Cacapon Watershed Conservation Plan

Cacapon Watershed Collaborative (CWC)

ITERATION: 2024-06

In line with adaptive management principles, the CWC will continually, iteratively update this plan.

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About this plan

This Cacapon Watershed Conservation Plan is developed by the Cacapon Watershed Collaborative (CWC), a partnership of more than 18 organizations and people, including conservation non-profits, government agencies, educational institutions, and local landowners, to protect the vital Cacapon and Lost Rivers Watershed.

The Cacapon Watershed contains valuable geographic and ecological attributes that make it particularly climate resilient (TNC, 2016, Resilience), and able to provide outsized ecosystem services, including clean water and clean air, to millions of people in communities throughout the Chesapeake Bay Watershed. It is also at the nexus of a critical migratory pathway that birds, mammals and amphibians will be increasingly reliant on as climate change effects surge (TNC, 2016, Migrations).

This plan is structured as a living document to guide strategic interventions to combat the significant threats facing the watershed. Intended users include CWC partners, non-profit organizations, agencies, and individuals with an interest in or mission to protect the Cacapon and Lost Rivers Watershed.

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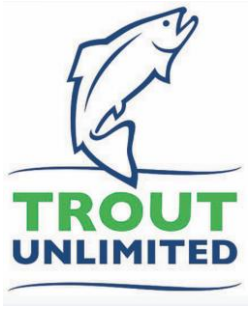
Participating Organizations



Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Nelson Institute for
Environmental Studies
UNIVERSITY OF WISCONSIN-MADISON

Project Team

Names and affiliations of key members of the Cacapon Watershed Collaborative planning team (alphabetically by first name).

Table 1. Project Team

Name	Affiliation	Role
Alana Hartman	Environmental Resources Analyst, West Virginia Department of Environmental Protection (WVDEP)	CWC Member, Streams Working Group Convener
Alison Jewell	Hampshire County Farmland Protection Board	CWC Member, Farms Working Group
Candace DeLong	West Virginia University-Extension	CWC Member, Farms Working Group
David Parker	Hampshire Co. farmer; Hampshire Co. Farmland Protection Board	CWC Member; Farms Working Group
Dottie Eddis	CLRLT Board Member, Hampshire County Landowner	CWC Member, Farms Working Group
Emily Warner	Executive Director, Cacapon & Lost Rivers Land Trust (CLRLT)	CWC Member, Forests Working Group
Frank Rodgers	Executive Director, Cacapon Institute,	CWC Member, Streams Working Group
Glenn Archer	President, Friends of the Cacapon River (FCR)	CWC Member (new as of 10/23)
Henry Ireys	CLRLT Board Member; Hampshire County Landowner	CWC Member, Farms WV
Jarred Kinlein	Service Forester, West Virginia Division of Forestry	CWC Member; Forests Working Group Convener
Kevin Oxenrider	Wildlife Biologist, WV Division Natural Resources (WVDNR)	CWC Member, Streams Working Group
Maria Russo	Clean Water Campaign Coordinator, WV Rivers Coalition	CWC Member, Streams Working Group
Marika Suval	Deputy Director, Cacapon & Lost Rivers Land Trust (CLRLT)	CWC Member, Facilitator
Nathaniel (Than) Hitt	Research Fish Biologist, United States Geological Survey (USGS)	CWC Member, Streams Working Group
Rebecca Royal	Soil Conservationist, West Virginia, USDA Natural Resources Conservation Service (USDA NRCS)	CWC Member; Farms Working Group Convener

Name	Affiliation	Role
Ryan Cooper	Project Manager, Trout Unlimited- Potomac Headwaters	CWC Member, Streams Working Group
Todd Miller	Director of Conservation Programs, The Nature Conservancy (West Virginia)	CWC Member, Forests Working Group
Timothy Reese	Board Member, Friends of the Cacapon River (FCR)	CWC Advisor?
Tristan Puffenberger	Cacapon Institute	CWC Member (new as of 11/23)
University of Wisconsin Team		
Arlyne Johnson	Adjunct Professor, UW-Madison	UW Process Facilitator
Hilary Habeck Hunt	Teaching Assistant, UW-Madison	UW Process Facilitator
Ari Silberman	Graduate Student, UW-Madison	UW Project Team Member
Brandon Schmit	Graduate Student, UW-Madison	UW Project Team Member
Lily Butler	Graduate Student, UW-Madison	UW Project Team Member
Marta Karlov	Graduate Student, UW-Madison	UW Project Team Member
Rhiannon Erhardt	Graduate Student, UW-Madison	UW Project Team Member
Former Members		
Christi Hicks	USDA - NRCS (moved)	CWC Member (former)
Curtis Roth	Trout Unlimited (moved)	CWC Member (former)
Jeff Blount	Cacapon Institute (retired)	CWC Members (former)
Jenna Dodson	WV Rivers Coalition (new member appointed)	CWC Member (former)
Sam Urban	WV Conservation Agency now with Trout Unlimited)	CWC Member (former)
Tyler Williamson	WV Division of Forestry (retired)	CWC Member (former)

Executive Summary

The Cacapon Watershed Collaborative (CWC) aims to protect the Cacapon and Lost Rivers Watershed's valuable ecosystems and residents' way of life. This Watershed Conservation Plan outlines the key strategies to achieve that mission.

Located in the Central Appalachian Mountains, the Cacapon and Lost Rivers Watershed of eastern West Virginia is nationally recognized as one of the most ecologically beneficial tributaries to the Chesapeake Bay. Functional, largely intact natural ecosystems still characterize much of the region. Its forests, which cover about 85% of the watershed, constitute the great “lungs” of the East, providing oxygen, regulating the water cycle, sequestering greenhouse gases, and moderating climate. These aspects, along with the north-south oriented ridges and valleys, provide important habitat for rare and threatened species, a critical migratory corridor, and high levels of resiliency against a warming climate.

Yet, situated less than two hours from Washington DC, and adjacent to some of the nation’s fastest-growing areas, the watershed faces significant threats, particularly from unplanned and unsustainable development. Indeed, the pace of land conversion proceeds unabated. Meanwhile, local landowners—many of them small family farmers—face numerous challenges to their way of life as they struggle to hold onto their land while market pressures mount and succession concerns loom. Ultimately, this means that tracts of land with intact ecosystems and significant conservation values face imminent risk of degradation, subdivision and fragmentation.

The fact that about 85 percent of land in the watershed is privately owned, underscores the need to support landowners to hold onto and protect their land. Therefore the CWC prioritizes strategies that emphasize and rely on landowner collaboration.

The mission of the Cacapon Watershed Collaborative (CWC) is to efficiently increase conservation of the streams, forests, farms, and species of this landscape —a vision we can advance by working together, sharing resources and building the capacity of under-resourced partner organizations, local governments, and landowners. This Cacapon Watershed Conservation Plan is a roadmap to realize this mission.

To address the most critical threats facing the watershed the CWC will focus on five initial strategies:

- S1. Develop or expand Farmer Information and Financial Aid programs
- S2. Secure conservation easements on high-priority lands
- S3. Incentivize restoration of riparian buffers
- S4. Improve or develop native brook trout patches
- S5. Promote Forest Management Plans (FMPs) focused on long-term forest health

The CWC has chosen to focus on three key conservation targets over the next 7 years: Streams, Forests, and Farms. These primary conservation targets contain indicator species as nested targets. This CWC Plan includes strategies to advance conservation of all three target areas. Some of the conservation goals for each target area are summarized below.

Goals for Streams:
By 2030:

- The watershed has 80% or greater riparian natural cover in all subwatersheds of the Cacapon Watershed, including any shrubs, trees, and plants, not crops or built infrastructure. (do we want to suggest a depth of riparian cover as a goal?)

- The Family Biotic Index (FBI), a field assessment of organic pollution, is less than 4.25 on average across test sites in the Cacapon Watershed.
- At least five brook trout patches have been improved through the completion of stream restoration projects. And, at least one new brook trout patch has been created or documented within the watershed.
- At least # acres will be under conservation easement (forest or farm).

Goals for Forests:
By 2030:

- Cacapon Watershed has had no loss of forest cover relative to the 2022 baseline.Cacapon Watershed has 20,000 acres (% of forest?) under forest management plans.
- Cacapon Watershed has a mosaic of diverse age classes (if data available).
- At least # acres of forest will be under conservation easement.

Goals for Farms:
By 2030:

- At least 90% of the watershed's farmlands will remain intact, relative to 2020 baseline numbers.
- At least # acres will remain under agricultural production.
- At least # acres of farmland will be under conservation easement.

The CWC believes that by implementing the strategies of the Cacapon Watershed Conservation Plan over the next seven years, we can successfully reach the conservation goals for each target area (streams, forests, and farms), thereby helping preserve the watershed's precious ecosystems, biodiversity, communities, and heritage including health and safety, rural livelihoods, and resilience to climate change.

To ensure we stay on track, this Watershed Conservation Plan includes a monitoring plan, which will allow us to track progress to implement the strategies and reach the goals. To this end, the team will collect data and meet regularly to gauge progress and adapt the plan as needed, according to the principles of good adaptive management.

Safeguarding the health and resiliency of the watershed requires thoughtful, evidence-based strategic planning, followed by implementation of specific actions, monitoring and evaluation of results, and smart adaptation to keep pace with complex and rapidly changing realities.

1. Project Summary

1.1 Project Name
Cacapon Watershed Collaborative Conservation Plan

1.2 Project Location
The Cacapon & Lost Rivers Watershed (Cacapon Watershed) is located in West Virginia, within portions of Hardy, Hampshire, and Morgan counties. The 112-mile Cacapon River is the third largest tributary to the Potomac River. In total, the Cacapon Watershed, including the Lost and North Rivers and many streams, covers 680 square miles.

1.3 Project Vision
A thriving and interconnected network of protected lands throughout the Cacapon Watershed ensures the region's ecological resilience, water quality, and economic vitality in perpetuity.

1.4 Convener Contact Name and Address
Cacapon & Lost Rivers Land Trust
PO Box 57
Capon Bridge, WV 26711
304-856-1188

1.5 Project Start and End Dates
Planning Period: August 2022 – December 2023
Implementation of initial key strategies: 2024 – 2030

1.6 Project Description
The Cacapon Watershed Collaborative (CWC), convened by the Cacapon & Lost Rivers Land Trust (CLRLT), aligns and coordinates the efforts of 18+ partner **stakeholders** dedicated to the preservation of the Cacapon and Lost Rivers Watershed, with the ultimate **goal** of increasing the watershed's conservation value and ensuring the region's ecological resilience, water quality, and economic vitality in perpetuity. A stakeholder is a person or group who has interest or influence over a project area and a goal defines a project's desired future **impact** (see Glossary).

The Cacapon Watershed is a unique ecosystem, with 85% forest cover and various geology, landforms, and elevations contributing to high levels of biodiversity and habitat resilience (Cacapon & Lost Rivers Land Trust, 2023). The West Virginia Department of Natural Resources (WVDNR) has identified 240 plant and animal species that are of greatest need for conservation in this area. Coordinated conservation **actions** (see Glossary) are required to leverage resources more effectively to alleviate existing **stresses** and boost habitat resilience against climate impacts (University of Virginia & Institute for Engagement and Negotiation, 2021). A stress is a degraded aspect of a target resulting from human activities (see Glossary).

The CWC members bring a wide range of capabilities to the partnership. Partners include, among others, members of Trout Unlimited, the United States Department of Agriculture Natural Resources Conservation Service (NRCS), The Nature Conservancy (TNC), the West Virginia Department of Environmental Protection (WVDEP), the West Virginia Division of Forestry (WVDOF), the West Virginia Conservation Agency, West Virginia University (WVU) Extension and County Farmland Protection Boards. The CWC has outlined the following specific objectives for their work:

- Identify shared priorities within the Cacapon Watershed;
- Align efforts in the watershed to accelerate the achievement of strategic priorities;
- Identify gaps in information or knowledge that impact collective success;
- Identify areas of the watershed most in need of permanent protection that address multiple factors including resiliency, water quality, species protection and farm productivity;
- Identify strategies for supporting the rural economy and ecologically responsible land management;
- Work together to bring more resources to the watershed to achieve shared goals.

Since their initial conservation planning process began in August 2022, the CWC has identified three **conservation targets** within the watershed: forests, streams, and farms. Conservation targets are elements of biodiversity (either a species, habitat, or ecological system) on which the **project** will focus (see Glossary).

The CWC also identified the **direct threats** of climate change, residential and commercial development, poor forestry practices, and detrimental farming practices. Direct threats are human activities that directly or indirectly degrade the targets (see Glossary). The team took these targets and threats into account when developing the conservation plan.

2. Introduction

2.1 Developing a Strategic Conservation Plan for the Cacapon Watershed: Past and Present

In 2003, the leadership of the Cacapon & Lost Rivers Land Trust (CLRLT) convened more than 30 stakeholder groups to develop a GIS (Geographic Information System) model for conservation, which has been used since to inform strategic choices in the watershed. In 2019, the CLRLT applied for funding from a variety of sources to form a collaborative with these stakeholders to leverage each others' capabilities and limited resources (University of Virginia & Institute for Engagement and Negotiation, 2021). In 2021, CLRLT received a two-year grant from the National Fish and Wildlife Foundation (NFWF) to support the work of the newly-formed CWC to develop a watershed plan. Among other things, the grant funds facilitated services from the Institute for Engagement & Negotiation (IEN). IEN worked with the Executive Director of the CLRLT to lay the groundwork for the collaborative. Funding supported co-learning and increased the Collaborative's understanding of landowners' views on conservation and the future of the watershed through an extensive Landowner Motivations and Barriers survey. Funding also supported an ongoing partnership with Trout Unlimited for brook trout restoration (University of Virginia & Institute for Engagement and Negotiation, 2021).

Since August 2022, CWC members have participated in a collaborative strategic planning process using the Conservation Standards (see Section 3.2 and Glossary), to develop its Cacapon Watershed Plan. The process is currently facilitated by Marika Suval, Deputy Director of CLRLT. Through the process, the collaborative has developed its **conservation targets**, identified **ecosystem services** and **human wellbeing targets**, mapped out **biophysical factors**, and listed **direct threats** (these terms are defined in more detail in the Glossary).
The CWC worked with a graduate student team at the University of Wisconsin's Nelson Institute for Environmental Studies to gain insight into the strength of their **evidence** (see Glossary) and identify any limitations of their work. Evidence is relevant information used to support an assumption (Conservation Measures Partnership, 2020).

2.2 Relevant Documents

Important documents for the development of this plan are outlined in Table 2.

Table 2. Relevant Documents

Document	Year	Description
West Virginia State Wildlife Action Plan (SWAP)	2015	A plan developed by the West Virginia Department of Natural Resources is the state's wildlife conservation strategy (as mandated by the US Congress) that provides a roadmap for the DNR and its partners for conserving WV's biological diversity. It identifies Species of Greatest Conservation Need, terrestrial and aquatic habitats, and threats to conservation across the state. It also develops Conservation Focus Areas, which are places where stresses and conservation actions are geographically linked.
Action Plan for the Cacapon River And Patterson Creek Conservation Focus Area (CFA)	2021	Edited by the WVDNR. This document is a follow-up to the WVDNR's State Wildlife Action Plan published in 2015, which identified 21 Conservation Focus Areas (CFAs) (West Virginia DNR, 2021).
Cacapon Watershed Collaborative (CWC) Blueprint Plan	2021	Completed by the University of Virginia and the Institute for Engagement and Negotiation. It outlines the history and objectives of the CWC and describes survey responses from stakeholders around watershed perceptions (University of Virginia & Institute for Engagement and Negotiation, 2021).
West Virginia State Forest Action Plan (SFAP)	2020	The West Virginia Division of Forestry is required to complete an SFAP at least every 10 years. This plan considers forest issues, threats, and benefits, and includes strategies to address them (West Virginia Division of Forestry, 2019).
Trout Unlimited 2021-2026 Strategic Plan Summary	2021	This document outlines the five-year plan for Trout Unlimited to drive a conservation agenda with a focus on priority rivers and streams and strong partnerships with staff, volunteers, and supporters (Trout Unlimited, 2021).
West Virginia Phase 3 Watershed Implementation Plan	2012	West Virginia's portion of the Chesapeake Bay Total Maximum Load, outlining strategies needed to achieve nitrogen and sediment reduction targets by 2025.
Cacapon & Lost Rivers Land Trust 2020-2025 Strategic Plan	2020	This plan outlines the roadmap the organization will follow to protect land in the watershed to benefit the local community and the broader Potomac River watershed community (Cacapon & Lost Rivers Land Trust, 2020).

3. Strategic Planning Approach

This plan, developed by the Cacapon Watershed Collaborative (CWC), is based on a framework known as the Conservation Standards for the Practice of Conservation (hereafter, "Conservation Standards") developed by the Conservation Measures Partnership (CMP) (2020). The framework consists of tools, principles and best practices that maximize a team's ability to strategically determine the best course of action, to monitor the results of interventions, and to quickly adapt when outcomes do not occur as expected or within the expected timeframe. For a full description of the planning approach, see Appendix A.

The plan is organized as follows. The **vision** (see Glossary) is a description of the desired state or ultimate condition that the CWC is working to achieve within the Cacapon and Lost Rivers watershed (see sec 4.2). In essence, it is a succinct description of what conservation success looks like to the CWC. Three **conservation targets** (ecological values) were identified (sec 4.3), and the CWC agreed that if these three targets were healthy and in good ecological condition (as defined quantitatively in sec 5), the vision would be achieved. To achieve maximum transparency and accountability, the CWC established measurable, long-term **goals** for each target that quantitatively describe the impact partners hope to achieve as plan implementation progresses.

Unfortunately, several human activities and associated conditions negatively affect the three conservation targets (sec 6.1). Through a brainstorming and prioritization process, the team identified and rated these **direct threats**, producing a short list of critical threats that must be addressed to improve target health. The CWC explored each critical threat, considering enabling conditions and other factors contributing to the persistence of each threat. This exercise helped identify key intervention points where targeted **strategies** (sec 8) could be implemented to reduce threats or directly improve target health.

To ensure accountability and transparency and to establish a framework for monitoring the progress and effectiveness of implemented strategies, a **theory of change** was developed for each final strategy using **results chains**. A results chain documents a team's assumptions about the order and timing of intermediate results that are expected to occur, which would lead from strategy implementation to the reduction of threats and achievement of target goals. Each results chain identifies specific actions, assumptions, and intermediate objectives to measure progress and effectiveness.

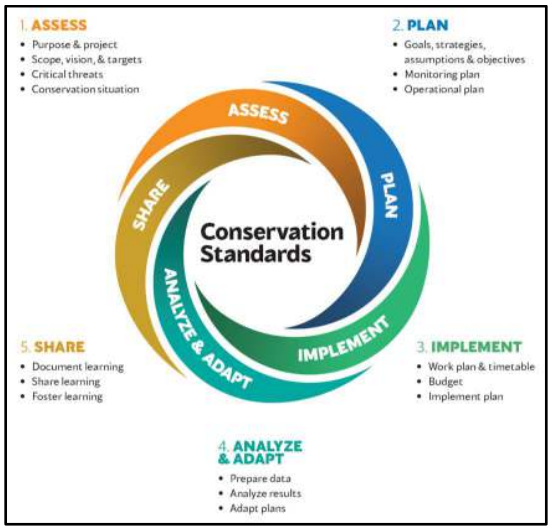


Figure 1. Open Standards for the Practice of Conservation Project Cycle
(Conservation Measures Partnership, 2020)

4. Scope, Vision and Targets

4.1 Scope and Maps

A project's **scope** indicates the broad extent of the project and helps guide the conservation planning process (see Glossary). There are three common categories of scope; these include place-based scopes which focus on protecting all of the biodiversity in a given geographic area; target-based scopes which focus on protecting certain species or ecosystems (sometimes a charismatic species or one of greatest concern); and thematic-based scopes which target specific threats, conditions, or opportunities that are leading to environmental degradation (see Glossary). The scope of the CWC Watershed Plan is a **place-based scope**, focusing on conserving all of the important ecosystems in the Cacapon Watershed in West Virginia. The scope was identified as place-based due to the fact that the CWC is focused on the watershed as a whole, rather than a specific target or theme.

Located in the Central Appalachian Mountains, the Cacapon and Lost Rivers Watershed of eastern West Virginia is nationally recognized as one of the most ecologically beneficial tributaries to the Chesapeake Bay. Functional, largely intact natural ecosystems still characterize much of the region. Its forests, which cover about 85% of the watershed, constitute the great "lungs" of the East, providing oxygen, regulating the water cycle, sequestering greenhouse gasses, and moderating climate. These aspects, along with the north-south oriented ridges and valleys and myriad microclimates, provide important habitat for rare and threatened species, a critical migratory corridor, and high levels of resiliency against a warming climate.

