FINAL REPORT

American Southwest Carbon Marketplace Workgroup

Spring 2023

The Biophilia Foundation

biophiliafoundation.org

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List of Acronyms

- ASCMW: American Southwest Carbon Marketplace Workgroup
- BDA: beaver dam analog
- C / CO_2: carbon / carbon dioxide
- DBH: diameter at breast height, a standard measurement practice for tree size
- LTPBR: Low-tech, process-based restoration
- Mg: megagram, equivalent to one metric tonne
- NCEAS: National Center for Ecological Analysis and Synthesis
- PBR: Process-based restoration
- tCO_2e: tonnes of carbon dioxide equivalent, the unit of measurement for most carbon credits

List of Hyperlinks

- Biophilia Foundation: www.biophiliafoundation.org
- CREEC documentation: https://creec.conservation.ca.gov/app/about
- CREEC tool: https://creec.conservation.ca.gov
- Dr. Ellen Wohl, Colorado State University: https://sites.warnercnr.colostate.edu/ellenwohl/
- Research by Dr. Ellen Wohl on riverine carbon: https://sites.warnercnr.colostate.edu/carbon/
- Utah Implementation of the Riparian Recovery Potential analysis: https://rcat.riverscapes.net/UtahImplementation
- Utah's Watershed Restoration Initiative: http://wri.utah.gov/

See also: References, page 22

Final Report of the American Southwest Carbon Marketplace Workgroup

The American Southwest Carbon Marketplace Workgroup (ASCMW) met from fall 2021 to fall 2022 to identify a carbon credit mechanism to fund riverscape restoration at scale in the arid southwestern US. This report provides an overview of ASCMW findings and advice for others involved in riparian carbon sequestration projects.

Introduction and Background

The goal of the workgroup was to identify a pathway to earn carbon credits for process-based riparian restoration in the arid Southwest US. Process-based restoration (PBR)[1] is a set of techniques that aim to reestablish the physical, chemical, and biological processes that create and sustain river and floodplain ecosystems. These processes include erosion and deposition, channel migration, and growth and succession of riparian vegetation. In general, process-based methods are more cost-effective than engineered approaches, and, if coupled with removal of harmful influences, they can stimulate self-sustaining restoration. In addition to the numerous biodiversity, hydrology, and resilience benefits, restoration can also sequester carbon. These benefits led Dr. Richard Pritzlaff, Chair of the Biophilia Foundation, to convene the ASCMW workgroup to discuss the state of knowledge of carbon credits for riparian restoration and identify a path to carbon finance for PBR.

Delivering a practical and efficient carbon credit mechanism for stream and watershed restoration requires scientific knowledge, practical experience, and advocacy. To bring these elements together, the Biophilia Foundation brought together researchers, restoration practitioners, and policy experts from Utah, Colorado, Arizona, and New Mexico. Participants included:

- Gita Bodner, The Nature Conservancy of Arizona
- Greg Costello, Wildlands Network

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[1] Also referred to as low-tech, process-based restoration (LTPBR)

- Jennifer Gooden, Biophilia Foundation
- Kris Hulvey, Working Lands Conservation
- Aaron Lien, University of Arizona
- Todd Lopez, Rio Grande Return
- Bre Owens, Western Landowners Alliance
- Richard Pritzlaff, Biophilia Foundation
- Nicole Rosmarino, Southern Plains Land Trust
- Rose Smith, Sageland Collaborative

In 2021, the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara accepted ASCMW as a project. The workgroup met at NCEAS for its first two meetings, utilizing the NCEAS facility to work on questions of science, practice, policy, finance, and governance of carbon credits. The workgroup held its final two meetings in Santa Fe and Park City in order to view on-the-ground examples of process-based restoration implemented by workgroup participants.

Information about the American Southwest Carbon Marketplace Workgroup and the Biophilia Foundation is available at www.biophiliafoundation.org.

Questions Addressed by the Workgroup

To identify the best way to earn carbon credits for process-based riparian restoration in the Southwest, the workgroup sought answers to questions addressing social, ecological, policy, and governance aspects of carbon credit generation. Information that may be useful for others is summarized here. Note that this information is based on the professional opinions of ASCMW members and is not intended to be definitive.

