastern Arizona and Mexico. Presentations and field trips will be posted. Partners for this symposium include: Western New Mexico University, United States Forest Service, Native Plant Society of New Mexico – Gila Chapter, Bureau of Land Management, the Audubon Society (Southwestern New Mexico Chapter), and the Western Institute of Lifelong Learning. Everyone may attend the Natural History of the Gila Symposium FREE OF CHARGE. For more information please visit; http://wnmu.edu/gilasymposium/.

February 25th - 26th - hybrid in person + virtual event. *Rio Chama Watershed Congreso 2022: THE FUTURE OF SNOW + WATER IN A CHANGING CLIMATE*. The 7th Annual Rio Chama Congreso is the San Juan - Chama Watershed Partnership's capstone event. Each year we focus on a natural resource related theme that impacts the Rio Chama watershed. This year's theme is snow & water in our changing climate. We strive to provide sound information on environmental issues including balanced perspectives on difficult problems. The event (and the Partnership) is open to everyone, including landowners, agency managers, nonprofit organizations, students, and residents. For our most current agenda of events as well as detailed session and presentation information, please visit Congreso landing page at : https://www.sanjuanchama.org/rio-chama-congreso-2022. Registration information will be provided in your registration confirmation email.

January-October 2022 - Solitude Monitoring in the Sabinoso, Cerro Del Yuta, and Rio San Antonio Wilderness Areas. Do you like hiking and want to volunteer to help our Public Lands? NM Wild is seeking volunteers to collect data on visitor use in these BLM Wilderness areas. This data informs us on the level of use in each of these areas, which is key to better management. Volunteers must complete a 30-minute phone training with NM Wild's Wilderness Rangers. Email will@nmwild.org to sign up or visit https://www.nmwild.org/event/solitude-monitoring-in-the-sabinoso-cerro-del-yuta-and-rio-san-antonio-wilderness-areas/.