The Cacapon River is a 112-mile-long American Heritage River known for its beautiful scenery, fishing, boating, and wildlife. The Cacapon River Watershed is made up of three major river segments and several smaller tributaries. The headwaters of the Cacapon River are called the Lost River (Friends of the Cacapon River, 2023). The Cacapon and Lost Rivers are 125 miles long and are actually the same river. They have two different names because the 30.9-mile-long Lost River flows underground for a mile and emerges as the Cacapon River. The Lost River has a drainage area of . The North River is the largest tributary of the Cacapon River and it covers 206 square miles. In total, the Cacapon & Lost Rivers encompass 680 square miles watershed (Cacapon & Lost Rivers Land Trust, 2023). Figure 2, from the Cacapon Institute, shows where the Cacapon Watershed is located within the state, as well as the geography of its tributaries (Cacapon Institute, n.d.). Figure 3 shows the public and privately owned protected lands in the watershed (Cacapon & Lost Rivers Land Trust, 2023).

The Cacapon River is a part of the Chesapeake Bay Watershed and is one of the watershed's most biodiverse tributaries. It is also one of the cleanest rivers in West Virginia. Depending on the source, 70-85% of the Cacapon River Watershed is forested with a mix of deciduous and coniferous species (Friends of the Cacapon River, 2023). It is home to a diverse group of aquatic and terrestrial flora and fauna, including 45 species of rare, threatened, or endangered plants and animals (Cacapon & Lost Rivers Land Trust, 2023). The watershed also supports brook trout, Appalachia's only native trout, providing climate change refugia for the species. Climate change refugia are areas that are relatively resistant to the impacts of climate change over time, allowing sensitive species to persist there (Morelli et al., 2016).

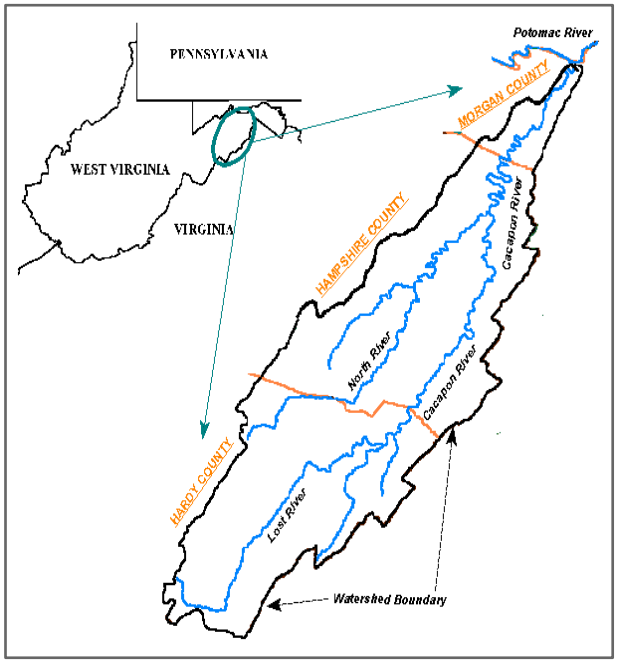


Figure 2. Map of the Cacapon Watershed (Cacapon Institute, n.d.)

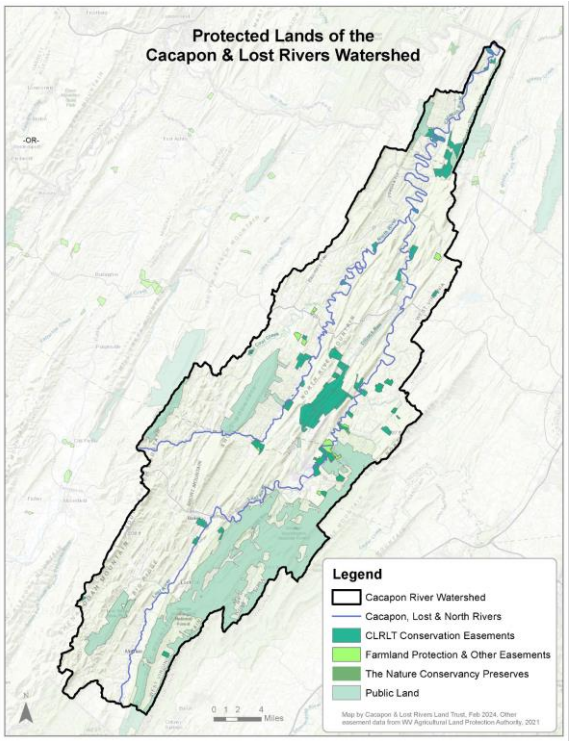


Figure 3. Map of Public and Private Protected Lands in the Cacapon & Lost Rivers Watershed (Cacapon & Lost Rivers Land Trust, 2024)

4.2 Project Vision

A vision is a description of the state or ultimate condition the project is striving to achieve (see Glossary). This project envisions a thriving and interconnected network of protected lands throughout the Cacapon Watershed and ensures the region's ecological resilience, water quality, and economic vitality in perpetuity. This plan is strategically designed to create conditions that will enable the realization of this vision.

4.3 Focal Targets overview: Conservation Targets and Human Wellbeing Targets

To achieve the plan's vision of a healthy watershed, the team identified three conservation targets that represent the overall biodiversity of the watershed: **Streams** (aquatic/riparian ecosystems), **Forests** (forest ecosystems) and **Farms** (agricultural landscapes). These conservation targets were developed in collaboration with the CWC members and the guidance of the partner representatives. Farms are somewhat unusual as a conservation target but appropriate for this scope and context, because they form an integral part of the watershed. It is critical to the health of the watershed that they are protected from conversion to residential/commercial development. The team recognizes that there are threats to the watershed that originate from detrimental farming practices, (West Virginia DNR, 2021, 15). It is for these reasons that the team chose strategies that specifically address the threats of detrimental farming practices on the aquatic/riparian and forest ecosystems of the watershed. The conservation targets are represented in Figure 4 by **green outlined ovals**.

The team also identified the human wellbeing services that these conservation targets provide if they are healthy and functioning. Healthy biodiversity targets provide "**ecosystem services**" to humans and are represented in Figure 4 by **yellow boxes**. The team grouped these into 3 broad categories: Recreation (a cultural

ecosystem service), Regulating Services, and Pollination (although a regulating service, it is grouped separately as it impacts two of the human wellbeing targets).

Regulating ecosystem services include water/air purification, biodiversity and disease/pest resistance, microclimate regulation, carbon sequestration, erosion/flood control, and soil formation. These regulating services positively affect the human wellbeing targets of rural livelihoods, human health/safety, and climate change resilience. Pollination and recreation have a positive impact on rural livelihoods and human health/safety.

Human Wellbeing Targets:

- Human health and safety targets include human mental and physical health, access to adequate nutrition and a clean environment, and assurance of a safe and secure place to live.
- Rural livelihoods include recreation jobs (tour/river guides, hunting/fishing instructors, etc), agricultural jobs (farming, ranching, etc), and others.
- Climate change resilience refers to the ability of a community to adapt and respond to changes in climate, including the increased frequency and severity of weather events, the change in availability of certain natural resources, and more. There is increasing evidence to support that climate change will have large impacts on communities across the globe; being resilient means that a community is able to survive these impacts, in some cases lessening them, or thriving in spite of them.

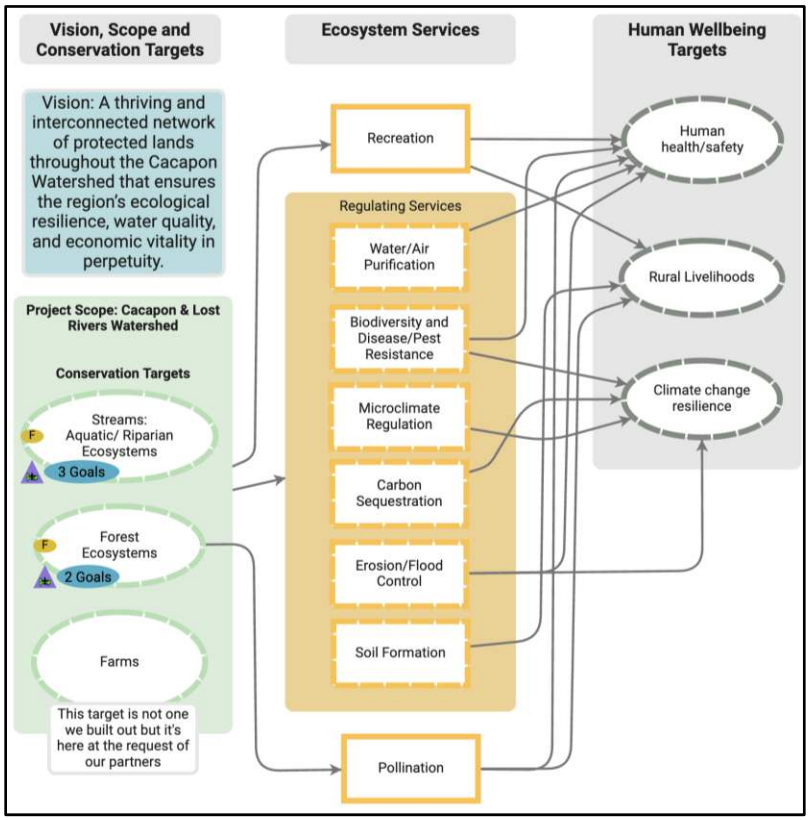


Figure 4. Project Targets

4.3.1 Conservation Targets Description

Streams (Aquatic/Riparian Ecosystems)

The watershed's stream and riparian habitats are important for many Species of Greatest Conservation Need (SGCN) that are found in this part of West Virginia (CFA, WV DNR). These SGCN include wood turtles and spotted turtles, harperella (a plant listed as *endangered* under the Endangered Species Act), 12 fish species, and 13 mussel species (West Virginia DNR, 2021, p14). The headwater tributaries in the Cacapon River, although at low elevations, are cold water streams that support native brook trout populations. The lower sections of the Cacapon River and Patterson Creek are warmer, low-gradient, medium-sized rivers. (See the map of aquatic habitat types in Figure 5 from the WVDNR's CFA Action Plan.) These streams and rivers are tightly connected with their adjacent floodplain, wetland, and riparian habitats. In addition to native fish, streams and wetlands in the Cacapon CFA support 28 dragonflies and damselfly SGCN, which is a large number for the state (West Virginia DNR, 2021, p14).

Forests (Forest Ecosystems)

The Forest Ecosystem (hereafter referred to as "Forests") target includes all forest patches and linking corridors. The Cacapon Watershed is described as having a pristine forest cover, up to 85% in places (Cacapon & Lost Rivers Land Trust, 2023). In fact, a majority of the medium and large intact forest areas in the CFA are located within the Cacapon Watershed. Intact forest patches with a mix of habitat types, and corridors between them are critical for SGCN and rare communities (West Virginia DNR, 2021, 8). Habitat diversity and connectivity can support plant and animal diversity and impact how the entire watershed will adapt to climate change.

This area contains over 15% of West Virginia's dry calcareous forests and pine-oak rocky woodlands, and over half of the state's Eastern Ridges Oak-Hickory-Graminoid Forest (West Virginia DNR, 2021, p10-24). Figure 6 shows the matrix of woodland habitat types in the watershed, from the CFA Action Plan. These forests host several rare plant communities that are vulnerable to disturbance by logging and grazing activities and to the spread of non-native invasive plants. The CFA Action Plan emphasizes that these kinds of disturbances should be avoided and that the introduction/spread of non-native invasive plants should be managed effectively (West Virginia DNR, 2021, 24).

Watershed forests support a large collection of forest interior bird species, including broad-winged hawk, wood thrush, cerulean warbler, and worm-eating warbler. Early successional habitats support the Prairie Warbler and Black-billed Cuckoo. Wood turtles are also supported by forest habitats during certain parts of their life history. They rely heavily on protected connections between aquatic/riparian and forest habitats (West Virginia DNR, 2021, 14-21). The diversity of forest types in the Cacapon Watershed require tailored management to specific site and forest conditions. If these pristine forest ecosystems were to be fragmented or disturbed, it would impact both the forest species and aquatic/riparian ecosystems and species by increasing surface water temperatures and storm water run-off (West Virginia DNR, 2021, 15).

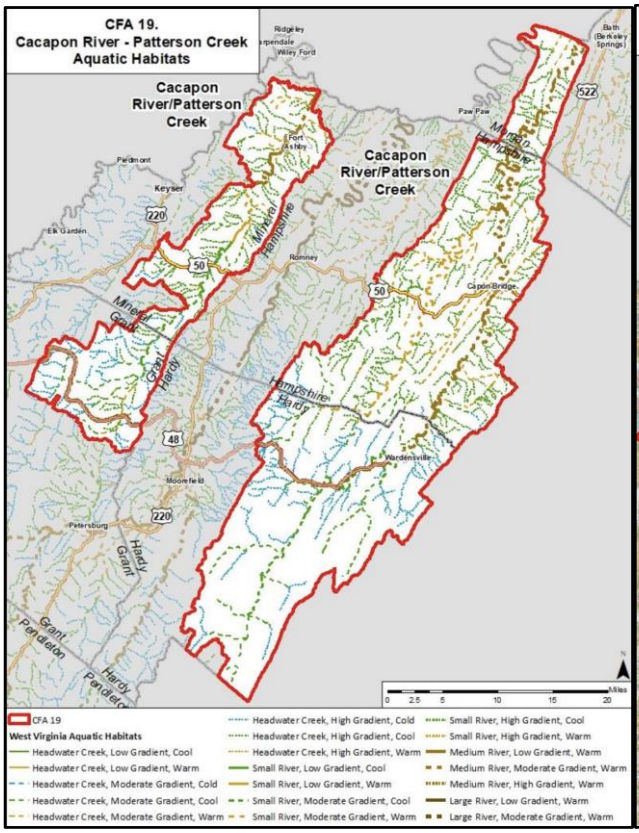


Figure 5. Cacapon Watershed Aquatic Habitats (West Virginia DNR, 2021, p13)

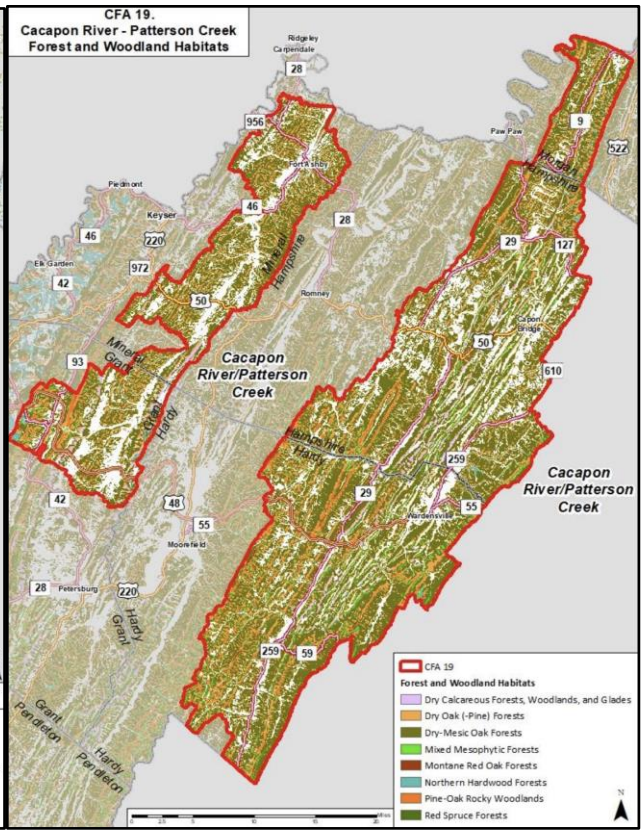


Figure 6. Cacapon Watershed Forest Habitats (West Virginia DNR, 2021, p11)

Farms (Agricultural Landscapes)

Unlike the other two conservation targets, farms are not a natural part of the watershed ecosystem. However, agricultural landscapes, including grasslands and croplands, provide unique habitats, occur in larger patch sizes , and facilitate greater connectivity than similar land covers in residential or commercial areas. Consequently, wildlife is more diverse and abundant on agricultural lands than in developed areas. Approximately 13% of the Cacapon watershed is used primarily for cattle farming (West Virginia DNR, 2021, 10), attesting to the scale of this land type in the watershed. Farms are particularly important to the local culture and economy. To achieve the CWC vision of an ecologically resilient watershed with good water quality and sound economic vitality, the conservation value of agricultural lands must be preserved, degraded farms must be restored and the ecological problems caused by poor farming practices addressed, and high-value parcels must be integrated into a network of protected lands.

The CWC characterizes the Farms target as non-forested lands greater than five acres (?) where the predominant land cover is grass (i.e., pasture or fallow ground) or crops. It does not include gardens or pastures less than 5 acres.

4.3.2 Human Wellbeing Targets Description

Human Wellbeing Targets represent the components of human wellbeing that healthy and functioning conservation targets provide to humans. Residents of the Cacapon Watershed and downstream areas will benefit in many ways if the three conservation targets described above are healthy and well-conserved over the long term. The CWC has identified three primary human wellbeing targets: rural livelihoods, human health and safety, and climate change resilience.

Rural Livelihoods

Rural livelihoods is an important human wellbeing target in the Cacapon watershed that is well-aligned with the United Nations Sustainable Development Goal #8, which aims to ensure decent work and economic growth for all (United Nations, n.d.). Each conservation target listed above supports rural livelihoods in the watershed. Healthy streams and riparian ecosystems provide clean drinking water, water to support agricultural operations, and healthy recreational activities such as fishing, kayaking, canoeing, and swimming. Statewide, forest ecosystems support a $3.2 billion forest products industry (West Virginia Economic Development, 2023), providing both jobs and wood products. Forests provide clean air, clean water, and wildlife habitat critical to fishing, hunting, and bird watching, and public forest lands also offer hiking, camping, and other outdoor recreation. Large areas of the watershed are designated as National and State Forest land (West Virginia DNR, 2021, 17). Coupled with intact private lands, these forests and the recreational activities they provide could become critical to this rural economy, contributing to jobs and tourism income in the area.

As farms are preserved and remain economically viable, they provide food, income for producers and agricultural support industries, and habitats and food sources of wildlife. Many species require edge habitats like those created on well-managed farms. Streams and forests also help maintain productive soils to support farming. Water infiltrates the ground, introducing new sediment and minerals that form the basis of soils (Beem, 2017). Forests aid in the creation and conservation of soils by weathering rock material with their roots, decomposing organic matter, and holding soils in place (Clawson, 2023). Forests and streams are also essential for the survival of a wide array of valuable insects and other animal pollinators, which are essential for food production. Roughly 35% of global crop production is dependent on pollination by insects and animals, connecting pollination to livelihoods (USDA, 2020).

Human Health and Safety

Healthy streams, forests, and farms enhance human health and safety. The Cacapon Watershed's forests and streams supply clean water and air purification that are essential for human health. Forests contribute to clean air by filtering pollutants and emitting oxygen, and they help produce clean water by capturing rainwater and filtering pollutants before it enters waterways. Streams provide clean water by filtering organic and inorganic matter, and riparian buffers also intercept pollutants and remove excess nitrogen and phosphorus that can pollute drinking water (*The Science Behind the Need for Riparian Buffer Protection: ConservationTools*, n.d.).

Healthy forests, farms, and streams enhance water capture and infiltration and provide vegetation to hold soil. As a result, they protect against soil erosion and provide flood control. The Cacapon Watershed supports a wide variety of plant and animal species. A healthy ecosystem with high biodiversity contributes to human health by preventing the spread of pests and disease (COHAB initiative, n.d.). As discussed above, the Watershed's forests and streams also support insects and animal pollinators, which are essential for healthy food production. The Cacapon Watershed's forests and streams sustain healthy ecosystems which create outdoor recreational opportunities like hunting, fishing, and wildlife viewing (West Virginia DNR, 2021, 30), all of which may contribute to mental, emotional, and spiritual health and wellbeing. Studies show that people who spend two hours a week in natural environments are more likely to report good health and psychological wellbeing than those who don't (Robbins, 2020).