How much carbon is stored in dryland riparian areas and in what pools?

Several researchers have looked at the amount of carbon stored in riparian systems. An excellent source is Dr. Ellen Wohl at Colorado State University's Warner College of Natural Resources, who conducts research on riverine carbon. Sutfin, Wohl, and Dwire (2016) provide the following estimates of the primary carbon reservoirs in riparian areas. Estimated ranges are large due to a variety of biogeographic factors. Carbon reservoirs in rivers include:

- Above- and below-ground standing biomass (riparian vegetation): 7 to 2794 Mg C / ha
- Large in-stream and downed wood: 1.7 to 2500 Mg C / ha
- Sediment on floodplain surface and subsurface, including soil organic carbon, litter, and humus: 1.4 to 7735 Mg C / ha
- In-stream biomass, including filamentous algae, periphyton, benthic invertebrates, fish, and particulate organic matter: 0.2 to 4.8 Mg C / ha

In addition, ASCMW workgroup member Kris Hulvey and her team at Working Lands Conservation conducted a literature review to identify how much carbon was found in various carbon pools across multiple studies. They used a range of search terms in Google Scholar to locate papers that might contain relevant data (BOX 1), and then examined the bibliographies of these initial papers to find additional literature.

Box 1: Search Terms
• stream restoration carbon sequestration • stream restoration carbon storage • carbon sequestration streams • carbon storage streams • soil carbon sequestration streams • soil carbon storage streams • semiarid riparian soil carbon

Over 1300 papers were initially identified. They narrowed the literature pool to approximately 100 papers using title, abstract, and whole paper content. Inclusion criteria included data on carbon in one of the following pools: trees, soils, in-stream soils, in-stream wood, floodplain wood, or shrubs. Papers also needed to provide data in one of the following formats: percent of organic carbon in soils (%OC), organic carbon stocks (e.g., Mg/ha or convertible unit), or rate of organic carbon sequestration (Mg/ha/time or convertible unit). Last, they chose papers that presented data from target biomes (Box 2), which narrowed the final number of papers to approximately 40, with 293 lines of data that could be analyzed. Relevant to the goals of this working group, there was a notable gap of studies located in the southwestern United States (Dybala et al., 2019).

Box 2: Target Biomes	
Deserts and xeric shrublands	3 studies
Mediterranean forests & woodlands	3 studies
Temperate coniferous forests	12 studies
Temperate grasslands, savanna & shrubland	12 studies
Temperate broadleaf & mixed forests (this served as an example of a biome that we hypothesized would sequester carbon more quickly due to wetter conditions)	12 studies

Some broad conclusions from examining basic graphs of data include the following:

- Most research has occurred in the floodplain, with few studies focused in the active channel or on the upper bank.
- Carbon pool stock size varied very widely among studies. Carbon stocks were roughly similar between soils and tree biomass in all biomes except temperate coniferous forests, where soils had 3 times more carbon than that found in tree biomass.
- Rates of sequestration appear to be fastest in temperate broadleaf and mixed forests, followed by temperate grasslands, savannas, and shrublands. Rates of sequestration are lower, and similar, within temperate coniferous forests and deserts and xeric shrublands.

Dr. Hulvey's team is preparing a journal article for publication.

What additional research is needed?

Research on carbon in riparian areas is in its early stages. Much more information is needed about where and how much carbon is stored in trees, understory vegetation, litter, deadwood, and soils. Of the limited research available, little was conducted in arid or semi-arid regions, where riparian restoration can have outsized impacts on wildlife, and this gap is an urgent priority. We also need more information about the anticipated carbon response to various restoration measures, including pace of carbon accumulation and stability of the carbon stocks.

How does process-based riparian restoration affect carbon sequestration?

Little information about the impacts of restoration on riparian carbon stocks has been documented in the peer-reviewed literature. Dr. Sarah Hinshaw conducted a literature review of floodplain carbon stocks and two case study carbon stock assessments along the South Fork of the McKenzie River and Deep Creek in Oregon, in an ecosystem that has some similarities with the southwestern US (Hinshaw and Wohl, 2021). This study found significantly higher soil organic carbon and large woody debris stocks in restored reaches of both rivers' floodplains, as compared with degraded (i.e., non-restored) reaches. The total difference in organic carbon stocks (soil and wood) were also higher in both rivers' treated sites (528 and 500 Mg C / ha) compared with associated degraded sites (437 and 225 Mg C / ha respectively).