Climate Change Resilience

Climate change resilience refers to "successfully coping and managing the effects of climate change" (*What Is Climate Resilience*, 2022). This is becoming increasingly emphasized in West Virginia, as aspirational forest management goals include prioritizing carbon projects in land management plans (West Virginia DNR, 2021, 91). A healthy Cacapon Watershed ecosystem provides microclimate regulation. Trees in forests create microclimates by providing shade and cool the air by evaporation of moisture from their leaves and branches. Action to protect big forest patches that have diverse topography and microclimates and action to maintain forest connectivity will allow for the forest to better adapt to climate stress (West Virginia DNR, 2021, 26).

Evidence also shows that when we restore and protect wildlife habitat, those areas may be more resistant to the impacts of climate change (West Virginia DNR, 2021, 57). Plants in forests and on agricultural lands absorb large amounts of carbon during photosynthesis and store it in the form of biomass, thus contributing to regional carbon sequestration. Forests take up about 12 percent of the carbon dioxide that Americans emit each year (*How Forests Store Carbon*, 2023). Forests also help mitigate the impacts of climate change and increase climate resilience with their ability to retain water and limit the amount and timing of water that enters nearby streams (Bastrup, 2020). Aquatic/riparian habitats also help create increased climate resilience, as riparian vegetation helps to stabilize soil near streams and control the amount of soil erosion that occurs (Association for Temperate Agroforestry, n.d.). Healthy forests with diverse tree age and structure provide cooling shade and a variety of microclimates that create a plethora of habitat niches that plants and animals can occupy as they adjust to climate change.

5. Viability Assessment: Evaluating the Current and Desired Health of Conservation Targets

5.1. Overview

To determine the current and desired future health of the chosen conservation targets, the team conducted a viability assessment. A viability assessment is a **method** for quantifying the most important ecological requirements of a healthy conservation target so that interventions can focus on reducing the threats that degrade them and implement strategies to improve them. It also serves as a foundation to set relevant and measurable goals for future target health and to develop monitoring plans.

The first step is to identify **key attributes (KAs)** of each conservation target. KAs are characteristics of a target that are essential to the conservation of that target over time (see Glossary) (Foundations of Success, 2020). For every KA, the team identified measurable **indicators** that will be used to track the health of the conservation targets over the lifespan of the project. Where data were available, the CWC team identified indicator values for four health categories: *poor*, *fair*, *good*, and *very good*. The team also identified and agreed upon the current and desired future status of each indicator using available evidence or expert opinion. Appendix B details the team's viability assessment process.

Below, key attributes, indicators, and indicator ratings are listed for each target, followed by goals for each. Each goal must represent a measurable improvement in the status of a key attribute.

5.2. Viability Assessment for each Target

For a description of the assessment method and details of each attribute, including tables and maps, see Appendix B.

5.2.1 Viability Assessment: Streams

Key Attribute 1: Amount of natural riparian buffer
Riparian forest buffers (RFBs) are strips of forest that border waterways. RFBs act as natural filters, as they effectively remove pollutants from runoff. Forest buffers are among the most cost-effective practices to improve water quality and to restore a sustainable landscape that supports clean water, native fish and wildlife, and resilience to climate change. Restoring RFBs is a high priority of West Virginia's Phase 3 Watershed Implementation Plan for the Chesapeake Bay. Allowing meadow plants and native grasses to grow along the stream is also a desired practice, as opposed to mowing to the edge or allowing cattle to graze along the stream; some wildlife habitat, filtering and streambank stabilization will still be provided. However, allowing trees and shrubs to create a forest buffer along a stream is the most impactful practice (https://extension.psu.edu/riparian-buffers-pennsylvanias-best-solution-for-protecting-its-waters).

Key Attribute 2: Abundance and diversity of macroinvertebrates
Aquatic macroinvertebrates (animals without a backbone that are large enough to see without a microscope) are excellent indicators of watershed health because they: live in the water for all or most of their life, stay in areas suitable for their survival, are easy to collect, differ in their tolerance to amount and types of pollution, are easy to identify in a laboratory and in the field, often live for more than one year, and are important components of a stream's nutrient and energy system (https://dep.wv.gov/WWE/getinvolved/sos/macros/Pages/Benthic.aspx). Abundance (amount) and diversity

(number of different kinds) are often used to determine whether a waterway has enough habitats and low enough pollution to support the expected or desired amount and kinds of living things. Tolerance values and mathematical indices are used to compare abundance and diversity in waterways to each other, or in the same waterway at different time periods, even if the samples analyzed don't contain the exact same species.

Key Attribute 3: Brook trout patches
The number of brook trout patches and the quality of known patches are important indicators of the health of coldwater streams. Quality of brook trout patches can be measured using the Trout Unlimited conservation success index, which incorporates data associated with measures of future security, habitat integrity, and population integrity.

Table 3. Key attributes and indicator ratings for the Streams conservation target. The current status of the indicator (as of the end of 2023) is characterized by the underlined value. The desired future status is identified with an asterisks (*) and bold font.

Key Attribute	Indicator	Indicator Ratings			
		Poor	**Fair**	**Good**	**Very Good**
Amount of natural riparian buffer	% of riparian natural cover along streams and rivers in the Cacapon watershed	<60%	60–69%	70–80%	**>80%***
Abundance and diversity of macroinvertebrates	Average Family Biotic Index (HBI)[1] score across test sites in the Cacapon Watershed.	>6.51	5.01–6.50	4.26–5.00	**<4.25***
Brook trout patches	Trout Unlimited Conservation Success Index (CSI) score	<60	60–69	**70–79***	>79
	Number of known brook trout patches				

Goals for the Streams target:

Streams 1: By 2030, the watershed has 80% or greater riparian natural cover in 14 of 19 subwatersheds in the Cacapon Watershed, which includes any shrubs, trees, and plants; not crops, mowed lawns or built infrastructure.

Streams 2: By 2030, the Family Biotic Index (FBI), a field assessment of organic pollution, is less than 4.25 on average across test sites in the Cacapon Watershed.

Streams 3: By the end of 2030, at least five brook trout patches are improved through the completion of stream restoration projects.

Streams 4: By 2030, at least five brook trout patches have been improved through the completion of stream restoration projects. And, at least one new brook trout patch has been created or documented within the watershed.

[1] The HBI is a field assessment of organic pollution

Streams 5: By 2030, the watershed will have 45,000 acres of land under conservation easement (forest/farm).

5.2.2 Viability Assessment: Forests

Key Attribute 1: Total forest cover
A healthy Forests target is one in which forest cover is widespread across the watershed.

Key Attribute 2: Large forest blocks
Large forest blocks provide "interior" forest critical for some wildlife species, and fragmented forests are not as easily managed or as resilient to threats as intact forests.

Key Attribute 3: Age diversity appropriate for forest type
A broad diversity of tree age classes is a critical component in a healthy forest. Distinct age classes support a wider variety of flora and fauna and are less susceptible to widespread disturbance such as fire and disease.

Key Attribute 4: Connectivity between blocks
Forest health will degrade if there is insufficient connectivity among forest patches. Connected patches preserve genetic heterogeneity and facilitate dispersal and migration of plants and animals.

Table 4. Key attributes and indicator ratings for the Forest Ecosystems conservation target. The current status of the indicator (as of the end of 2023) is characterized by the underlined value. The desired future status is identified with an asterisks (*) and bold font.

Key Attribute	Indicator	Indicator Ratings			
		Poor	Fair	Good	Very Good
Total forest cover	Square kilometers characterized as forest				
Large forest blocks	Average area (ha) of forest polygons within the watershed (relative to baseline)?				
Age diversity appropriate for forest type	Number of forest types wherein age class distribution is within a healthy range[!] across 80% or more of its distribution within the watershed	<3	3-4	**5-6***	All
Connectivity between blocks	Number of new corridors created between intact forest patches	Not identified	0	**1***	Not identified

[!]Healthy range is defined as follows: *[consider adding healthy range for each forest type]*

Goals for the Forest Ecosystems target:

Forests 1: By 2030, Cacapon Watershed has had no loss of forest cover relative to 2022 baseline

Forests 2: By 2030, Cacapon Watershed has 20,000 acres (% of forest?) under forest management plans.

Forests 3: By 2030, Cacapon Watershed has a mosaic of diverse age classes *(if data available)*.

Forests 4: By 2030, Cacapon Watershed will have # acres of forest under conservation easement.

Forests ?: By 2030, increase the number of new corridors between intact forest patches in the Cacapon Watershed from 0 to 1. (*FWG must determine applicability of this goal)*

5.2.1 Viability Assessment: Farms

A healthy Farms target is one in which conservation values of pastures and croplands are maximized and preserved, resulting in abundant ecosystem services that contribute to human wellbeing targets. Two key attributes were identified: viable farms and protected farmlands (Table 5).

Key Attribute 1: Viable farms
Farms must be economically viable or landowners may be forced to sell their property. If the land is sold to developers, the conservation value will be virtually eliminated. One indicator that farms remain viable is the number of acres within the Cacapon Watershed under cultivation or in pasture. If at least 90% of current agricultural lands are preserved as working lands, the team would consider this key attribute to be healthy and contributing to the overall health of the watershed.

This indicator provides important information about real conservation loss, but it is a lagging indicator in that it does not portend the upcoming sale of property.

Key Attribute 2: Protected farmlands
One of the surest ways to preserve the conservation value of farmland in perpetuity is to have conservation easements attached to the deed of the land. Thus, the amount of agricultural land protected under conservation easement in the watershed is an important indicator of the health of the Farms target. Currently, it is unknown how much land is under conservation easement, but the team believes more is necessary before the Farms target could be considered healthy.

Table 5. Key attributes and indicator ratings for the Farms conservation target. The current status of the indicator (as of the end of 2023) is characterized by the underlined value. The desired future status is identified with an asterisks (*) and bold font.

Key Attribute	Indicator	Indicator Ratings			
		Poor	**Fair**	**Good**	**Very Good**
Viable farms	# acres under agricultural production	Significantly less than current	Less than current	Current amount	More than current
Protected farmlands	# acres under conservation easement in the watershed		Current amount	**More than current***	

Goals for the Farms target:

Farms 1: By 2030, at least 90% of the watershed's farmlands will remain intact, relative to 2020 baseline numbers.
Farms 2: By 2030, at least # acres will remain under agricultural production.
Farms 3: By 2030, at least # acres of farmland will be under conservation easement.

6. Threat Assessment

6.1 Overview

Direct threats (hereafter "threats") are primarily human actions (e.g., unsustainable fishing) that immediately impact one or more targets by degrading their key attributes (e.g., adult survivorship). Threats may also be in the form of natural phenomena altered by human activities (e.g., flash flooding due to a denuded landscape) or relevant impacts of climate change (e.g., drought). Most conventional threats can be tied to one or more stakeholders.

The Conservation Standards differentiate between **conventional threats** or activities that have an immediate impact on an ecosystem, and **climate-related threats**, resulting from the changing of the climate due to greenhouse gas emission accumulation in the atmosphere (Foundations of Success, 2020).

Conventional threats that impact conservation targets include unsustainable residential and commercial development, detrimental farming practices, and inadequate forest and hunting management.

Two climate threats were evaluated: changes in temperature regime and changes in precipitation and hydrological regimes.

These were all analyzed for impact on conservation targets, resulting in the summary assessment values shown in table 8, below. The methodologies used for this Threat Assessment are described in Appendix C.

Table 6. Prioritized threats

Threats	Conservation Targets			
	Streams	**Forests**	**Farms**	**Summary Threat Rating**
Inadequate forest management	High	High	N/A	High
Changes in temperature regimes (climate change induced)	High	High	High	High
Unsustainable residential and commercial development	High	High	High	High
Changes in precipitation & hydrological regimes (climate change induced)	Medium	Medium	High	Medium
Detrimental farming practices	Medium	Medium	Medium	Medium
Inadequate hunting management	N/A Medium	Low	Medium	Medium
Lack of landowners protecting agricultural lands with conservation easements	N/A	N/A	Medium	Low
Summary Target Ratings	**High**	**High**	**Medium**	**Medium**

"N/A" signifies "not applicable," meaning the team does not believe the threat substantively affects the corresponding target.

Threat Assessment Summary:

The assessment yielded two "high" rated threats for Streams, three for Forests, and one for Farms. Changes in temperature regimes impact all targets, due to the breadth and severity of anticipated impacts.

While residential and commercial development was not rated equally for the three ecosystem targets, it is anticipated that the rate of land use change will continue due to pressures from housing and energy infrastructure developers seeking affordable land. This poses a risk to riparian and wetland habitats as well as forest structure and biodiversity, and to farms in general. Further, inadequate forest management was rated high for both target ecosystems, due to the strong impacts of poor early successional and interior habitat maintenance, as well as uncontrolled logging and fire suppression (West Virginia DNR, 2021, 24).

Hydrological regime changes were rated lower; they are considered closely connected to temperature shifts. Extremely heavy storms have increased by more than 25% in the eastern United States since the late 1950s, and this is expected to continue. In West Virginia, the overall amount of precipitation will increase in winter and spring, and higher temperatures will result in early snow melt, increasing evaporation and resulting in dry soil in summer and fall (Environmental Protection Agency (EPA), n.d.).

Figure 9, below, depicts how direct conventional and climate-related threats place stresses on ecosystems by negatively impacting their biophysical characteristics, which in turn contribute to the degradation of streams, forests, and farms targets, as represented by the arrows that connect the boxes. These relationships are explained in more detail in section 6.2 and section 6.3, below. The figure also describes how **direct threats (red boxes)** and **stresses/biophysical factors (tan boxes)** interact.

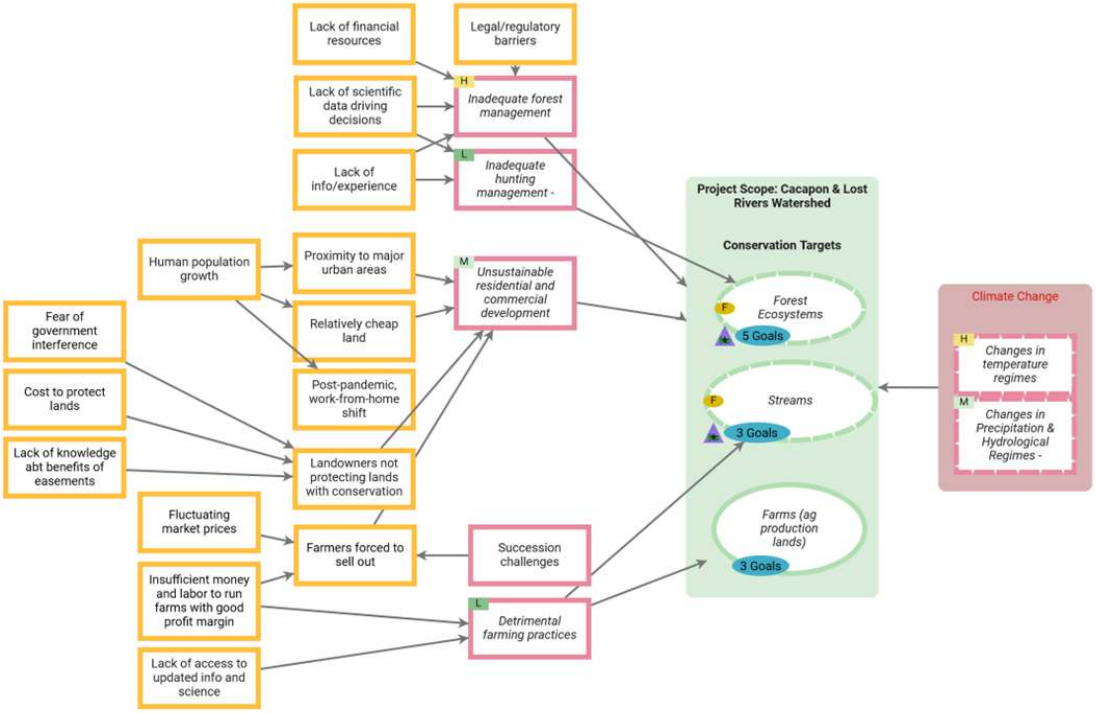


Figure 9. Threat Analysis Model

6.2 Threat Description and Details

6.2.1 Residential and Commercial Development (Summary threat rating = **HIGH**)

Development pressure is significant in the Cacapon Watershed, with substantial commercial, residential and second-home development, especially along major streams (West Virginia DNR, 2021, p15). This, among other threats like climate change and detrimental farming practices, compromises the water quality and hydromorphology of the Cacapon Watershed. Some of the streams and tributaries, home to clusters of SGCN and biodiversity hotspots, are already impaired. Improving water quality in these impaired streams and conserving the healthy ones is an important conservation action, especially where priority SGCN are present.

Threat Description and Affected Target: This threat impacts all three targets: streams, forests, and farms. As of 2021, residential and commercial development covered 4% of the Cacapon and Patterson Creek watersheds, with higher prevalence in the Cacapon Watershed along the river and major streams.

Stresses and Impact to Targets: Conversion of forests and farmland presents a host of stresses and impacts to forest and aquatic/riparian ecosystems by covering land with impervious materials, utility infrastructure, rights-

of-way, and waste removal infrastructure. When the forest is converted to housing or commercial use, deforestation activities fragment and disturb habitats for plant and animal species that depend on them for nutrients and mobility. In addition, there is an increase in forest edges, which changes the microclimate of the forest, making it inhospitable to many species. Such conditions are conducive to the growth of invasive species that can weaken native species necessary for the biodiversity and health of the ecosystem. Such changes can also impact fire regimes. Impervious surfaces impede the absorption of precipitation into the soil, contributing to higher volumes of nutrient and chemical loads from urbanized environments and construction to aquatic/riparian ecosystems, in addition to higher flows during precipitation events, which can cause streambank erosion. This further pollutes water sources for aquatic species and human consumption. Stream research generally indicates that certain zones of stream quality exist, most notably at about 10% impervious cover, where sensitive stream elements are lost from the system (https://www.stormwatercenter.net/monitoring%20and%20assessment/imp%20cover/impercovr%20model.htm). Further, deforestation leads to a higher probability of flooding due to the loss of vegetation that, when in a healthy state, absorbs water and regulates the flow to streams and rivers.

Factors that drive or contribute to this threat: Development pressure in the Cacapon Watershed is due in large part to residential and second home construction (West Virginia DNR, 2021, 15), driven by the affordability and beauty of the land (Weaver, 2023). Interest is growing. In fact, land use for development in West Virginia doubled between 1982 and 2017 (National Association of State Foresters, n.d.). There are strong pressures in the local real estate market evidenced by a flurry of unsolicited requests to land owners from realtors and solar and wind developers awash with money from recently approved legislation such as the Inflation Reduction and Infrastructure Acts. Another contributing factor is incentives of up to $20,000 that were offered to any new WV residents in an attempt by the state government to stanch a population loss of 3.2% between 2010 and 2020 (Renn, 2023; State of West Virginia, 2022). Farmers have been hit particularly hard by inflation and natural succession realities as younger generations are not as interested in working the land, which might prompt farmers to sell their land to developers.

Threat Assessment: Due to the magnitude of land degradation caused by the building of homes, commercial structures, and solar panel installation, this threat was determined to have very high severity and irreversibility. The current scope of this threat requires more research but anecdotal evidence supports the fact that this threat is growing at a fast pace, resulting in a ranking of HIGH for this criterion.

6.2.2 Detrimental Farming Practices (Summary threat rating = **LOW**)

Threat Description and Affected Target: This threat has a primary impact on aquatic/riparian ecosystems. Farming activity considered for this analysis consists of livestock production farms, which often include pasture, hay fields, and corn production.

Stresses and Impact to Target: Low land cleared for agriculture has resulted in the loss of floodplain habitats and riparian corridors, contributing to water quality and aquatic habitat degradation (West Virginia DNR, 2021, 35). Farm fields treated with pesticides or herbicides are a source of toxic runoff which degrades the Watershed. High usage of fertilizer causes nitrogen and phosphorus runoff into streams resulting in eutrophication, reduced water oxygen levels, and a decline in macroinvertebrates and fish populations (Friends of the Cacapon River, 2012). In addition, when cattle have unrestricted access to the river, they graze on riparian plants, causing erosion and sedimentation that affect stream flashiness (how quickly water enters and leaves a stream); they also directly deposit waste into the water. This analysis is supported by the West Virginia DEP, which lists agriculture/pasture as a source of pollution in the watershed (West Virginia DEP, 2022).

Factors that drive or contribute to this threat: The reasons farmers use unsustainable farming practices are complex and may include goal alignment issues, cost, time, and geographic location. According to researchers at Ball State University, there is strong evidence that external social, geographic, and economic factors shape regional farming systems (Grover, S., & Gruver, 2017). Some farmers use practices that allow for detrimental nutrient management and chemical use (West Virginia DNR, 2021, 24). This issue is exacerbated by the fact that farmers face social and structural challenges to adopting sustainable agriculture practices (Leffer et al., 2021). According to the *Cornell Chronicle,* "current research shows that with the right management practices, farmers could effectively grow crops while maintaining, and in some cases even enhancing ecosystem services". While some producers have incorporated more holistic practices in the Cacapon, many are not yet interested or equipped to do so.

Threat Assessment: This threat was rated for the aquatic/riparian ecosystem as medium in scope due to the fact that agriculture is 13.7% of the combined Cacapon and Patterson Creek Conservation area, with approximately the same distribution in each, compared to 85% forest cover. The severity rating is high due to the immediate effect on nutrient loads in streams and rivers and the large impact of the erosion and sedimentation caused by cattle encroachment. Irreversibility was ranked as very high due to the difficulty of restoring oxygen levels in streams, repairing riparian buffers, and reducing sedimentation caused by erosion.

6.2.3 Inadequate Forest Management (Summary threat rating = **HIGH**)

Threat Description and Affected Targets: Inadequate forest management is of concern to forest ecosystems and to farms that contain forest ecosystems. According to CWC partners, there is a gap in the way forest landowners are supported to create forest management plans. Landowners work with a forester to create plans that help them achieve their goals for their forests, including logging or improving habitats. However, these plans are often built with the purpose of gaining a profit, leaving out conservation-driven options. As an example, they cite the use of select cutting for profit as opposed to silviculturally-sound thinnings and harvests which improve the health of the forest by adjusting species composition, selecting for higher quality individual trees, and fostering wildlife habitat. Prioritizing logging over creating habitat or removing invasive species can result in crowded-out tree seedlings, invasive species introduction, poor tree regeneration, and unfavorably altered age mosaics.

Stresses and Impact to Target: CWC partners report that financially focused logging and poorly managed (or lack of) fire regimes are major threats to forest ecosystems. As a result, the forest exhibits poor maturation and structure. This information is of high concern to the WVDNR. This threat might also lead to an increase of invasive species that outcompete native herbs and shrubs. In a negative cycle, invasive species are more prone to catching on fire and can increase fire intensity (West Virginia DNR, 2021, 41). Figure 9 shows how these factors impact targets.

Factors that drive or contribute to this threat: A primary contributing factor to inadequate forest management is economic pressure on landowners. Some landowners work directly with logging companies, which are focused on profit. According to the WVDOF, "with over 260,000 non-industrial private woodland owners in West Virginia, the Division of Forestry places importance on providing landowner assistance for management and protection of woodlands" (West Virginia DOF, n.d.). This approach seems to be giving primacy to financial outcomes versus conservation of biodiversity. The National Association of State Foresters mentions that other factors that may be contributing to inadequate forest management are regulatory barriers and lack of resources, which are issues across the country for forestry agencies (National Association of State Foresters, n.d.).

Threat Assessment: Inadequate forest management is of strong concern to CWC partners. Because of the large forest cover in the Cacapon Watershed, the scope was rated very high. Due to the potential damage caused by unsustainable logging, severity was rated high. Irreversibility was rated medium since evidence-based (see Glossary) forest restoration processes are well known, and due to the medium degradation being caused, can be implemented successfully. Evidence-based refers to utilizing relevant information in all steps of a conservation practice.

6.2.4 Inadequate Hunting Management (Summary threat rating = **LOW**)

Threat Description and Affected Targets: This threat primarily impacts forest ecosystems. Inadequate hunting management in West Virginia as it relates to deer overpopulation leads to over-herbivory in forests (West Virginia DNR, 2021, 24).

Stresses and Impact to Target: Deer overgrazing represents stresses for forest ecosystems such as decreased tree age diversity and native understory, leading to decreased biodiversity, poor forest maturation and structure, and eventually an increase in invasive species. According to Cote et. al. (2004), overabundance needs to be defined in context, and propose four options, including that animals are overabundant when they "cause ecosystem dysfunction". The authors posit that though tolerance to herbivory varies among species and individuals within species, deer grazing impacts competitive relationships among species, with negative impacts on cover and diversity, forest succession, and ecosystem processes such as energy transfer, soil development, and nutrient and water cycles (Cote et al., 2004.)

Factors that drive or contribute to this threat: Hunting demand is a primary driver of deer population growth. CWC partners report that deer are being cultivated by hunters, further increasing the population in the watershed. Proximal research reveals that White-tailed Deer is one of the most sought-after big game species in West Virginia (West Virginia DNR, 2023). Every year, more than 200,000 resident and non-resident hunters participate in the whitetail deer hunting season (West Virginia DNR, n.d.).

Currently, the WVDNR is leading a study of the white-tailed deer population in three areas of the state including Hampshire County, the largest in the Cacapon Watershed. The study, which is due to be completed in 2026, includes an objective to develop an integrated population model. This work represents an opportunity for the CWC to influence how ideal population density is calculated and managed (West Virginia DNR, 2023).

Threat Assessment: This threat was rated as high in scope, as deer populations and hunting occur throughout West Virginia (West Virginia DNR, 2023). It was rated as medium in severity due to the slow progression of the threat and as low in irreversibility since once the threat is removed, forests tend to recover relatively quickly.

6.3 Climate Threats

The climate vulnerability analysis focused on changes in temperature regimes and in precipitation and hydrological regimes as threats to forest and aquatic/riparian ecosystems and agricultural landscapes. Greenhouse gasses are the major contributing factor that leads to climate change. The global average atmospheric carbon dioxide was 417.06 parts per million in 2022 and the increase in carbon dioxide emissions between 2021 and 2022 was the 11th year in a row that carbon dioxide increased by more than two parts per million (Lindsey, 2023). It is important to note that these threats act in tandem with one another and with conventional threats, and thus can be addressed with strategies that have a holistic impact on various threats.

Below is a description of each threat and a climate vulnerability analysis for each conservation target.

6.3.1 Changes in Temperature Regimes (Summary threat rating = **HIGH**)

Threat Description and Affected Targets: A shift in temperature regimes to higher temperatures is expected in the watershed, with larger changes in winter and fall (West Virginia DNR, 2021, 21). Higher temperatures will impact both forest and aquatic/riparian ecosystems. For example, water temperatures in the Chesapeake Bay watershed are shown to have increased between 1960 and 2014 (EPA, n.d.).

Stresses and Impact to Target: In West Virginia, it is expected that rising temperatures will contribute to earlier snow melts in spring and increased evaporation in summer drying the soil, and stressing both plant and animal species in forests. Still, the EPA does not anticipate a negative impact on forest cover, but rather in forest composition (Environmental Protection Agency (EPA), n.d.). Drought lowers fire tolerance and stresses forest species, making them more vulnerable to other stressors like pests and disease, and increasing the risk of wildfire and the abundance of invasive species. In addition, patches of forests created through development or where tree age diversity is low will be more vulnerable to temperature increases. In the Cacapon Watershed, this means severe fires combined with other stressors can lead to increased mortality of native species.

Increased temperatures increase allostatic load, which is the cumulative burden of chronic stress and life events. Allostatic load affects both stream and forest ecosystems, putting negative pressure on species that are unable to adapt, and impacting biodiversity by lowering species resilience and genetic diversity.

In streams, temperature shifts will affect migration, growth rate, body composition, and fecundity of aquatic species. Specific stresses to coldwater fish, mollusks, and other species associated with cold water will be likely. Warming surface water is also more likely to be conducive to algal growth, eutrophication, and water quality degradation. Species that require cold water habitats will also likely be negatively impacted by higher temperatures, as well as by reduced water levels which contribute to lower dilution of pollutants (West Virginia DNR, 2021, 45). Water temperature influences quality by accelerating chemical reactions resulting in additional nutrients in the water, as well as circulation patterns (EPA, 2023b).

Threat Assessment: Threats related to climate change were rated for forests as very high in scope, but medium in severity due to the high forest cover prevalent across the watershed, and high as a management challenge, since the conservation targets may adapt, but it may be costly to reverse the impact or promote adaptation. For aquatic/ riparian ecosystems it was considered that the severity would be high, due to the sensitive nature of species to changing temperature. Species living in streams are adapted to specific ranges of water temperature (EPA, 2023b)

6.3.2 Changes in Precipitation & Hydrological Regimes (Summary threat rating = **HIGH**)

Threat Description and Affected Targets: Precipitation has increased in West Virginia since the 1950s, and the state has seen a 25% increase in frequency of heavy storms. It is expected that this trend will continue, with winter and spring affected the most (EPA, 2023a).

Stresses and Impact to Target: Shifts in hydrological regimes will result in higher precipitation in winter and spring, drought in summer and fall, a lower snowpack, and longer growing seasons for forest and some animal species (West Virginia DNR, 2021, 25), stressing forest and aquatic/riparian ecosystems - including where they occur on farms - as well as agricultural landscapes. Higher precipitation will contribute to flooding, landslides, erosion, and changing soil patterns in forests, as well as sedimentation in streams (Cacapon & Lost Rivers Land

Trust, 2023). The early melting of snow in spring, as a result of higher temperatures, results in floods and lower water levels in rivers, lakes, and streams in summer and fall, contributing to lower pollutant reduction capacity and a higher probability of low oxygen levels due to algal bloom growth plus eutrophication (American Rivers, n.d.). Erosion and sedimentation caused by this threat combined with fragmentation and invasive species will limit the adaptation capacity of riparian forests (West Virginia DNR, 2021, 41).

Threat Assessment: Threats related to climate change were rated for forests as very high in scope, but medium in severity due to the high forest cover prevalent across the watershed. Management challenge was rated high, since the conservation targets may adapt, but it may be costly to reverse the impact or promote adaptation. For aquatic/riparian ecosystems the severity is considered to be high, due to the sensitive nature of species to changing temperature. Species living in streams are adapted to specific ranges of water temperature (EPA, n.d.). In addition, a result of increased frequency and severity of storms and flooding are statewide stresses for aquatic ecosystems (West Virginia DNR, 2021, 4).

6.3.3 Climate Vulnerability Analysis for Conservation Targets

According to Glick et al. (2011), a climate vulnerability analysis involves the assessment of the sensitivity, exposure, and adaptive capacity of a conservation target. This information becomes input for adaptation and/or mitigation strategies and plans (Glick et al., 2011). Sensitivity refers to how much a target is likely to be affected by climate change; exposure includes a measure of the extent of the change; and adaptive capacity includes how well the target can adapt to change. Below is an assessment for each of the targets in this plan for expected changes in temperature and climate regimes in West Virginia.

Forest Ecosystems: Forest exposure to climate changes will be high; temperatures are expected to continue rising; precipitation events will be more frequent and severe in winter and spring, and drought will be more prevalent in summer and fall, as mentioned above. The degree of sensitivity will vary over time - invasive species, wildfires, and pests can occur in a short timeframe and forests can recover relatively quickly if healthy; longer-term changes to structure and animal or plant populations will take much longer to become evident (EPA, 2023a). The adaptive capacity of this ecosystem is dependent on attributes like connectivity and tree age diversity, which are considered to be in fair condition for this ecosystem. As a result, climate change is considered a direct threat to forests in the Cacapon watershed.

Aquatic/Riparian Ecosystems: Streams, rivers, and riparian buffers will be strongly affected by climate change; as ambient temperature increases, so will surface water temperatures rise, and as precipitation increases, flooding events will become more frequent. This will result in an increase in erosion of buffers and sedimentation of springs, as well as unsustainable conditions for some aquatic species, an increase in the flow of pollutants during high precipitation periods, and a slow dilution of chemicals during droughts (EPA, 2023b). The degree of sensitivity will vary depending on the type of change - water temperature will shift more slowly while flooding and erosion events will happen sooner. The adaptive capacity of aquatic/riparian ecosystems will thus depend on the strength of these events and will vary considerably within a year. For these reasons, climate change is included in this analysis as a direct threat to aquatic/riparian ecosystems in the watershed.

Farms (agricultural landscapes): Agriculture is highly susceptible to weather and climate (EPA, 2023c). Climate change is expected to increase the frequency of heavy precipitation; this can harm crops by eroding soil and depleting soil nutrients. Heavy rains can also increase agricultural runoff into lakes, and streams which harms water quality. Because hay is a critical crop in the watershed, heavy and unpredictable precipitation may have particular effects on the financial viability of both hay and livestock farmers in this area.

Climate change may lead to longer growing seasons, which could have both beneficial and detrimental outcomes. It might increase the threat of wildfires EPA, 2023c), representing major risks to farmlands, grasslands, and rangelands. Temperature and precipitation changes will likely expand the occurrence and range of insects, weeds, and diseases, which might require greater need for weed and pest control. Pollination, which is vital to more than 100 crops grown in the United States, is vulnerable to warmer temperatures and changing precipitation which can lead to mismatches between when plants flower and when pollinators emerge.

7. Strategies

7.1 Strategy Selection Process

A strategy is a set of activities with a common focus that work together to reduce threats and improve the health of conservation targets. The CWC team identified draft strategies as they considered factors contributing to and exacerbating threats and as they discussed ways to improve conservation target key attributes. Draft strategies were then rated based on their (1) potential to mitigate a threat or restore a target (i.e., potential impact), and (2) feasibility of implementation. For each criterion, the team assigned one of four ratings: Low (1 point), Medium (2 points), High (3 points), or Very High (4 points). The result was a list of strategies rated according to perceived effectiveness (very effective, effective, less effective, and not effective; Table 7). After draft strategies were rated (for method, see Appendix E), the top five were selected to be implemented as part of the current action plan.

Table 7. Results from strategy rating process.

Strategy Number	Strategy Name	Potential Impact	Feasibility	Summary Rating
S1	Farmer Information and Financial Aid	3	4	3.5 - Effective
S2	Protect Prioritized Lands with Conservation Easements	3	4	3.5 - Effective
S3	Incentivize Restoration of Riparian Buffers	3	4	3.5 - Effective
S4	Improve and Develop Native Brook Trout Patches	2	4	3 - Effective
S5	Promote Forest Management Plans focused on Long-term Forest Health	2	3	2.5 - Need More Info

The following sections describe each strategy including providing background information and a description of the challenges and threats that the strategy is designed to mitigate. Following the strategy description, the

CWC's **theory of change** (glossary) is articulated, followed by a figure of a **results chain** (glossary) that depicts the theory of change in diagrammatic form. In essence, the theory of change is the team's working hypothesis for how the strategy, if implemented correctly, will produce measurable results, ultimately leading to threat reduction and maintenance or improvement of the conservation target. These measurable results, called **objectives** (glossary), are benchmarks that will be monitored to demonstrate strategy effectiveness and to provide the evidence required to adjust the strategy as necessary. Finally, a high-level work plan is provided for each strategy listing the primary activities required to achieve desired results.

7.1.1 Strategy 1: Develop or Expand Farmer Information and Financial Aid

Full title: Develop and deliver information and financial support to assist farmers in creating a comprehensive conservation plan

Conservation targets affected
Streams, Forests, Farms

Relevant Goals
If successful, this strategy would contribute to achievement of all goals for each target.

Direct threats addressed:
Unsustainable residential and commercial development, detrimental farming practices, succession challenges, Drivers: financial barriers, succession challenges, lack of labor, lack of access to materials and resources, lack of access to updated info and science (e.g., nature-based practices).

Background and Challenge to be Addressed

Farmers know their land best and often embrace new practices to bolster the sustainability of their enterprise. Many sustainable farming practices have been developed to support farmers and lighten the impact of farming on streams and adjacent riparian areas without reducing profitability. However, financial concerns, access to materials and resources, and lack of information often impede the adoption of conservation practices (Remsberg, 2023). In West Virginia, over 40% of farmers report that barriers to sustainable methods of farming include lack of labor and costs of fencing, among others (McCartney, 2019). In addition, it has been shown that financial compensation improves the adoption of better farming practices (Sawssan et al., 2023).

One area of opportunity to address these barriers is for the CWC to collaborate with NRCS. NRCS works directly with farmers to develop comprehensive conservation plans for their lands and to find financial aid to reduce material costs.[2] These services are offered free, and funding is usually available for practices such as developing riparian buffers and providing alternative water sources, among other conservation practices. The engagement process for the plan includes an assessment of the current condition of natural resources and ecosystem services. Recommendations to farmers consist of practical solutions to improve and protect soils and water management, while at the same time supporting farm viability (Natural Resources Conservation Service, n.d.). The National Conservation Planning Partnership (NCPP) is the agency that directs the process, which typically starts with a visit by a planner. Importantly, the approach is triggered by a request from the farmer.

[2] Personal communication with Rebecca Royal, acting district conservationist for the Potomac Valley Conservation District, October 10, 2023.

Most farmers care deeply about the wellbeing of the land and the impact of their operations, but hesitate to change familiar operations because of potential costs in time and dollars. Many farmers in this watershed are not aware of support available from NRCS or other agencies. Consequently, they continue to use traditional farming methods that may not be environmentally sound.

Strategy Summary

This strategy represents a collaborative effort among NRCS, Trout Unlimited, and other CWC members to develop and deliver information and support to farmers, likely resulting in their engagement with the NRCS to create a comprehensive conservation plan. These conservation plans would be customized, and aligned around the farmer's personal and business objectives. The plan would capture best management practices to help encourage sound conservation on the land base. A nine-step conservation planning process would be used to improve the overall farming operation.

Members of CWC will reach out personally to farmers within the watershed, inviting them to participate in information-sharing workshops developed by NRCS. These workshops will explain the NRCS program, its benefits to farmers' bottom line and to downstream ecosystems, and financial support options (National Association of RC&D Councils et al., 2019)[3].

In a complementary effort, CWC will develop, promote, and support a farmer peer-to-peer network to build a conservation-minded community, develop a shared-resources network, and create an outlet for success stories. Simultaneously, the CWC will develop a survey and send it to large-tract landowners for the purpose of understanding their motivations and the barriers to conservation-minded changes to their operations.

Theory of Change

The CWC believes that if they share information with farmers about sustainable practices while offering support for securing financing for improvement efforts, farmers will integrate best management practices into their current farming operations(Figure 13). If they join the program, they will request a conservation plan from NRCS. Further evidence suggests that personalized invitations and peer-to-peer outreach are effective ways to encourage enrollment in these knowledge-sharing sessions (Czap et al., 2019). Experience shows that in-person sessions during the winter months are optimal. Field days and workshops where farmers can learn from each other are also recommended for effective knowledge sharing (PennState College of Agricultural Science, n.d.). NRCS and CWC member Rebecca Royal, who works closely with Hampshire County farmers, favors peer-to-peer networking, by matching successful host farms with prospective applicants to foster a "learn from others approach" (R. Royal, personal communication, October 24, 2023). Once conservation plans are completed to their satisfaction, farmers should have the information needed to apply for financial assistance from the various sources suggested. (Once financial assistance is secured, farmers should be able to update practices, and reduce long-term destructive processes such as cattle encroachment and nutrient/chemical runoff.) Such modifications will help reduce erosion, excessive sedimentation, and stream flashiness. Lower nutrient and chemical loads will improve water quality for local communities and reduce eutrophication (Friends of the Cacapon River, 2012).

[3] Farm bill programs available to producers include the Environmental Quality Incentive Program (EQIP), the Agricultural Management Assistance Program (AMA), the Conservation Reserve Enhancement Program (CREP), plus additional funding for practices needed to create a riparian buffer and provide alternative water along with other supporting practices (personal communication, R. Royal, NRCS District Conservationist, October 15, 2023).

Such paths for improvement will increase fish and macroinvertebrate abundance and improve the overall health of the Streams conservation target.

Objectives:

Objective 1-1: Beginning in 2024, at least 10% of farmers in the watershed attend a workshop about conservation planning every year, for a total of 70% by December 2030.

Objective 1-2: By December 2030, 35% of farmers in the Cacapon Watershed have a comprehensive conservation plan from the NRCS.

Objective 1-3: By December 2030, 35% of farmers in the watershed have completed one conservation practice.

Objective 1-4: Decrease total nutrients (nitrogen/phosphorus) in farm-adjacent streams from baseline measurement (add the baseline) to less than 2.0 ppm by 2030.