In addition, Dr. Hinshaw's doctoral thesis included carbon stock estimates from floodplains along grouped restored, degraded, and reference reaches of eight additional process-based restoration sites (Hinshaw, 2022). Reference reaches, when available, represented sections of streams that were deemed fully functional within the same stream/river system. Three of these restored / degraded / reference comparisons were located along beaver dam analog (BDA) projects in Park City, Utah (FIGURE 1), with the remainder a mixture of BDAs and 'stage zero' sites (Cluer and Thorne, 2014) in Oregon and Colorado.

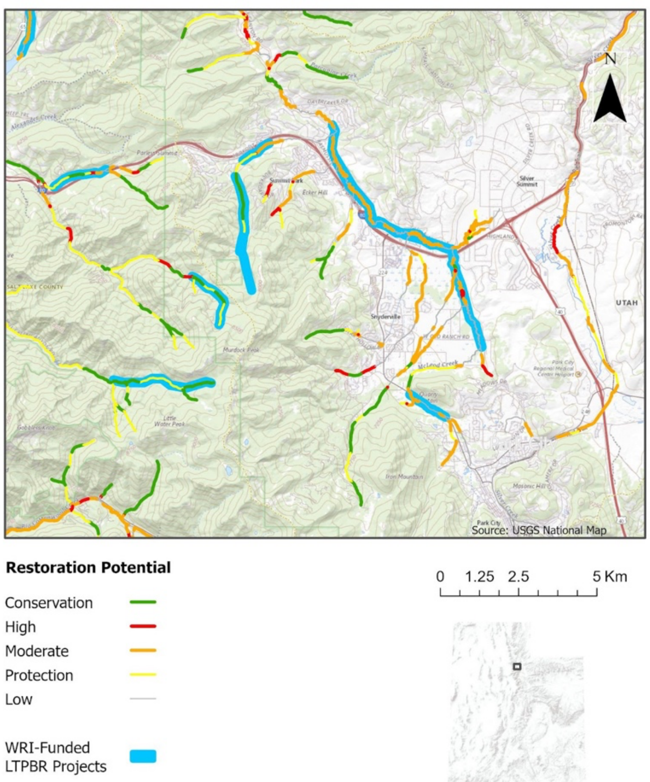

FIGURE 1. Example of Park City projects with restoration projects occurring on streams with recovery potential characterized as moderate, conservation, and protection.

Results showed that overall, soil organic carbon stocks did not differ significantly in degraded vs. treated sites. Reference sites did, however, have significantly higher soil organic carbon content than either restored or degraded sites (Hinshaw, 2022, see fig. 4.2 and 4.3).

Beyond these publications, practitioners of process-based restoration have observed increases in woody and herbaceous vegetation, suggesting that further research is warranted.

What data and modeling products support decision-making?

Currently, there are several data products that can support decision making. Dr. Rose Smith with Sageland Collaborative, a partner in ASCMW, extracted data from Utah's Watershed Restoration Initiative database for all completed, current and proposed LTPBR projects across Utah since the inception of the program (FIGURE 2).