High-level Work Plan:

KEY ACTIVITIES	WHO	WHEN	STATUS
1.1. Create or enhance curriculum for farmer education and conduct reviews at the beginning of each project year.	NRCS		Not started
1.2. Send personalized, handwritten notes to invite farmers to workshops and field days to appeal to their interest in learning and improving their farms.	CWC team member. Who takes the lead?		Not started
1.3. Lead four workshops/field days per year for the duration of the project for 25 participants each.	NRCS		Not started
1.4. Work with farmers one-on-one to develop customized conservation plans	NRCS		Not started
1.5. Source financial assistance from relevant agencies for specific activities in the plan and support farmers with the application process.	NRCS		Not started

Figure 13: Farmer Information and Financial Aid Results Chain. Objective numbers correspond to the list of objectives above. (For expanded image, see Appendix F)

7.1.2 Strategy 2: Secure Conservation Easements on High-Priority Lands

Full title: Generate funding and sufficient capacity to secure conservation easements on high-priority lands.

Conservation targets affected:
Streams, Forests, Farms

Relevant Goals:
If successful, this strategy would contribute to achievement of goals for each target

Direct threat addressed:
Unsustainable residential and commercial development

Background and Challenge to be Addressed

Residential and commercial development are collectively one of the most critical threats to the Cacapon Watershed's ecological integrity. Due to the pace at which development companies and realtors are taking advantage of interest in this area, the unique ecology of the Cacapon Watershed could be degraded to the point of irreparable harm to aquatic and forest ecosystems in coming years (personal communication (M.Suval, CLRLT Deputy Director, 8 September, 2023). Building hubs and corridors of protected lands is a foundational strategy to enable other strategies, including restoration. To this end, the CLRLT partners with private landowners, who own the vast majority of land in the Cacapon and Lost Rivers Watershed. Conservation easements have been an effective tool for CLRLT and county Farmland Protection Boards in curtailing development in high priority ecological areas and on important agricultural soils. However, these small organizations are limited by the number of landowners with which they can build relationships, staff capacity to develop conservation easements, and funding to purchase conservation easement value and/or pay for due diligence and transactional costs of the process.

Strategy Summary

Strategy 2 aims to address the three primary challenges of conservation easement production: 1) effective outreach, 2) easement production capacity, and 3) funding. At present, landowner interest in conservation easements exceeds capacity and funding. As such, the CWC's current focus is on acquiring funding and building capacity. If interest later wanes or existing outreach no longer attracts owners of high priority lands, then the outreach sub-strategy (strategy 2B) will become more important.

To fund specific conservation easement projects and to build capacity, CLRLT and FPBs will seek funds from private foundations and state and federal agencies. Other CWC members may also seek funding to support their land protection partners. For example, Trout Unlimited and CLRLT have a history of capitalizing on one another's landowner networks and providing financial support to one another (in the way of pass-through grant funding) to achieve their shared goal of steam restoration on protected lands. More CWC members may be able to similarly support the conservation easement strategy through their own funding streams (just as the land trusts may support other partners/strategies through their grants).

As needed, the CWC will initiate the outreach portion of the strategy (2B in the Theory of Change). CLRLT and participating FPBs will share with CWC members the basics of their programs, priorities, and

the conservation easement process. CWC members will then be prepared to promote conservation easements to landowners of properties identified as high value for conservation.

Theory of Change

The conservation easement theory of change is depicted in Figure 14. In summary, if owners of priority lands are identified and educated by CWC members about conservation easements, and if sufficient funds and personnel capacity are acquired to complete conservation easements, then easement processes will be completed, priority lands will be protected, and conservation targets will be met (M. Suval, personal communication, October 19th, 2023).

Priority Land Identification: It is essential to identify priority land before attempting to protect parts of an area (Vick, 2019). The CLRLT has a prioritization model in place already for this purpose (Cacapon & Lost Rivers Land Trust, 2023), and the farmland protection boards have agriculture-focused criteria with which to evaluate their potential projects. If priority lands are identified, then land trusts and other CWC members will promote conservation easements to high priority landowners.

Engagement Plan: If priority parcels/areas are identified and CWC members are well-informed about conservation easement processes and the programs of member land trusts, then CWC members will communicate easement and land trust information to their priority landowner contacts. Some CWC members might inform landowners about the CE process in casual conversations (J. Kinlein, personal communication, October 6th, 2023). If the CWC informs priority landowners about conservation easements, then priority landowners may commit to conservation easements for their properties.

Evidence suggests that landowners are more likely to participate in the easement process when information is given to them by a technical advisor or member of a stewardship social network (Kemink, 2020). If the initial contacts promote conservation easements with their neighbors, there would be a further increase in participation (Nohner, 2018). There is evidence that people tend to follow their peers' example, but there is still uncertainty that easement education will lead directly to easement participation, hence the dotted line. If landowners commit to conservation easements (and adequate funding and capacity are available, as discussed below), then the easement process will be completed.

Easement production capacity and funding: If the CWC generates sufficient funding and personnel capacity to secure conservation easements on high-priority lands, easement production processes will be carried out and conservation easements will be completed. If conservation easements are completed and recorded in the county land records, annual monitoring plans will be put in place to ensure easement compliance. If easements are completed and monitoring is performed, easement compliance will result. Easement compliance is assumed because 1) people who go through the effort of placing their land into a conservation easement (or who purchase land with a conservation easement) are usually committed to the conservation goals (Warner, 2019) and 2) if landowners do not comply, the land trusts will identify violations during annual monitoring and enforce compliance (Warner, 2023). See the easement compliance box in Figure 14. If easement compliance occurs, then parcels within the Cacapon Watershed with conservation easements are protected from development (Rissman, 2007). If priority parcels are protected from development, then the farms, forests, streams, and related aquatic/riparian ecosystems, forest ecosystems, wildlife habitat, and agricultural viability of those Cacapon Watershed lands will remain healthy and resilient.

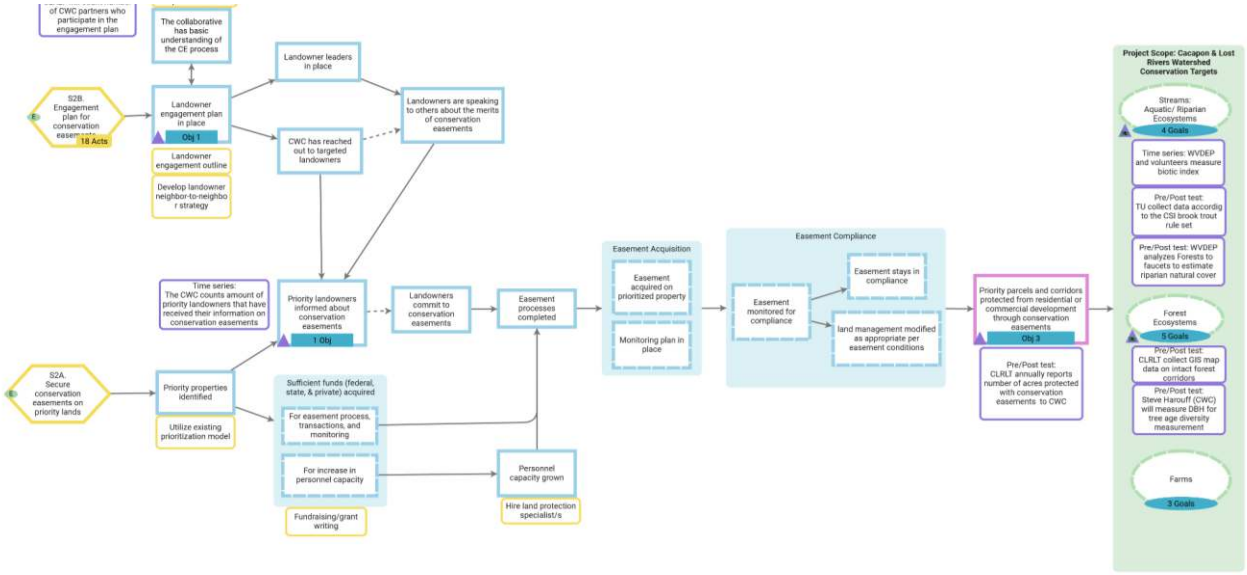


Figure 14: Results Chain: Secure conservation easements on priority lands (For expanded image, see Appendix F)

Objectives

Objective 2-1: By mid 2024, CWC members will be well informed about conservation easements and member land trust's programs and thus equipped to educate their landowner contacts.

Objective 2-2: By January 2026, CWC members will have informed 50 new landowners about conservation easements.

Objective 2-3: By January 2026, CWC members will have raised $500,000 for conservation easement acquisition (for easement purchases, due diligence/transaction costs, or staff costs).

Objective 2-4: By the end of 2030, 3,000 new acres within priority areas of the Cacapon Watershed will be protected by a conservation easement.

High-level Work Plan

KEY ACTIVITIES	WHO	WHEN	STATUS
Identify priority properties using CLRLT's existing GIS land prioritization model	CLRLT	End of 2023	Complete
Create "conservation easement talking points" to assist CWC members in outreach to their landowner contacts	CLRLT & FPBs	May 2024	50%
Hold a conservation easement training session for CWC members, so they're better prepared to promote conservation easements to their landowner contacts.	CLRLT & FPBs	by mid-2024	Not started

As needed: CWC members share information about conservation easements with their landowner contacts	All	NA currently	NA currently
Apply for state and federal funding and engage private donors to receive funding for conservation easement transactions and expanded personnel capacity.	All members; CLRLT leads	Ongoing	TU secured easement $ in 2022. CLRLT applied for OHCF $ 12/2023.
Complete conservation easement production processes	CLRLT, Hamp FPB Hardy FPB	Ongoing	CLRLT closed 1 easement Dec '23. FPBs?
Monitor all existing conservation easements & ensure compliance	CLRLT, Hamp FPB Hardy FPB	Annual, Ongoing	In Progress
Optional: Recruit and hire a land protection specialist to expand capacity as funding permits.	CLRLT		Not started

7.1.3 Strategy 3: Incentivize Restoration of Riparian Buffers

Full Title: Incentivize and support landowners to restore riparian buffers

Conservation targets affected:
Streams, Forests

Relevant Goals (see Sections 5.2.1 and 5.2.2):
Streams 1: By 2030, the watershed has 80% or greater riparian natural cover in all subwatersheds of the Cacapon Watershed, including any shrubs, trees, and plants, not crops or built infrastructure.

Streams 2: By 2030, the Family Biotic Index (FBI), a field assessment of organic pollution, is less than 4.25 on average across test sites in the Cacapon Watershed.

Forests 1: By 2030, increase the number of new corridors between intact forest patches in the Cacapon Watershed from 0 to 1.

Forests 2: By 2030, Cacapon Watershed has had no loss of forest cover relative to 2022 baseline.

Direct threat addressed:
Strategy 3 is a restoration strategy. As such, its purpose is not to reduce a threat, but rather to improve key attributes of the Streams conservation target.

Background and Challenge to be Addressed:

Aquatic ecosystems are inextricably connected to surrounding terrestrial ecosystems. A healthy riparian buffer of native vegetation protects the stream it borders from pollutants carried by runoff, helps control erosion by anchoring the soil on a streambank, and serves as habitat for riparian species (West Virginia DEP, 2009). Additionally, riparian buffers can help reduce flood damage and provide essential shade, creating a more resilient defense against increases in precipitation and temperature due to climate change (U.S. Department of Agriculture, n.d.).

The key threat facing the watershed, unsustainable residential and commercial development, impacts streams partly because riparian buffers are typically mowed to allow development near the river and streams, even for temporary housing like hunting cabins.

During the 19th and early 20th centuries, farming and livestock production practices often resulted in the elimination of woody vegetation near streams. Cattle are especially destructive to riparian habitats when they have unrestricted access. In recent decades, science and conservation-minded landowners have recognized that traditional farming and ranching methods degrade streams and riparian ecosystems, resulting in a loss of wildlife, aesthetic value, and recreational angling opportunities. Even though many landowners now recognize the damage caused by past practices, it takes time, money, and specialized knowledge to restore riparian areas with native plants that support wildlife and healthy aquatic ecosystems. In most cases, lack of one or more of these resources impede landowners from taking steps to restore riparian buffers along streams that transect their land.

Targeted conservation and restoration of riparian buffers near cultivated and pasture lands and on forested lands within the Cacapon Watershed would protect and improve water quality, ensuring clean drinking water for local communities (West Virginia DNR, 2021, 30). When riparian areas are buffered

with woody and herbaceous plants, the vegetation shades streams, thereby reducing water temperature and maintaining habitats for cold-water fish and other species, even as average air temperatures rise. Restoring riparian ecosystems in the Cacapon Watershed also would help stabilize river and stream banks, prevent erosion, provide flood control, and decrease the severity and frequency of floods that impacts human safety (WeConservePA, n.d.).

Highly degraded stream and river banks are those that are high, steep, erodible, and eroding. Restoration of such banks is often costly, but critical to improving aquatic ecosystems. Stream banks that are less degraded but lacking forest cover can be restored with much lower cost with simple reforesting effort. If both types of restoration are pursued where streams intersect cultivated, pasture, and other deforested lands within the Cacapon Watershed, water quality would be preserved or improved, ensuring clean drinking water for local communities (West Virginia DNR, 2021, 30). When riparian areas are buffered with woody and herbaceous plants, the vegetation shades streams, thereby reducing water temperature and maintaining habitats for cold-water fish and other species, even as average air temperatures rise. Thus, restoration of degraded banks ameliorates climate-related threats to fisheries. Restoring riparian ecosystems in the Cacapon Watershed also would help stabilize river and stream banks, prevent erosion, provide flood control, and decrease the severity and frequency of floods that impacts human safety (WeConservePA, n.d.).

Strategy Summary

The aim of this strategy is to incentivize and facilitate the establishment of riparian buffers on private lands throughout the watershed where banks are highly degraded and where less degraded banks lack adequate forest cover. Although landowners often wish to conserve their lands and the waterways that transect them, incentives are usually required to motivate them to put time and financial resources into a restoration project. CWC members will create and publicize an incentive program that will provide grants and cost-share programs to landowners who are willing to lead a restoration project on their land. Member organizations will prioritize stream banks in the watershed where restoration would provide the greatest benefits to stream ecosystems, prioritizing important habitat features and locations such as brook trout patches (CFA, WV DNR). After stream banks are prioritized, a multi-faceted marketing campaign will publicize this conservation opportunity, and owners of high priority areas will be contacted and invited to participate. Trout Unlimited and the USGS will provide technical support for restoration activities.

Is anyone going to monitor these areas afterward? If so, that info could go here or perhaps in the monitoring section.

Theory of Change

Three to four years will be required to develop an incentives program and prioritize stream banks. By the beginning of 2025, outreach will have begun in several watersheds with known brook trout patches, including Dillons Run, Cold Stream Run, Hiett, Three Springs, and Trout Run. Assuming incentives are sufficiently motivating, it is expected that concentrated marketing and personal invitations will result in at least 10 landowners signing up for the program by the end of the year. With assistance from NRCS, at least five of these landowners will have completed conservation plans by the end of the following year. Most projects will take one or two years to complete, and our aim is that by 2028, site-appropriate native riparian plants will have been planted on at least 1.5 km of stream bank.

Riparian vegetation grows quickly, and within a few years after planting, bank erosion will be

reduced in planted areas and nutrient overloading in the streams will be minimized because of reduced flashy runoff during rainstorms. These results rely on the assumption that funding will be available to install costly fencing and water systems where necessary to redirect cattle access. Plantings associated with brook trout patches will increase shade and reduce the temperatures of the water, improving habitat for the species. As stream ecosystems are improved, brook trout will thrive, enhancing recreational opportunities for anglers.

Objectives:

Objective 3-1 (same as Objective 4-1): By January 2025, targeted outreach has begun in seven known brook trout patches representing middle percent watersheds.

Objective 3-2: By the end of 2025, 10 landowners have signed on to the program.

Objective 3-3: By the end of 2026, 5 conservation plans have been completed.

Objective 3-4: By 2028, x landowners have planted riparian buffer, of x length

High-level Work Plan:

KEY ACTIVITIES	WHO	WHEN	STATUS
Identify funding sources			Not started
Review Forests to Faucets map for data on key areas to target	DEP	2024?	In progress
Implement citizen science projects to monitor stream temperature	USGS	2024	Not started
Check social marketing studies for appropriate outreach methods and language	?	2024?	Not started
Build outreach capacity	TU and?	2024?	Partially Achieved
Secure funding to offer grants to landowners	TU and ?	2024?	In progress
Provide technical support to landowners for protecting riparian buffers	TU, USGS?		In progress

7.1.4 Strategy 4: Improve or Develop Native Brook Trout Patches

Full title: Support the improvement, identification, and creation of brook trout patches

Conservation targets affected:
Streams

Relevant Goals (see Section 5.2.1):
Streams 3: By the end of 2030, at least five brook trout patches have been improved through completion of stream restoration projects. .

Streams 4: By 2030, at least 1 new brook trout patch has been identified or created within the watershed.

Direct threat addressed:
Strategy 4 is a restoration strategy. As such, its purpose is not to reduce a threat, but rather to improve key attributes of the Streams conservation target.

Background and Challenge to be Addressed

Brook trout are the only trout species native to the eastern United States, but their habitats have been slowly invaded by non-native brown trout and rainbow trout, particularly in the Appalachian region (Trout Unlimited, 2007). The Cacapon watershed's cold headwater and groundwater influenced streams provide support to these threatened native brook trout patches and are a key attribute of the Streams conservation target (West Virginia DNR, 2021, 14; Cacapon & Lost Rivers Land Trust, 2023). Like many chars (genus Salvelinus), brook trout are highly sensitive to increases in water temperature, non-native fish, and polluted waters, making them an excellent indicator of stream health (Trout Unlimited, 2007). The native brook trout is a charismatic species, particular for the state of West Virginia where it is recognized as the "state fish". Brook trout have a large following among anglers as a highly sought after game fish. Landowners often tell stories of how their ancestors angled for brook trout on their land and take pride in their presence on the landscape. However, their presence is not guaranteed for future generations. It will require targeted action to combat impacts from natural disasters, climate change, and a variety of other anthropogenic effects. These actions are typically well received by landowners. With some outreach and education they quickly understand the need and benefits of stream restoration.

Strategy Summary

The primary aim of this strategy is to improve and expand existing brook trout patches, as well as identify or create new patches within the watershed.. The primary funding source will be Farm Bill programs managed through the Natural Resource Conservation Service (NRCS), namely the Environmental Quality Incentives Program (EQIP). Additional funding is available through Trout Unlimited (TU) to reduce the financial burden for landowners and make conservation an easy choice. Along with the Cacapon Watershed Collaborative (CWC) members, TU will conduct targeted outreach within known brook trout patches. Once an eligible landowner is identified, TU will work directly with the NRCS to plan the best management practices that would be suitable for both the brook trout and the landowner's objectives. Additionally, TU's conservation crew has the ability to implement the planned practices, providing a turn-key service to landowners seeking assistance with conservation projects. TU will also assist in locating unknown brook trout patches through their annual electrofishing efforts. Finally, If a stream is identified as a potential candidate for Brook Trout reestablishment, the

West Virginia Division of Natural Resources would take the lead and be the decision maker for that effort.

Theory of Change

The CWC is confident that funding will be secured during 2024 to implement stream work on private and public lands through NRCS and TU. As funding is being arranged, outreach capacity within the CWC will be developed. Simultaneously, TU will document and prioritize existing brook trout patches and will continue to search for new ones. If these results are achieved by the beginning of 2025, outreach will commence in that year with individuals who have prioritized brook trout patches on their land. If outreach occurs on a regular basis, landowners will become aware of the habitat improvement program and funding opportunities. The CWC expects that by the beginning of 2026, at least five landowners will have signed on to the program and have access to its associated funding.

After landowners sign up for the program, TU staff will assist them in creating conservation plans for their lands, and CWC expects that by the beginning of 2027, at least 5 plans will be completed for landowners. With plans in place and landowner support, TU, WVDNR, and subcontractors will implement the conservation plans and associated practices. The CWC believes that as conservation plans are implemented, existing and newly-discovered brook trout patches will be improved—measurably so by the end of 2030. Further, it is possible that improved habitat will open the way for new patches to be recolonized. Together, these results will improve the health of the Streams target and increase recreational opportunities for anglers.

Objectives:

Objective 4-1 (same as Objective 3-1): Beginning January 2025, TU contacts at least 5 landowners per month personally to gauge interest in participating in the brook trout patch restoration program.

Objective 4-2: By January 2026, 5 landowners with known brook trout patches on their lands have signed onto the program.

Objective 4-3: By January 2027, 5 plans have been completed by TU and the NRCS.

Objective 4-4: By the end of 2030, 5 projects have been completed.

High-level Work Plan:

KEY ACTIVITIES	WHO	WHEN	STATUS
Identify funding sources			Not achieved
Targeted education and landowner outreach			Not achieved
Technical assistance and conservation planning assistance for new projects	TU		Not achieved

Implementation of planned stream work			Not achieved
Complete electrofishing surveys to confirm or deny the presence of brook trout within suspected patches	TU WVDNR		On Track
Reintroduce brook trout (if applicable)	WVDNR		Not started

7.1.5 Strategy 5: Promote Forest Management Plans Focused on Long-term Forest Health

Full title: Implement an outreach campaign that motivates private landowners to develop, implement, and maintain scientifically-sound forest management plans.

Conservation targets affected:
Forests

Relevant Goals:

- Forests 1: By 2030, Cacapon Watershed has had no loss of forest cover relative to 2022 baseline
- Forests 2: By 2030, Cacapon Watershed has 20,000 acres (% of forest?) under forest management plans.
- Forests 3: By 2030, Cacapon Watershed has a mosaic of diverse age classes *(if data available)*.
- Forests 4: By 2030, Cacapon Watershed will have # acres of forest under conservation easement.
- Forests ?: By 2030, increase the number of new corridors between intact forest patches in the Cacapon Watershed from 0 to 1. (*FWG must determine applicability of this goal)*

Direct threat addressed:
Unsustainable development, detrimental/inadequate forest management practices, detrimental hunting practices.

Background and Challenge to be Addressed

Forested landscapes that are managed according to sound scientific principles maintain a variety of successional stages, including diverse age classes and an abundant understory of native plant species. As a result, these forests are able to provide habitat for a wide array of wildlife species, efficiently provide ecosystem services like filtering of water and cycling of nutrients, and are resilient to high-intensity wildfires and other disturbances.

On private lands within the Cacapon watershed, forest management is often absent or inadequate in promoting and maintaining healthy, diverse forests. This happens for a variety of reasons including legal and regulatory barriers, lack of financial resources, industry infrastructure, and development pressures. In some cases, landowners desire to manage their forested lands to improve wildlife habitat, but lack a specific plan of action or do not know what should be done to achieve their desired results. In other cases, landowners' existing forest management plans emphasize timber production over a healthy forest ecosystem.

Many landowners could make impactful changes with proper forest management practices if they created and implemented a forest management plan with the assistance of a professional forester. Private landowners interested in getting such plans can face barriers in financial cost, waiting periods from consultants, or technical knowledge/assistance in carrying out management objectives.

Strategy Summary

The primary aim of this strategy is to improve forest management. The CWC intends to incentivize

adoption of scientifically-sound, holistic forest management plans by landowners in the Cacapon Watershed through an outreach strategy. The outreach campaign would highlight the benefits and elements of a good forest management plan, as well as the steps to developing a plan. The University of California has workshops, videos, and other tools that would be a good reference for this strategy in the future (Regents of the University of California, 2023).

Theory of Change

The CWC believes that if landowners are repeatedly exposed to clear marketing messages that explain the benefits of holistically-managed forests, many will wish to develop such plans on their lands. Further, if they are informed about available technical and financial assistance to develop such plans, many will proactively initiate the process of developing a holistic forest management plan. Assuming that sufficient trained foresters are available to support these planning efforts[4], the CWC predicts that by the end of 2026, XX landowners will have completed holistic plans to manage at least ?? acres of forest. Beginning in 2027, the CWC expects XX plans, guiding management of at least ?? acres, to be completed annually. One of CWC's goals is to have XX acres being managed under holistic forest management plans by the end of 2030. It will take a few years for positive, measurable impacts to be observed, but the CWC expects to document indicators of improved forest health by the end of 2030.

Objectives

[The Forests Working Group has not yet set objectives. Below are suggestions to consider]

Objective 5-1: By [month, year], a forest management outreach campaign is developed and implementation has begun.
Objective 5-2: Beginning in 2025, X number of Cacapon River Watershed landowners complete a holistic forest management plan.

High-level Work Plan

KEY ACTIVITIES	WHO	WHEN	STATUS
5.1. Develop content for marketing plan	?	2025?	Not started
5.2. Develop marketing strategies for marketing plan (physical brochures to distribute, radio spots, etc.)	Consultant?	2025?	Not started
5.3. Design & produce materials, recordings, web pages, etc.	Unknown		Not started

[4] The CWC decided to focus first on developing a marketing campaign. If that proves successful and there is a higher demand for new forest management plans than can be met with current personnel, CWC will implement another strategy to increase forester capacity. This strategy could involve increasing forester personnel or encouraging more private consulting foresters to assist with the workload.

7.1.6 Alternative Strategies

An additional strategy was identified in the situation analysis (see Figure 11) during the team's brainstorming sessions to address important threats to the Cacapon Watershed, but did not rank highly enough in Table 7 to be expanded into a theory of change for inclusion in this plan. The team might consider it for possible future implementation to protect the Cacapon Watershed from further threat.

Influence the Integrated Population Model for white-tailed deer. This strategy would be based on an emerging opportunity: The WVDNR is currently working on a population study on white-tailed deer that will be published in 2026. The study will inform the DNR and the public about deer survival rates, behavior, and movement patterns in a few counties in West Virginia, including Hampshire County which is a part of the Cacapon Watershed (West Virginia DNR, 2023). This study will inform the DNR's deer management recommendations, the strategy the team chose for the situation model works (see Figure 11) on this opportunity by influencing the DNR's updated goals on deer population targets to be lower so they have less of an impact on the forests of the Cacapon Watershed. This strategy requires more inquiries into the data the WVDNR are collecting and how the CWC might influence the population model. It was not feasible for this plan but may be a useful strategy to expand upon in the future. This work represents an opportunity for the CWC to influence how ideal population density is calculated and managed (West Virginia DNR, 2023).

8. Monitoring Plan

8.1 Overview

In the Conservation Standards, creating a **monitoring, evaluation, and learning (MEL) plan** (see Glossary) is a critical step that requires a team to define their **audience** (see Glossary), which is an individual or group that the team is trying to reach. The plan also requires the identification of information, data needs, timeframes, project roles/responsibilities, and methods for collecting data. If done correctly, the monitoring plan helps a team track the effectiveness of their strategies and adapt if needed (Conservation Measures Partnership, 2020). In order to develop a monitoring plan for each of the project goals, the team defined internal audiences like the project team and project partners and external audiences like policymakers and donors. Next, the project team identified the information and data needs of each audience. Then, the project team selected their approach and methods for data collection through the lens of what would be most accurate, reliable, cost-effective, appropriate, and feasible for the project (Foundations of Success, 2020). Finally, the team determined how to divide monitoring responsibilities and specified a timeframe.

In the sections below, the detailed monitoring plan for each of the goals is laid out as well as the threat reduction objectives and intermediate objectives. The MEL tables below show the indicators (what is measured), the methods (how an indicator is measured), the time frame (when the measurements will take place), roles and responsibilities (who will be in charge of measuring), and how the information will be used in further planning and decision-making. The team chose two types of monitoring approaches that measure the condition of an indicator: one approach was pre-test/post-test and one was time series. The pre-test/post-test approach involves collecting data before and after an intervention. The time series approach requires data collection at set intervals over a period of time (Conservation Measures Partnership, 2020).

8.2 Goals

We developed monitoring plans for two of our conservation targets: streams and forests ecosystems.

8.2.1 Goals for the Streams target

The team created three monitoring plans for the Streams conservation target. The first goal is that by 2030, there will be 80% or greater riparian natural cover, which includes any shrubs, trees, and plants(it does not include crops or any kind of built infrastructure) in all sub-watersheds of the Cacapon (see Table 10). The most feasible way to monitor this goal would be for a WVDEP staff member to analyze existing GIS data from the National Forests to Faucets database, a user-friendly tool that helps forest managers and planners understand riparian conditions (USDA Forest Service, 2022). A pre-test/post-test monitoring approach will be used to compare the 2022 riparian natural cover data to 2030 data.

Table 8. Monitoring Plan for Riparian Natural Cover

What	How	When	Who	Decision-Making
Goal: By 2030, the watershed has 80% or greater riparian natural cover in all subwatersheds of the Cacapon Watershed, including any shrubs, trees, and plants, not crops or built infrastructure				

Monitoring Approach: Pre-test / Post-test				
Percentage of riparian natural cover along streams and rivers in the Cacapon Watershed	Forests to Faucets GIS data from 2022	Analyzed in 2023 and 2030	USDA, USGS - has already collected the data. Alana Hartman at the WVDEP is responsible for analyzing the data	To determine if the strategy to improve riparian buffers through farmer education about NRCS conservation plans is working and if adjustments need to be made.

There are many different ways to measure macroinvertebrate abundance and diversity. One of the most well-regarded is the Hilsenhoff Biotic Index (HBI), which assigns a tolerance value to macroinvertebrates down to the species/genus level. While the HBI is the most precise measurement of a stream population's tolerance to pollutants and the general health of the stream, it is generally performed by experts in macroinvertebrate identification, and would likely require volunteers to verify any specimens they find in a lab. This could be costly and time-consuming; therefore, the project team chose to use the Family Biotic Index (FBI) instead. This should be much easier for the citizen monitoring volunteers from the WVDEP to be trained in and use correctly, as it is already in practice in many citizen monitoring programs in the United States (Water Action Volunteers, 2015). This monitoring plan (see Table 11) uses a time series approach, overseen by the WVDEP, to measure the FBI of ten sites twice a year until 2030.

What	How	When	Who	Decision-Making
Goal: By 2030, the Family Biotic Index (FBI), a field assessment of organic pollution, should be less than 4.25 on average across test sites in the Cacapon Watershed.				
Monitoring Approach: Time Series				
Abundance and diversity of macroinvertebrate species/taxa	Collection of macroinvertebrates and use of Family Biotic Index	Collect data twice a year, once in spring, once in fall	Stream monitoring volunteers from WVDEP and other partner organizations will perform biotic indexes	To understand general health of the stream and measure improvement over time

Table 9. Monitoring Plan for Macroinvertebrate Abundance and Diversity

The monitoring plan for measuring brook trout patches builds on the Brook Trout Conservation Success Index created by Trout Unlimited. The Conservation Success Index is calculated by evaluating indicators of future security (security from future threats, climate change, land conversion, resource extraction, invasive species), habitat integrity (condition of suitable habitat, watershed connectivity, water quality), and population integrity (population size, density, distribution, genetic purity). The Conservation Success Index utilizes GIS in combination with existing biological data collected from a variety of sources and has been used by Trout Unlimited to assess the current state of brook trout patches in the past, so it should be feasible to reimplement in the watershed (Trout Unlimited, 2007; Williams et al., 2007). The monitoring plan (see Table 12) will take place at the end of the project period, where the current score will be compared to the previous score using a pre-test/post-test approach.

Table 10. Monitoring Plan for Brook Trout Patches

What	How	When	Who	Decision-Making
Goal: By 2030, at least five brook trout patches have been improved through the completion of stream restoration projects. And, at least one new brook trout patch has been created or documented within the watershed.				
Monitoring Approach: Pre-test / Post-test				
Brook trout Conservation Success Index score from Trout Unlimited	Collect/evaluate data following the Conservation Success Index brook trout rule set	At the end of the seven-year conservation plan (2030)	Trout Unlimited (created the scoring system)	Track whether brook trout patches improved/worsened over the project timeline. Allows for understanding of how to adjust approach (what worked/didn't work and current status).

Table 11. Monitoring Plan for acreage under easement

What	How	When	Who	Decision-Making
Goal: By 2030, at least # acres will be under conservation easement (forest or farm).				
Monitoring Approach: Pre-test / Post-test				
Baseline acreage estimated at 18,700. Must be verified by HC FPB	Collect/evaluate easement data	Annually, and at the end of the seven-year conservation plan (2030)	CLRLT	Track acreage under easement from initial baseline metric provided by HC FPB

8.2.2 Goals for Forest Ecosystems

Our team created two monitoring plans to effectively assess the progress of our goals to reduce threats to our forest ecosystems conservation target. The first is to support the goal of increasing the number of new corridors between intact forest patches from 0 to 1 by 2030. The second is to monitor the stand age diversity (which represents the presence of a large range of age classes) in forests. Ideally, the watershed would have a monitor in place to measure the quality of connective habitat as well to improve species mobility.

After consulting with a conservation practitioner with land trust forest protection experience, the team established a monitoring system that tracks the increase in number of new corridors between intact forest patches from 0 to 1. A research paper titled Connectivity Metrics for Conservation Planning and

Monitoring reviewed 37 papers and defined 35 metrics for measuring connectivity (Keely, 2021). Another metric identified in the referenced paper as “distance to neighboring patches'' can also be used to show connectivity success. These monitoring plans rely on a CLRLT staff member to measure the number of new connections using GIS mapping tools at the end of the planning period in 2030 (see Table 13).

What	How	When	Who	Decision-Making
Goal: By 2030, increase the number of new corridors between intact forest patches in the Cacapon Watershed from 0 to 1.				
Monitoring Approach: Pre-test / Post-test				
Number of new corridors created between intact forest patches	CLRLT tracking of land protected and GIS mapping	Collect data at the beginning and at the end of project	CLRLT	To understand progress toward the goal and make adjustments as needed to land trust strategy

Table 11. Monitoring Plan for Forest Connectivity

The Diameter at Breast height (DBH) is a standard forestry measurement and can help estimate the age of a tree. The measurement is done with a soft measuring tape or diameter tape that can be wrapped around the tree at 4.5 feet above ground to measure the circumference (biltmore sticks or D tapes are used, and they directly give diameter when you measure,) which is divided by 3.14 (pi) to get the diameter. The diameter is then multiplied by the growth factor, which is dependent on the individual tree species (J. Kinlein, personal communication, October 6th, 2023). Collecting data on a sample of trees will give the approximate stand age diversity of the forest, and this can be done every 10 years by a member of the CWC with experience in the data collection method.

Table 12. Monitoring Plan for Stand Age Diversity

What	How	When	Who	Decision-Making
Goal: By 2030, increase the stand age diversity ranking, measured through the diversity of tree ages in a particular area, of the Cacapon Watershed from “fair” to “good”.				
Monitoring Approach: Pre-test / Post-test				
Age diversity of trees	DBH measurement	Every 10 years		To understand progress toward the goal of better forest management and healthier forests

Table 13. Monitoring Plan for No Loss of Forest Cover

What	How	When	Who	Decision-Making
Goal: By 2030,Cacapon Watershed has had no loss of forest cover relative to the 2022 baseline.				
Monitoring Approach: Pre-test / Post-test				
Percentage of forest cover	GIS forest cover maps & data	Every 2 years		To measure progress toward the goal of maintaining/improving forest cover relative to 2022 baseline

Table 14. Monitoring Plan for Acreage under Conservation Easement

What	How	When	Who	Decision-Making
Goal: By 2030, at least # acres of forest will be under conservation easement.				
Monitoring Approach: Pre-test / Post-test				
Acres under forest cover	GIS forest cover maps & data	Every 2 years	CLRLT	To measure progress toward the goal of increasing acreage under easement

Table 15. Monitoring Plan for # acres under Forest Management Plan (FMP)

What	How	When	Who	Decision-Making
Goal: By 2030, Cacapon Watershed has 20,000 acres (% of forest?) under forest management plans				
Monitoring Approach: Pre-test / Post-test				
Acres under forest cover	GIS forest cover maps & data	Every 2 years	CLRLT	To measure progress toward the goal of increasing acreage under easement

8.3 Threat Reduction Objectives

The team identified two threat reduction objective monitoring plans; one for each results chain. The first is measuring the percentage of farmers in the Cacapon Watershed who have completed at least one conservation practice by 2030, and the second is measuring the number of acres within priority areas protected in a conservation easement.

After a farmer has received their conservation plan, the NRCS member of the CWC will track the farmer's progress in implementation. This will be done with a phone survey during times of the year that

are sensitive to a farmer's work schedule. Telephone surveys have been used successfully to gather information from farmers, and have even been found to encourage participation in various programs (French, 1957, 154). The survey will be conducted every six months and pose questions about barriers to completion and strategies that can be altered or new strategies can be implemented in response to feedback. See Table 15 for the full monitoring plan.

Table 13. Monitoring Plan for Farmer Conservation Practices

What	How	When	Who	Decision-Making
Objective: By December 2030, 35% of farmers in the Cacapon Watershed have completed one conservation practice.				
Monitoring Approach: Time series				
Percentage of farmers in the watershed that completed one conservation practice	NRCS call with a questionnaire to determine farmer progress and reasons for delays	Every 6 months	NRCS	Determine what is keeping farmers from making progress and how the NRCS can support them

The CLRLT is already collecting data on the sufficient number of acres of priority landscape protected with conservation easements and updating the data on their website with every new CE they establish. The team suggests that the CLRLT can feasibly share this information with the CWC as it is collected and updated on their website.

Table 14. Monitoring Plan for CEs

What	How	When	Who	Decision-Making
Objective: By 2030, a sufficient number of acres within priority areas will be protected in a conservation easement.				
Monitoring Approach: Pre-test / Post-test				
Sufficient number of acres of priority landscape protected with conservation easements	Counting the acres listed on each conservation easement signed with the CLRLT	Annually report to CWC.	CLRLT	The reason for collecting this data is to track the protection of each priority parcel in the watershed

8.4 Intermediate Objectives

8.4.1 Farmer Information and Financial Aid Strategy: Intermediate Objectives

The team developed three intermediate objective monitoring plans to track progress toward achieving the farmer information and financial aid goals. The first tracks the number of farmers who attend annual

NRCS workshops. The second tracks the number of farmers who have a comprehensive plan in place by 2030. The third monitors the total nutrient loads in streams within the Cacapon Watershed.

An NRCS staff member (who is also a member of the CWC) could feasibly use a tracking sheet to monitor the number of farmers who attend NRCS conservation planning workshops. They can then report this information to the CWC after every workshop. See Table 17 for the detailed monitoring plan.

Table 15. Monitoring Plan for Conservation Workshops

What	How	When	Who	Decision-Making
Objective: Every year of the project 10% of farmers in the watershed attend a workshop about conservation planning, for a total of 70% by December 2030				
Monitoring Approach: Time series				
Number of people attending workshops	Tracking sheet	After each session	Workshop instructor	If attendance is low try other ways to entice farmers to attend

The key to monitoring the success of the NRCS farmer program is tracking the number of farmers who enroll in the program. Since the NRCS staff members will be working with farmers on an individual basis, they can monitor the percentage of farmers who have established a conservation plan and report this information to the CWC. See Table 18 for the detailed monitoring plan.

Table 16. Monitoring Plan for Conservation Plans on Farms

What	How	When	Who	Decision-Making
Objective: By December 2030, 35% of farmers in the Cacapon Watershed have a comprehensive conservation plan from the NRCS.				
Monitoring Approach: Time series				
Percentage of farmers who enroll in NRCS program	NRCS calls with a questionnaire to determine if they signed up and if they didn't, what barriers they are facing	After each workshop/field day	NRCS	Inform the team whether strategies to persuade farmers to participate are working. Identifies barriers to participation

According to *Source Magazine,* which focuses on monitoring water quality across the globe, it is customary for watersheds to use volunteer-based monitoring to help restore a specific tributary and gather data on the condition of a watershed throughout the restoration process. Nutrient monitoring is used to identify point-source (nutrients from a single source) or nonpoint-source (harder-to-identify sources or from many places all at once) pollution (Hayward, 2018). According to the WVDEP, water

samples should be "collected from the most represented portion of a stream", usually the run (a fast-moving area without surface breaks) and as close to the downstream end of the reach as possible. They also detail how analysis can be performed either in the field or the lab (*Water Quality*, n.d.). Since the WVDEP already organizes volunteer water quality monitoring in the state, it should be feasible for them to do this in the Cacapon Watershed as well (WVDEP, n.d.). Volunteers will collect water samples in ten streams adjacent to farms and send them to a lab for testing once a month from May to October (Water Action Volunteers, 2015). See Table 19 for the detailed monitoring plan.

Table 17. Monitoring Plan for Total Nutrient Measurements

What	How	When	Who	Decision-Making
Objective: Decrease total nutrients (nitrogen/phosphorus) in nearby streams from baseline measurement to less than 2.0 ppm by 2030.				
Monitoring Approach: Time series				
Amount of total nutrients (nitrogen and phosphorus) (ppm) in water samples	Collect water samples at streams adjacent to farms and send them in for testing	Once a month from May-Oct	Stream monitoring volunteers from WVDEP and other partner organizations	To understand the health of the watershed over time and inform strategies to reduce pollution

8.4.2 Conservation Easement Strategy Intermediate Objectives

The project team has implemented two intermediate objective monitoring plans to track progress toward establishing conservation easements. The first is counting the number of CWC members who have agreed to the landowner engagement plan. The second is counting the number of landowners who have had communication with a CWC member.