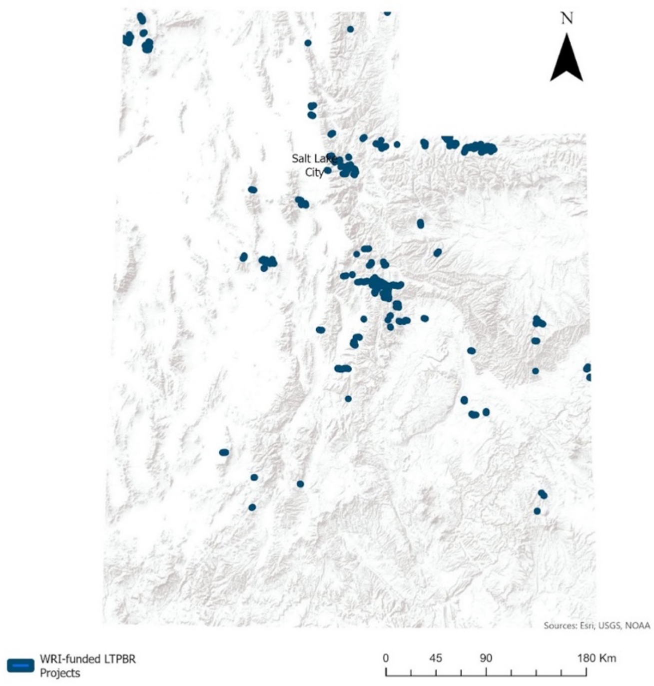

FIGURE 2. Comprehensive map of LTPBR projects funded by Utah's Watershed Restoration Initiative as of 2022.

This curated dataset is being used in a story map (forthcoming, 2023). Dr. Smith overlaid this stream restoration dataset with existing modeled 'riparian recovery potential,' which was prepared by Utah State University researchers using historic and current vegetation indices, geomorphology, and land cover datasets. The Utah Implementation of the Riparian Recovery Potential analysis datasets are useful for future project planning and prioritizing restoration sites with carbon sequestration in mind.

The recovery potential tool categorizes stream reaches with several categories. The 'Conservation' category corresponds to stream reaches with intact vegetation that appear relatively undisturbed. The 'Protection' category corresponds to streams that are in moderate to good condition but may require maintenance. Moderate and high recovery potential correspond to the varying degrees of degradation (i.e., a vegetation community that has departed from historic) and the degree to which the river's historic floodplain is open or 'available' for reconnection (FIGURE 3). Low recovery potential corresponds to low-elevation, often urbanized areas.

In addition, Dr. Virginia Matzek of Santa Clara University has created an online tool, the Carbon in Riparian Ecosystems Estimator for California (CREEC), to calculate the impact of stream restoration in various California ecosystems. The tool and its documentation are freely available online.