The CWC can work together to create a landowner engagement plan that will provide a framework for engaging with landowners within the Cacapon Watershed on the topic of establishing CEs. It will be feasible for the CWC to measure members' support of the landowner engagement plan. See Table 20 for the detailed monitoring plan.

Table 18. Monitoring Plan for Landowner Engagement

What	How	When	Who	Decision-Making
Objective: By 2025, the Cacapon Watershed Collaborative will have a landowner engagement plan in place that was standardized by the Cacapon and Lost Rivers Land Trust.				
Monitoring Approach: Pre-test / Post-test				

What	How	When	Who	Decision-Making
Numbers of CWC members who agree to plan	Count number of CWC partners who have signed on/agree to the plan	By 2025	CLRLT with CWC members	Help to ensure that CWC members understand the engagement plan and have tools to discuss CEs in work

After the landowner engagement plan is completed, the CWC can use it to communicate with landowners about establishing CEs on their properties. Members of the CWC can feasibly keep track of what landowners they relay CE information to and every year report numbers and locations to the CLRLT. It is assumed that they already have their own records of landowner discussions and can easily send that information to the CLRLT every year. See Table 21 for the detailed monitoring plan.

Table 19. Monitoring Plan for CE Outreach

What	How	When	Who	Decision-Making
Objective: By 2027, A sufficient number of landowners in priority areas within the Cacapon Watershed have communicated with CWC members about conservation easements.				
Monitoring Approach: Time series				
Number of priority landowners contacted by CWC	Count number of landowner responses to CE outreach	Annually	CLRLT with CWC members	Data can be used to understand if/how outreach and engagement with landowners is effective. Allows for CLRLT to adjust strategy if needed

9. Work Plan and Budget

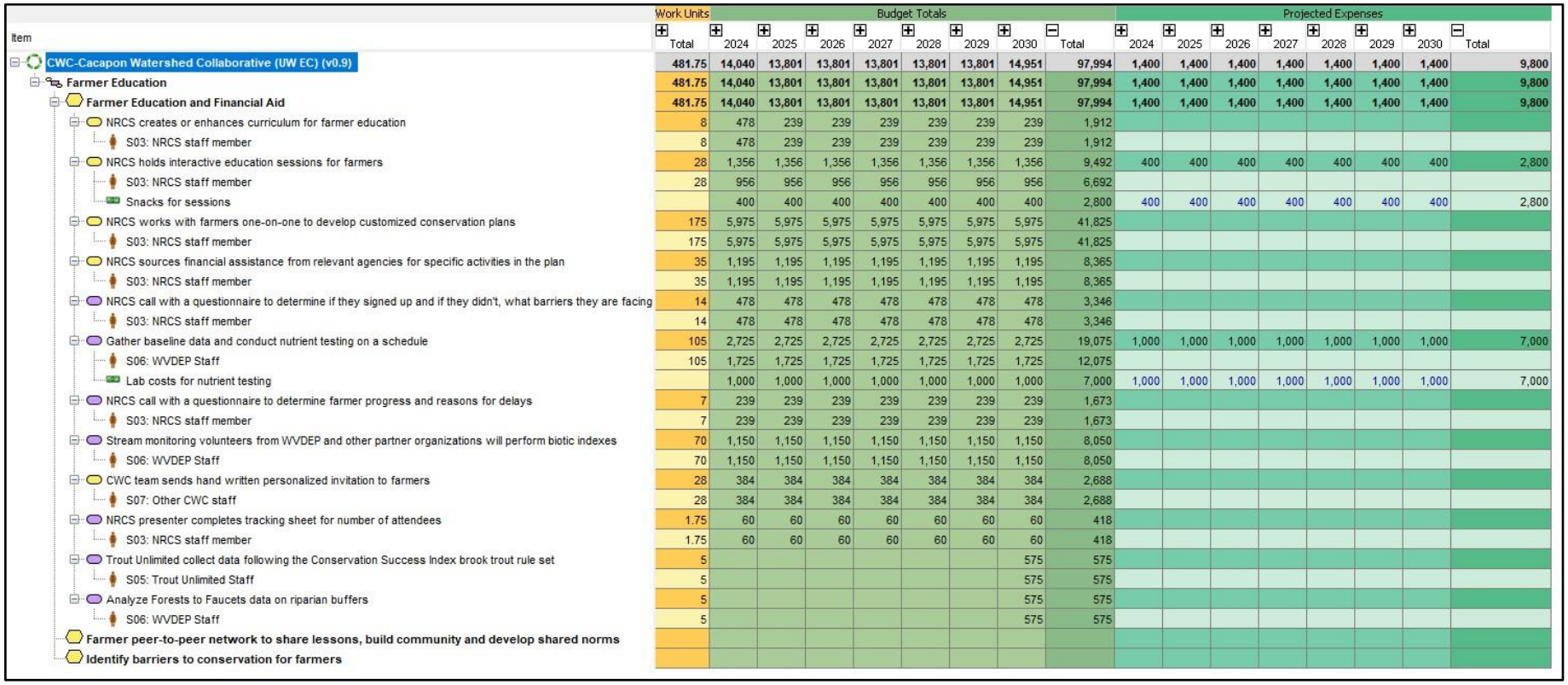
Work plans and budgets will be developed as part of the Implementation phase of the Cacapon Watershed Plan, starting in 2024. Below is a sample work plan and a draft budget for Strategy 1, Providing Farmer Information and Financial Aid. This strategy involves a series of activities that teach and show farmers how conservation practices improve productivity and stewardship of their environment and guide them through a detailed plan customized to their land. A work plan is a schedule for implementing an action or monitoring plan (see Glossary). Monitoring of intermediate results will also be conducted, as well as threat indicator changes from baselines described in the viability analysis. Figure 15 below, includes each activity to execute for the strategy, who will perform it, and the number of days required.

Item	Work Units							
	2024	2025	2026	2027	2028	2029	2030	Total
CWC-Cacapon Watershed Collaborative (UW EC) (v0.9)	**68.25**	**67.25**	**67.25**	**67.25**	**67.25**	**67.25**	**77.25**	**481.75**
Farmer Education	**68.25**	**67.25**	**67.25**	**67.25**	**67.25**	**67.25**	**77.25**	**481.75**
Farmer Education and Financial Aid	**68.25**	**67.25**	**67.25**	**67.25**	**67.25**	**67.25**	**77.25**	**481.75**
NRCS creates or enhances curriculum for farmer education	2	1	1	1	1	1	1	8
S03: NRCS staff member	2	1	1	1	1	1	1	8
NRCS holds interactive education sessions for farmers	4	4	4	4	4	4	4	28
S03: NRCS staff member	4	4	4	4	4	4	4	28
NRCS works with farmers one-on-one to develop customized conservation plans	25	25	25	25	25	25	25	175
S03: NRCS staff member	25	25	25	25	25	25	25	175
NRCS sources financial assistance from relevant agencies for specific activities in the plan	5	5	5	5	5	5	5	35
S03: NRCS staff member	5	5	5	5	5	5	5	35
NRCS call with a questionnaire to determine if they signed up and if they didn't, what barriers they are facing	2	2	2	2	2	2	2	14
S03: NRCS staff member	2	2	2	2	2	2	2	14
Gather baseline data and conduct nutrient testing on a schedule	15	15	15	15	15	15	15	105
S06: WVDEP Staff	15	15	15	15	15	15	15	105
NRCS call with a questionnaire to determine farmer progress and reasons for delays	1	1	1	1	1	1	1	7
S03: NRCS staff member	1	1	1	1	1	1	1	7
Stream monitoring volunteers from WVDEP and other partner organizations will perform biotic indexes	10	10	10	10	10	10	10	70
S06: WVDEP Staff	10	10	10	10	10	10	10	70
CWC team sends hand written personalized invitation to farmers	4	4	4	4	4	4	4	28
S07: Other CWC staff	4	4	4	4	4	4	4	28
NRCS presenter completes tracking sheet for number of attendees	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.75
S03: NRCS staff member	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.75
Trout Unlimited collect data following the Conservation Success Index brook trout rule set							5	5
S05: Trout Unlimited Staff							5	5
Analyze Forests to Faucets data on riparian buffers							5	5
S06: WVDEP Staff							5	5
Farmer peer-to-peer network to share lessons, build community and develop shared norms								
Identify barriers to conservation for farmers								

Figure 15: Work Plan

The budget period starts on January 1, 2024, and ends on December 31, 2030. Cost estimates, shown below in Figure 16, are based on the number of

work days projected for each individual responsible for an activity, plus other expenses. This was calculated based on a set of assumptions for duration and skills required. Monitoring costs for the strategy plan are 34% of the total budget. In this scenario, costs would be borne primarily by the NRCS and the WVDEP, with some support from the CLRLT. It is expected that the CWC core partner team will review this budget and that individual members will confirm or adjust activities and associated costs.



Item	Work Units	Budget Totals								Projected Expenses							
	Total	2024	2025	2026	2027	2028	2029	2030	Total	2024	2025	2026	2027	2028	2029	2030	Total
CWC-Cacapon Watershed Collaborative (UW EC) (v0.9)	**481.75**	**14,040**	**13,801**	**13,801**	**13,801**	**13,801**	**13,801**	**14,951**	**97,994**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**9,800**
Farmer Education	**481.75**	**14,040**	**13,801**	**13,801**	**13,801**	**13,801**	**13,801**	**14,951**	**97,994**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**9,800**
Farmer Education and Financial Aid	**481.75**	**14,040**	**13,801**	**13,801**	**13,801**	**13,801**	**13,801**	**14,951**	**97,994**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**1,400**	**9,800**
NRCS creates or enhances curriculum for farmer education	8	478	239	239	239	239	239	239	1,912								
S03: NRCS staff member	8	478	239	239	239	239	239	239	1,912								
NRCS holds interactive education sessions for farmers	28	1,356	1,356	1,356	1,356	1,356	1,356	1,356	9,492	400	400	400	400	400	400	400	2,800
S03: NRCS staff member	28	956	956	956	956	956	956	956	6,692								
Snacks for sessions		400	400	400	400	400	400	400	2,800	400	400	400	400	400	400	400	2,800
NRCS works with farmers one-on-one to develop customized conservation plans	175	5,975	5,975	5,975	5,975	5,975	5,975	5,975	41,825								
S03: NRCS staff member	175	5,975	5,975	5,975	5,975	5,975	5,975	5,975	41,825								
NRCS sources financial assistance from relevant agencies for specific activities in the plan	35	1,195	1,195	1,195	1,195	1,195	1,195	1,195	8,365								
S03: NRCS staff member	35	1,195	1,195	1,195	1,195	1,195	1,195	1,195	8,365								
NRCS call with a questionnaire to determine if they signed up and if they didn't, what barriers they are facing	14	478	478	478	478	478	478	478	3,346								
S03: NRCS staff member	14	478	478	478	478	478	478	478	3,346								
Gather baseline data and conduct nutrient testing on a schedule	105	2,725	2,725	2,725	2,725	2,725	2,725	2,725	19,075	1,000	1,000	1,000	1,000	1,000	1,000	1,000	7,000
S06: WVDEP Staff	105	1,725	1,725	1,725	1,725	1,725	1,725	1,725	12,075								
Lab costs for nutrient testing		1,000	1,000	1,000	1,000	1,000	1,000	1,000	7,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	7,000
NRCS call with a questionnaire to determine farmer progress and reasons for delays	7	239	239	239	239	239	239	239	1,673								
S03: NRCS staff member	7	239	239	239	239	239	239	239	1,673								
Stream monitoring volunteers from WVDEP and other partner organizations will perform biotic indexes	70	1,150	1,150	1,150	1,150	1,150	1,150	1,150	8,050								
S06: WVDEP Staff	70	1,150	1,150	1,150	1,150	1,150	1,150	1,150	8,050								
CWC team sends hand written personalized invitation to farmers	28	384	384	384	384	384	384	384	2,688								
S07: Other CWC staff	28	384	384	384	384	384	384	384	2,688								
NRCS presenter completes tracking sheet for number of attendees	1.75	60	60	60	60	60	60	60	418								
S03: NRCS staff member	1.75	60	60	60	60	60	60	60	418								
Trout Unlimited collect data following the Conservation Success Index brook trout rule set	5							575	575								
S05: Trout Unlimited Staff	5							575	575								
Analyze Forests to Faucets data on riparian buffers	5							575	575								
S06: WVDEP Staff	5							575	575								
Farmer peer-to-peer network to share lessons, build community and develop shared norms																	
Identify barriers to conservation for farmers																	

Figure 16: Budget

10. Plan Maintenance

While creating high-level and 12-month work plans that include necessary monitoring activities, the team should develop a system and schedule to ensure those responsible for leading activities and tasks have an opportunity to give an accounting on their assignments and to receive assistance and feedback on issues. Without proper accountability, even an excellent action plan will quickly fall into disarray and team members will become unfocused and distracted, reducing momentum and productivity. The following system is proposed for the CWC Team:

10.1. Quarterly and Annual Meetings

1. **Quarterly Alignment and Refocus Meetings**—Every 90 days, the team should convene to report on progress and to refocus on the highest priorities for the next 90 days. Vast experience suggests that if meetings are spaced farther than 90 days apart, project momentum will suffer, as it is human nature to become unfocused and distracted within 90 days (Wickman 2007). Ideally the quarterly meeting would be at a venue that poses minimal distractions so team members can fully engage. At a minimum the following should be covered during this meeting.
    a. Review the team's vision, conservation targets, and goals.
    b. Report on accomplishments and challenges from the past 90 days.
    c. Review near-term objectives and identify priorities for the next 90 days. Assign task leads.
    d. Prioritize and tackle key issues identified during the challenge report.
        i. For an example of a quarterly meeting agenda, see Appendix G.
        ii. Benefits of a quarterly meeting: It provides an opportunity for the team to evaluate performance, refocus, set priorities for the next 90 days, and resolve issues that are impeding progress.

2. **Annual Meetings**—This meeting is merely an expansion of one of the quarterly meetings. Additional topics to address during this meeting include:
    a. Review any element of the action plan where circumstances have changed or where data suggests that adaptations need to be made.
    b. Acknowledge progress in achieving objectives and adjust missed objectives.
    c. Document progress and determine how to archive and share lessons learned.

10.2 Recording Core Processes and Lessons Learned

To improve the likelihood that long-term success of a collaborative project will be achieved, the team should assemble and maintain documentation of all core processes the group has agreed to, and members should develop a system for capturing, documenting, and disseminating lessons learned.

Core Processes:

When and where do team meetings occur? Who leads or facilitates the meetings? When are habitat monitoring data to be submitted to the database curator? How are results disseminated? These are but a few of the questions that the team should answer and document to create a long-term adaptive management culture. For each process or procedure that contributes to plan maintenance and implementation, roles and responsibilities should be clearly defined and accountability mechanisms established. This should be done at a high level so as not to create a large amount of unnecessary work or a bloated processes document. The team should simply

identify each process that is essential to the proper functioning of the group and the adaptive management plan and add some bullets illustrating some of the basic steps and who is responsible for each. These are merely guideposts to help the team become consistent and efficient and to maintain continuity when key members of the group move on (Wickman 2007).

Lessons Learned:

There are likely as many ways to document and build upon lessons learned as there are individuals and projects. Regardless of the system used, the team should commit early on to a process of documenting lessons learned. A living, adaptive management plan is a good place to incorporate lessons learned about strategy implementation. As problems arise, these and possible solutions may be recorded in the minutes of each quarterly and annual meeting. Adjustments (i.e., the incorporation of lessons learned) can be made directly to any plan component with accompanying documentation.

If the team has documented its core processes, lessons learned on how best to maintain group cohesion, unity, and momentum can be incorporated directly into the core process documentation. If these core processes are referred to regularly (e.g., documentation on how to run a quarterly meeting are reviewed prior to each quarterly meeting), the team will incorporate lessons learned.

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Glossary of Terms

The following terms and their meanings come from the Open Standards for the Practice of Conservation (Conservation Measures Partnership, 2020).

Action – A general term used to refer to the work of conservation teams. This includes strategies, activities, and tasks.

Action Plan – A description of a project's goals, objectives, and strategies to abate identified threats and make use of opportunities.

Activity – A specific action or set of tasks undertaken by project staff and/or partners to reach one or more objectives. Sometimes called an action, response, or strategic action. (See relationship to strategies).

Assumption – An explicit statement of what a team assumes is true. The logical sequences linking project strategies to one or more targets as reflected in a theory of change. Assumptions may also include a team's expression of how they anticipate external variables may influence the achievement of results (see also risk factor). Assumptions are also present in situation models linking presumed influencing factors to other factors.

Audience – Those individuals or groups a project team is trying to reach, be it for communication purposes or to influence a particular behavior.

Conceptual Model – A synonym for situation model.

Conservation Practice – A process that involves a defined group of practitioners agreeing on desired outcomes for a given situation and then taking action(s) designed to achieve these outcomes. The Conservation Standards provide a common framework and set of "best" practices that explicitly incorporate principles of collaboration, evidence-based conservation, and adaptive management. More broadly, a discipline that encompasses the collective people, institutions, and body of knowledge of the global conservation community.

Conservation Target – An element of biodiversity (species, habitat, or ecological system) at a project site on which a project has chosen to focus. All targets should collectively represent the biodiversity of concern at the site. (Synonymous with biodiversity target, conservation focus, or conservation value).

Direct Threats – Conventional threats are primarily human actions that immediately degrade one or more conservation targets (e.g., illegal logging or unsustainable fishing). They can also be climate-related, as in natural phenomena altered by human activities (e.g., increase in extreme storm events due to climate change). Typically tied to one or more stakeholders. (Sometimes referred to as a pressure or source of stress).

Ecosystem Service - Services that intact, functioning ecosystems, species, and habitats provide and that can benefit people.

Evaluation – An assessment of a project or program in relation to its own previously stated goals and objectives.

Evidence – Relevant information (data, studies, syntheses, or theory) used to assess one or more assumptions (hypotheses) related to a question of interest. Evidence Base – The body of all information (data, studies, syntheses, and theory) used to assess a particular set of assumptions.

Evidence-Based (or -Informed) Conservation – The explicit use and generation of relevant information in all steps of conservation practice. Specifically, practitioners make decisions and take actions informed by systematic analyses of both their own and the world's previous experiences. Practitioners also document their results and contribute their findings back to the evidence base. The Conservation Standards explicitly bring evidence-based conservation principles into conservation practice.

Factor – A generic term for an element of a situation model, including direct and indirect threats, and opportunities. It is often advantageous to use this generic term since many factors – for example, tourism – could be both a threat and an opportunity. (See also root causes or drivers).

Goal – A formal statement detailing a project's desired impact, such as the desired future status of a target. A good goal meets the criteria of being specific, measurable, achievable, results-oriented, and time limited (SMART).

Human Wellbeing Target – In the context of a conservation project, human wellbeing targets are those components of human wellbeing affected by the status of conservation targets. All human wellbeing targets at a site should collectively represent the array of human wellbeing needs dependent on the conservation targets.

Impact – The desired future state of a conservation target. A goal is a formal statement of the desired impact.

Indicator – A measurable entity related to a specific information need, such as the status of a target, change in a threat, progress toward an objective, or association between one or more variables. A good indicator meets the criteria of being: measurable, precise, consistent, and sensitive.

Indirect Threat – A factor identified in an analysis of the project situation that is a driver of direct threats. Often an entry point for conservation actions. For example, logging policies or demand for fish. (Sometimes called a root cause or underlying cause. Compare with direct threat).

Information Need – Something that a project team and/or other people must know about a project. The basis for designing a monitoring plan.

Intermediate Result – A specific result that a project is working to achieve en route to accomplishing a final goal or objective ("intermediate" typically refers to a temporal dimension).

Intervention – A synonym for a specific or targeted strategy.

Key Attribute – Aspects of a target's biology or ecology that, if present, define a healthy target and, if missing or altered, would lead to the outright loss or extreme degradation of that target over time. (Also known as a key ecological attribute).

Key Ecological Attribute (KA) – Synonym for key attribute.

Key Intervention Point – Priority factors (threats, opportunities, or targets) within a situation model on which a team should take action.

Monitoring – The periodic collection and evaluation of data relative to stated project goals and objectives. (Also referred to as monitoring and evaluation (M&E) or monitoring, evaluation and learning (MEL)).