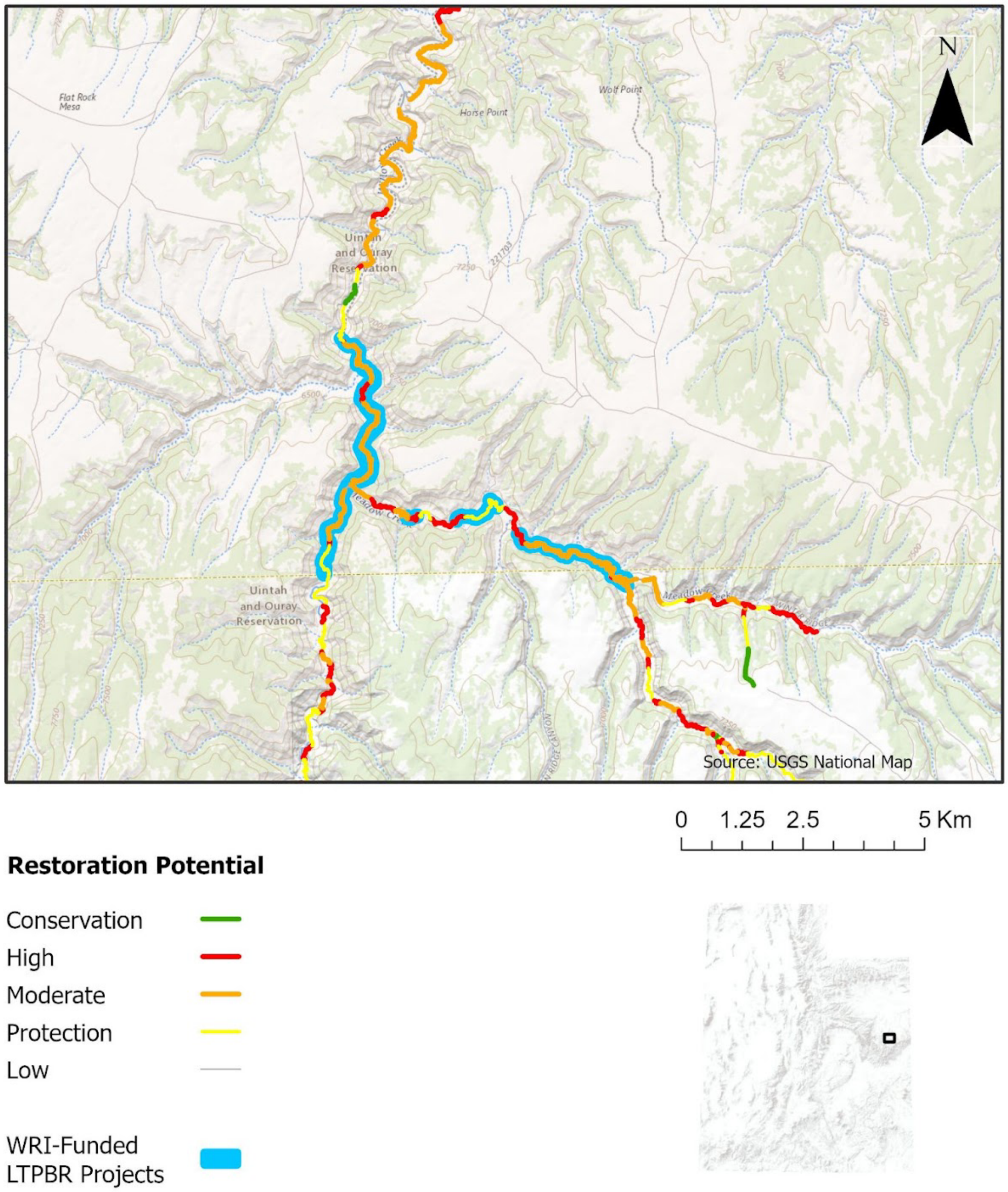

FIGURE 3. Example of restoration projects in the Book Cliffs, or Tavaputs plateau, of east-central Utah, which are characterized as moderate to high recovery potential.

Can carbon credits pay for riparian restoration?

At the conclusion of ASCMW (fall 2022), carbon credits for high quality NbS projects with co-benefits were worth $15-30 per tCO_2e. At this price, carbon credits are insufficient to pay for riparian restoration projects, even when using cost-effective restoration methods such as beaver dam analogs. Currently, for soil carbon projects, a price of $20/tonne is unlikely to cover the cost of soil sampling required by the carbon registry, as the cost of soil sample collection and processing remains high.

However, some ASCMW partners are considering a pilot project because the price of carbon credits is projected to increase significantly in the future. Within five years, the price may be sufficient to pay for ongoing project maintenance. In addition, there is currently grant funding from government and private sources for riparian restoration work, which may cover the cost of restoration activities, soil sampling, and other expenses necessary to develop carbon projects and therefore result in a greater net to the project owner. As an illustration, a restoration project with grant funding for riparian restoration could register for carbon credits prior to implementation. As the project area accrued carbon over the first ten years, the credits could be sold to fund structure maintenance. Alternatively, the anticipated credits could be forward sold to pay for part of the initial installation costs, supplemented by funding from other sources. This scenario may be possible under some registries but not others, depending on their approach to additionality.

Changes in carbon stocks in response to restoration vary by climate, ecosystem, and intervention, but in general we think that projects with an increase in woody vegetation are more likely to benefit from carbon finance in the near term. This is because baseline assessment and monitoring expenses are often lower for tree carbon than soil carbon. At this point in time, there is also some indication that buyers may be more comfortable buying credits for carbon stored in trees than soils, due to the longer track record of tree carbon projects and the greater amount of data. However, there is increasing concern about the instability of forest carbon projects due to forest fire, a concern that is less important to soil and grassland projects, where carbon is stored underground. In the future, carbon credits that cover a range of carbon stocks, diversifying the investment, may be seen as a more stable and durable carbon product.

What registries and protocols are applicable to process-based riparian restoration?

We evaluated multiple protocols as part of the ASCMW project. The initial step was a review conducted by the consulting firm Carbonomics, which recommended the Gold Standard's Afforestation and Reforestation Methodology and Verra's VM0042 Methodology for Improved Agricultural Land Management as starting points. Another possibility is BCarbon's soil protocol, which shares some similarities with others (e.g., Verra VM0032). However, BCarbon differs in its fee structure and approach to permanence. Only soil carbon is included in the protocol, but BCarbon has recently released a forestry protocol, which could be stacked with the soil protocol for sites that project an increase in woody vegetation.[2]

How should one choose a registry and protocol?

We advise others to consider the following factors when selecting a registry:

- **Relevance**, or the ability to account for changes in carbon stocks in the project. First, the project developer must estimate how much carbon is likely to accrue in which stocks (trees, soil, etc.) as a result of the restoration project. With this information, it is possible to compare protocols to see what stocks count toward credits. For example, the BCarbon Soil Protocol includes only soil carbon, but American Carbon Registry's Afforestation and Reforestation of Degraded Lands protocol includes carbon in soil, deadwood, trees, and litter.

- **Eligibility**. Some protocols apply only to specific geographic areas or exclude some governance types (e.g., federal land). Other eligibility criteria could include minimum project size or ecosystem type. Note that many protocols specifically exclude drainage channels.

- **Fees**. Fees and fee structures vary significantly across registries. Some charge on a per-tonne basis, while others have a mix of flat and per-tonne

[2] See page 17 for more information about stacking credits.

fees. Bigger or smaller projects will find that one or another fee structure is more favorable for their needs.

- **Principles**. Registries have different approaches to additionality and permanence. Regarding additionality, some registries are very strict, requiring evidence that the carbon would not have been sequestered without the carbon credit funding, a provision that may exclude conservation nonprofits if funding could be found elsewhere. Regarding permanence, some registries have permanence requirements (e.g., 100 years) that can discourage private landowners. Others can be lax, introducing a risk of greenwashing or meaningless credits. Project developers must find the right balance of rigor and practicality for the project.

- **Complexity**. Carbon credit projects are often complex, requiring multiple partners to achieve. Often, an external project developer, serving as the driver and central coordinator of the project, may be necessary or desired. In other cases, enthusiastic and motivated nonprofits or landowners may choose to fulfill the project developer role themselves.[3]

- **Measurement and monitoring**. Baseline and ongoing carbon measurement require skills and effort. Does the protocol require soil stratification and lab testing of soil samples? Transects and DBH measurements? Or will data entry in a spreadsheet suffice? Whatever is needed, the project must consider where to find these resources and how much they will cost.

- **Timeline**. Each registry has its own process for taking an enquiry through the application, implementation, verification, and certification processes, and various combinations of registry staff, project developers, and affiliated or unaffiliated third-party service providers are involved. Ask about the anticipated timeline for each step in the process and whether there are bottlenecks in service availability.

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[3] See page 20 for more information about roles and responsibilities.

- **Reputation**. Check out rankings, such as CarbonPlan (carbonplan.org) to learn how registries measure up.

Are there places that carbon credits cannot be used?

Some government programs, such as the Environmental Quality Incentives Program, Conservation Stewardship Program, Continuous Conservation Reserve Program, and Wildlife Habitat Incentive Program, administered by the USDA Natural Resources Conservation Service, are unclear on whether USDA payments and carbon offset payments may be stacked (see below for more information about stacking). Enrollment in such programs should be disclosed to registries as part of project enrollment and subsequent verification to determine whether the project meets the registry's additionality tests.

In addition, federal agencies have not determined whether they will permit the issuance of carbon credits for carbon stored on federal lands. We understand there is some movement to change this. ASCMW recommends that, if carbon credits are authorized on federal lands, that carbon credit revenue be restricted to use for land stewardship, not allocated to the general Treasury.

Can multiple carbon credit programs be used on the same land?

There are two types of stacking: combining two different carbon credit programs and combining carbon credits with payments for other ecosystem services.

When stacking two carbon credit programs, the guiding principle is 'no double dipping.' This means that a project cannot be registered for two programs that both provide credits for the same carbon stock in a given area. However, the same piece of land may be permitted enrollment in two different carbon credit programs if they cover different stocks of carbon. For example, a property could be enrolled in both soil carbon and tree carbon programs, as long as there is no overlap in carbon stocks. This is at the discretion of the registries; some registries permit and others prohibit the sale of additional credits on land for which any carbon credit has already been issued.

Carbon sequestration is but one ecosystem service provided by riparian restoration. Others include (but are not limited to) increased functionality of the water cycle and improved habitat for biodiversity. In theory, these other ecosystem services should also be monetizable or commodifiable. In practice, there has been little development of other payments for ecosystem services, but efforts are underway. Some registries are exploring options for creating a 'multi ecosystem service' credit that would bundle valuation of various ecosystem services into a single crediting system. If this is of interest for a particular project, query registries to find out whether there are any prohibitions on payments for multiple ecosystem services.

Did ASCMW encounter any unanticipated issues?

We found that communication with most carbon registries required patience. Enquires went unanswered, and the responses we did receive were often very delayed. We believe that the reasons for this are i) staff issues at the registries, where the pressures of a rapidly growing industry have led to competition between the nonprofit registries and for-profit carbon industry, and ii) registries' views on riparian carbon in drylands, which may have been a lower priority than other projects because of the lack of published data on carbon in riparian areas.

Some ASCMW participants have experienced bottlenecks in the verification process, with too few verifiers to meet demand. We advise those managing projects to ask about the availability of verifiers when selecting a registry.

What skills/roles are needed in a carbon credit project?

One of the decisions to be made is whether a third-party project developer is needed. Project developers create the financial model, liaise with the registry, serve as the official applicant, work with verifiers to obtain issuance of the carbon credits, and bear responsibility for compliance. External project developers' expertise can make the carbon credit process faster and easier, but they charge a fee or percentage of profits in exchange for their services. This fee will typically be 10% of gross receipts or higher. Alternatively, this role can be filled by the landowner, nonprofit, or other entity, depending on the complexity of the protocol and the partners' comfort with the skills necessary to steward the carbon credit process.

Function	Potential Responsible Entities
Fee ownership and legal control of the land	Landowner, landowner representative
Implementation of restoration/sequestration activities	Landowner, project developer, conservation organization, service provider
Paperwork, administration, communication with registry	Landowner, project developer, service provider
Measuring baseline carbon	Landowner, project developer, service provider
Measuring change in carbon	Landowner, project developer, service provider
Verification	Certified external verifier (must be certified by registry in which project is enrolled; the specific verifier is usually chosen by project leaders)
Issuing the credit	Registry

Selling the credit	Landowner, project developer, broker
Aggregating credits or combining credits as a cooperative	Landowner, project developer, service provider
Maintenance, stewardship	Landowner, conservation organization, service provider

Are there other things to consider?

We began the ASCMW initiative by identifying the values that would guide our restoration projects. For our purposes, we determined that projects and processes must be:

- Real
- Additional
- Measurable
- Verifiable
- Permanent
- Transparent
- Ecologically appropriate

In addition, while we applaud any initiatives that direct more resources toward ecosystem restoration in areas of high conservation value, we are also concerned about restoration offsetting environmental harm, including carbon emissions, elsewhere. When credits are purchased on the voluntary market and represent additional, voluntary action on the part of buyers, we believe carbon finance is justified. Ultimately, however, humanity's response to climate change requires both dramatic decreases in carbon emissions *and* draw-down efforts, including nature-based / natural climate solutions.

What's next?

The one-year ASCMW initiative concluded in fall 2022, but several threads of related work will continue.

- Sageland Collaborative is evaluating a potential pilot carbon credit project in collaboration with the Swaner Preserve and EcoCenter in Park City, UT.
- ASCMW researchers have applied for grants to assess the impacts of process-based restoration on carbon storage and other ecosystem services.
- Western Landowners Alliance and Working Lands Conservation have received USDA Partnerships for Climate-Smart Commodities grants, which will include ecosystem services monitoring for restoration projects on rangelands.
- The Biophilia Foundation remains interested in conservation finance, payments for ecosystem services, and market-based mechanisms and will incorporate these concepts into programs and grantmaking in the future.

More information

You can learn more about the American Southwest Carbon Marketplace Workgroup and the Biophilia Foundation at www.biophiliafoundation.org. Individual members of the workgroup may also be able to answer questions based on their expertise.

References

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Figure 4. The green ribbon is the riparian zone showing wildlife protected by a string of beaver ponds after a wildfire. Beaver dam visible in lower center of photo. Schmiebel, CC BY-SA 4.0.