Monitoring Plan – The plan for monitoring your project. It includes information needs, indicators, and methods, timeframe, and roles and responsibilities for collecting data.

Method – A specific technique used to collect data to measure an indicator. A good method should meet the criteria of being accurate, reliable, cost-effective, feasible, and appropriate.

Objective – A formal statement detailing a desired outcome of a project, such as reducing a critical threat. A good objective meets the criteria of being specific, measurable, achievable, results-oriented, and time limited (SMART). If the project is well-conceptualized and -designed, the realization of a project's objectives should lead to the fulfillment of the project's goals and ultimately its vision. Compare to vision and goal.

Opportunity – A factor identified in an analysis of the project situation that potentially has a positive effect on one or more targets, either directly or indirectly. Often an entry point for conservation actions – for example, demand for sustainably harvested timber. (In some senses, the opposite of a threat.)

Outcome – The desired future state of a threat or opportunity factor. An objective is a formal statement of the desired outcome. (Synonym for result.)

Practitioners – All people involved in designing, managing, and monitoring conservation projects and programs.

Pressure – Synonym for direct threat.

Project – A set of actions undertaken by a defined group of practitioners – including managers, researchers, community members, or other stakeholders – to achieve defined goals and objectives. The basic unit of conservation work. (Compare with program.)

Project Area – The place where the biodiversity of interest to the project is located. It can include one or more conservation areas or areas of biodiversity significance, as identified through ecoregional assessments. Note that in some cases, project actions may take place outside of the defined project area.

Project Team – A specific core group of practitioners who are responsible for designing, implementing, and monitoring a project. This group can include managers, researchers, operations staff, and other key implementers or stakeholders.

Result – The desired future state of a target or factor. Results include impacts, which are linked to targets and outcomes, which are linked to threats and opportunities.

Results Chain – A visual diagram of a project's theory of change. A results chain includes core assumptions and the logical sequence linking project strategies to one or more targets. In scientific terms, it lays out hypothesized relationships or theories of change.

Scope – The broad geographic or thematic focus of a project.

Situation Analysis – A process that will help you and your project team create a common understanding of your project's context – including describing the relationships among the biological environment and the social, economic, political, and institutional systems and associated stakeholders that affect the conservation targets you want to conserve. Depending upon the scale of the project and the resources available to it, a situation analysis can be an in-depth formal review of existing evidence and study of the area/problem or a less formal description based on input of those familiar with the area/problem.

Situation Model – A visual diagram of a situation analysis. A situation model (diagram) represents relationships between key factors identified in a situation analysis believed to impact or lead to one or more conservation targets. A good model should link the conservation targets to threats, opportunities, stakeholders, and key intervention points. (See also conceptual model.)

Stakeholder – Any individual, group, or institution that has a vested interest in or can influence the natural resources of the project area and/or that potentially will be affected by project activities and has something to gain or lose if conditions change or stay the same. Stakeholders are all those who need to be considered in achieving project goals and whose participation and support are crucial to its success.

Strategic Plan – The overall plan for a project. A complete strategic plan includes descriptions of a project's scope, vision, and targets; an analysis of project situation, an action plan, a monitoring plan, and an operational plan.

Strategy – A set of activities with a common focus that work together to achieve specific goals and objectives by targeting key intervention points, optimizing opportunities, and limiting constraints. A good strategy meets the criteria of being: linked, focused, feasible, and appropriate. (See also intervention.)

Stress – An impaired aspect of a conservation target that results directly or indirectly from human activities. For example, low population size, reduced river flows, increased sedimentation, and lowered groundwater table level. Generally equivalent to a degraded key attribute (e.g., habitat loss).

Target – Shorthand for conservation target.

Theory of Change – A series of causally linked assumptions about how a team thinks its actions will help it achieve both intermediate results and longer term conservation and human wellbeing goals. A theory of change can be expressed in text, diagrammatic (e.g., results chains), or other forms.

Threat – A human activity that directly or indirectly degrades one or more targets. Typically tied to one or more stakeholders. (See also direct threat and indirect threat.)

Vision – A description of the desired state or ultimate condition that a project is working to achieve. A complete vision can include a description of the biodiversity of the site and/or a map of the project area, as well as a summary vision statement.

Work plan – A short-term schedule for implementing an action or monitoring plan. Work plans typically list activities and/or tasks required, responsible individuals, and timing of the activity or task. They often link to budgets showing the money and resources required to implement the work plan.

APPENDIX A: Conservation Planning Approach

The conservation planning approach follows the principles and practices laid out by the Conservation Standards developed by the Conservation Measures Partnership (CMP) (2020). The Conservation Standards guide the conservation project management process through a 5-step cycle (Figure 1):

- The first step/phase of the Conservation Standards is **Assess**, which begins with defining the team roles and purpose. In this step, the team identified the scope and vision of the project (see section 4.1 and section 4.2, respectively). After reviewing the evidence from the Action Plan for the Cacapon River & Patterson Creek CFA, developed by the WVDNR, as well as from other resources, the team prioritized three primary conservation targets: Streams (aquatic/riparian ecosystems), Forests (forest ecosystems) and Farms (agricultural landscapes). They then identified the related ecosystem services and human wellbeing targets. Next, the team identified the key attributes (KAs) and indicators for each of these targets (see section 5.1). The KAs were finalized by gathering evidence from the CFA plan, other sources of specific and proximate evidence, and conversations with experts from the CWC. Then, the team developed a conceptual diagram in Miradi, a conservation planning and adaptive management software, listing the most important threats, stresses, and biophysical factors including both the climate change factors and human-induced factors (see section 6.1). Finally, the team identified the indirect threats and drivers (Conservation Measures Partnership, 2020).

- Second is the **Plan** phase, which focuses on developing the goals (see section 8) of the conservation plan, as well as creating strategies (see section 8.4) and a monitoring plan (see section 9). The team developed goals that reflect the desired status of each KA indicator. Next, the team developed strategies by ranking the threats and targeting the highest-priority threats. The strategies are a collection of activities that work together to achieve common goals, reduce threats, take advantage of opportunities, and restore natural systems. The team created results chains for both strategies, which are a "series of causally-linked assumptions about how a team thinks its actions will help achieve both intermediate results and longer-term conservation and human wellbeing goals" (Conservation Measures Partnership, 2020). A monitoring plan was also developed to measure the success of the strategies over time and help the **project team** adapt if needed. A project team is defined as a core group of people responsible for all aspects of a project (see Glossary). Within the monitoring plan, goals for each of the conservation targets were created, as well as several threat reduction objectives, and intermediate objects (see section 8). For each of these components, the team defined detailed data collection methods, a timeframe, and who would complete the monitoring activity.

- Next is the **Implementation** phase, which involves building a budget, and developing a work plan, and timetable for one of the project strategies (see section 10). The project team started this work by assigning monetary values and time scales for the activities mentioned in the monitoring plan. This phase also requires the team to assign specific individuals and organizations to complete each of the tasks. The team will work on this starting 2024.

- The fourth phase is **Analyze and Adapt**, which includes preparing data and evidence, and turning them into an informed plan of action. The team will work on this step in the coming months.

- The fifth and final step is to **Share** learning and results from the conservation planning process with both CWC members, partners, funders and agencies, and also with the wider conservation community. The team will work on this step in the coming months.

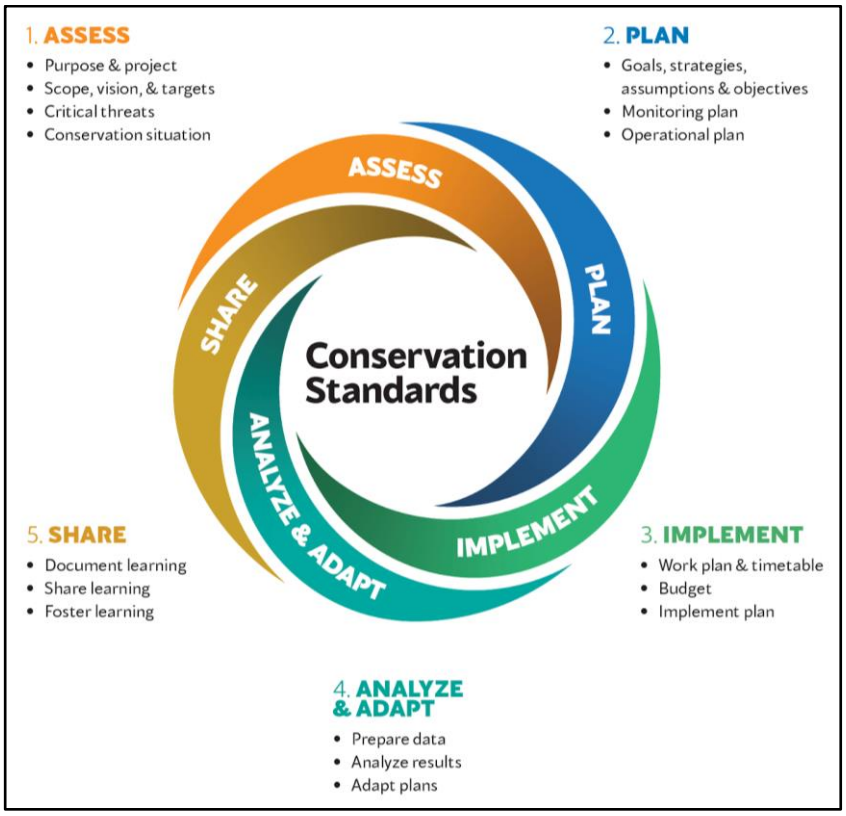


Figure 1. Open Standards for the Practice of Conservation Project Cycle (Conservation Measures Partnership, 2020)

APPENDIX B: Viability Assessment Methods

Overview: Measuring the Health of our Conservation Targets

To determine the current health of the chosen conservation targets, the team conducted a viability assessment. A viability assessment is a **method** for identifying the most important ecological requirements of a healthy conservation target so that interventions can focus on reducing the threats that degrade them and implement strategies to improve them. It also serves as a foundation to set relevant and measurable goals for future target health and to develop monitoring plans. The first step is to identify **key attributes (KAs)** of each conservation target. KAs are characteristics of a target that are essential to the conservation of that target over time (see Glossary)(Foundations of Success, 2020). For every KA, the team identified measurable **indicators** that could track the health of the conservation targets over the lifespan of the project. Where data were available, the CWC team identified indicator values for four health categories: *poor*, *fair*, *good*, and *very good*. The team also identified and agreed upon the current and desired future status of each indicator using available evidence or expert opinion. Appendix ? details the team's viability assessment process.

Below, key attributes, indicators, and indicator ratings are listed for each target, followed by goals for each. Each goal must represent a measurable improvement in the status of a key attribute.

An indicator is a method of determining **information needs** (see Glossary). The team rated these indicators *poor, fair, good,* or *very good* to assess their current status.

Attributes used to measure the health of each target

Streams: The attributes we chose to describe the health of the riparian ecosystem within the Cacapon watershed include the amount of natural riparian buffers, abundance and diversity of aquatic organisms, and amount of brook trout patches. The current status served as a baseline to set the desired future status, and this was marked on the viability charts, below. Four of our current attributes for the watershed were in the "fair" category, with only the aquatic organisms' status marked as "good".

Forests: The attributes we chose to measure the health of the forest ecosystem within the Cacapon watershed include forest connectivity and tree age diversity.

Farms: The attributes we chose to measure the health of farms include # acres under agricultural production, # acres under conservation easement; # stream miles on farmland bordered by healthy riparian buffers, and # acres of healthy forests on farms.

Overall, forest and aquatic/riparian ecosystems are currently rated as "fair"; farms are rated as "fair" to "good."

Goals were defined within a time span of seven years starting in 2024.

The guidelines for each indicator rating are listed below (Foundations of Success, 2020):

Poor - Restoration is increasingly difficult; may result in extirpation
Fair - Outside acceptable range of variation; requires human intervention
Good - Within the acceptable range of variation; some intervention is required for maintenance
Very Good - Ecologically desirable status; requires little intervention

Viability Assessment for each Target

Viability Assessment: Aquatic/Riparian Ecosystems

KA: Amount of Natural Riparian Buffers

Streams are not just their waters. A vital aspect of riparian health is what is between the river and the land. A riparian buffer of native vegetation protects the stream it borders from pollutants like runoff, helps control erosion by anchoring the soil on a streambank, and serves as a habitat for riparian species (West Virginia DEP, 2009). Additionally, riparian buffers can help reduce flood damage and provide essential shade, creating a more resilient defense against increases in precipitation and temperature due to climate change (U.S. Department of Agriculture, n.d.). The current status of this KA was determined by referencing the work of Alana Hartman (West Virginia DEP), which summarized the data from Forests to Faucets 2.0. It was found that about a third of the Cacapon's nineteen subwatersheds have 46-70% riparian natural cover, one-third have about 70-80%, and the remaining third has 80-95% cover (USDA Forest Service, 2022). Due to these findings, the team determined the current status of natural riparian buffers to be "fair" (see Table 6). By 2030 there should be an average of 80% or greater riparian natural cover in all subwatersheds of the Cacapon Watershed, which includes any shrubs, trees, and plants, not crops or built infrastructure.

Table 5. KA: Amount of Natural Riparian Buffers

Target	Category (size, condition, landscape context)	KA	Indicator	Indicator Ratings			
				Poor	Fair	Good	Very Good
Aquatic/Riparian Ecosystems	Size	Amount of natural riparian buffer	Riparian natural cover %	<60%	60-<70%	70-<80%	>80%
			Current Status			X	
			Desired Future Status				X

KA: Abundance and Diversity of Aquatic Organisms

The presence of many and diverse benthic aquatic macroinvertebrates is a popular indicator of stream and river health. Benthic macroinvertebrates vary in their tolerance to pollution and they demonstrate a predictable response to human disturbance (United States Environmental Protection Agency, 2022). For this indicator, the team used the Family Biotic Index (FBI), which was developed by William L. Hilsenhoff as a simplification of his earlier work, the Hilsenhoff Biotic Index (HBI). The FBI puts a value from 0 to 10 on each family of macroinvertebrates based on their sensitivity to organic pollutants; this value is called their tolerance value (0 being the most sensitive to pollutants, 10 being the most tolerant). The number of macroinvertebrates in each family is multiplied by the tolerance value for that family, the sum of which is divided by the total number of macroinvertebrates in the sample to get the FBI. The smaller the value of the FBI, the healthier the stream. The FBI can then be used to evaluate the water quality and the degree of organic pollution in the sample area. The current status of the watershed is "good", with a rating between 4.26 and 5.00 (Hilsenhoff, 1988). The goal is that by 2030, the Family Biotic Index should be below 4.25 on average across test sites in the Cacapon Watershed.

It is also possible that the project partners could choose to use the HBI instead, which identifies organisms down to their genus or species. The team did not choose this as the preferred indicator, however, since it is most often conducted by experts in a lab, not by volunteers in the field. It is also possible that a state-specific biotic index could be developed in time, reducing the list of species to ones commonly found in the area and making it even easier for volunteers to collect the data (Water Action Volunteers, 2015).

Table 6. KA: Abundance and Diversity of Aquatic Organisms

Target	**Category** (size, condition, landscape context)	**KA**	**Indicator**	**Indicator Ratings**			
				Poor	**Fair**	**Good**	**Very Good**
Aquatic/Riparian Ecosystems	size and condition	abundance & diversity of macroinvertebrates	Family Biotic Index (HBI)	> 6.51	5.01 – 6.50	4.26 – 5.00	< 4.25
Current Status						X	
Desired Future Status							X

KA: Brook Trout Patches

Brook trout's native range spans much of North America, but its habitats have been slowly invaded by non-native Brown Trout and Rainbow Trout, particularly in the Appalachian region (Trout Unlimited, 2007). The Cacapon watershed's cold headwater streams provide support to these threatened native brook trout patches and are a key attribute of stream and riparian ecosystems in the watershed (West Virginia DNR, 2021, 14; Cacapon & Lost Rivers Land Trust, 2023). Like many of the salmonids in the char genus, brook trout are highly sensitive to non-native fish and polluted waters, making them an excellent indicator of stream health (Trout Unlimited, 2007). For this KA, the team used Trout Unlimited's Conservation Success Index (CSI) as an indicator to measure the current and desired future status of brook trout patches. The CSI score is determined by multiple measures: future security, habitat integrity, and population integrity (Trout Unlimited, 2007; Williams et al., 2007). Based on CSI results, the total score for the Cacapon watershed areas sits around 60 or has an unknown status, placing it in the "fair" ranking (Trout Unlimited, 2007). The goal is that by 2030, the CSI score of brook trout patches in the Cacapon Watershed will increase to the 70-79 range.

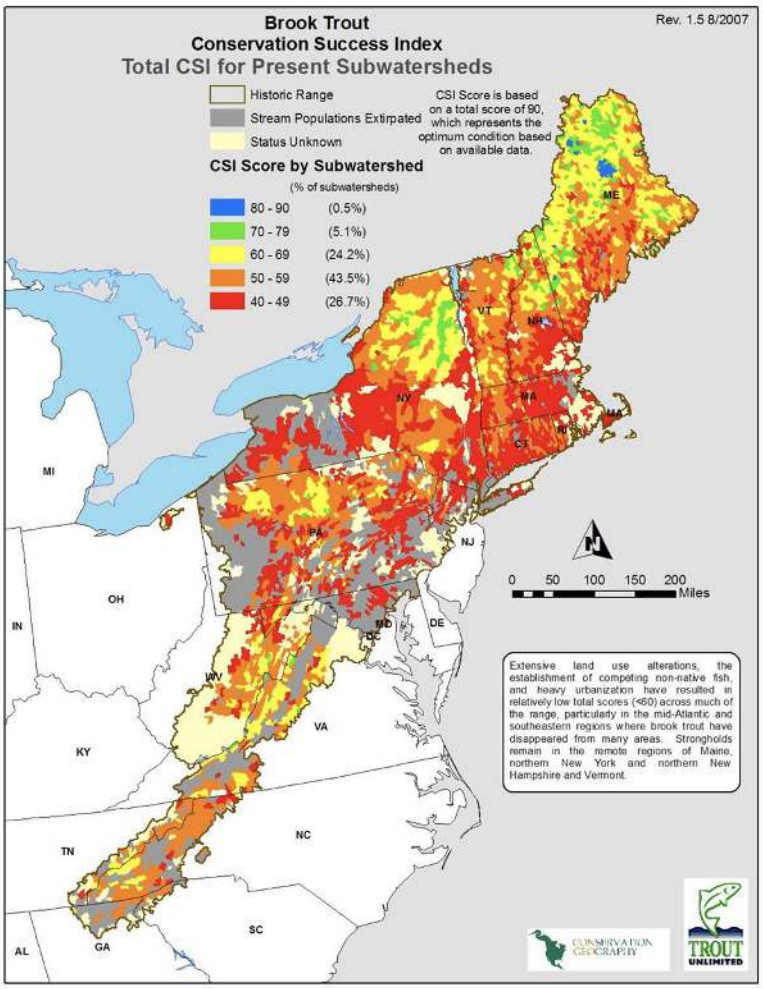


Figure 8. Brook Trout CSI (Trout Unlimited, 2007)

Table 7. KA: Brook Trout Patches

Target	Category (size, condition, landscape context)	KA	Indicator	Indicator Ratings			
				Poor	**Fair**	**Good**	**Very Good**
Aquatic/Riparian Ecosystems	size/condition	brook trout patches	Trout Unlimited Conservation Success Index (CSI)	<60	60-69	70-79	>79
			Current Status		X		
			Desired Future Status			X	

Viability Assessment: Forest Ecosystem

Key Attribute (KA): Forest Connectivity

An important indicator of forest health is the connectivity of forest patches (Regents of the University of California, n.d.). When forests are fragmented by human development they become less biodiverse. Edge areas also increase, making forests more vulnerable to invasive species and fragmentation. This also reduces species mobility, impacting their resilience against climate change (West Virginia DNR, 2021, 33). The team determined that one important attribute of the forest ecosystems of the Cacapon watershed that could be impacted within the timeframe of the project would be connectivity, measured as the number of new corridors created. The mapping of the watershed in Figure 7 shows areas of **opportunity** between existing intact forest patches where corridors can be developed, expanding habitats and enabling species migration as a **result** of climate threats. An opportunity is a factor that may impact a target positively, either directly or indirectly and a result is the future point a target is aiming for (see Glossary). The current connectivity rating for the watershed is "fair", which is defined as zero new corridors created between intact forest patches. The desired future status is "good" which the team defined as one new corridor between intact forest patches by 2030.

Table ? KA: Connectivity

Target	**Category** (size, condition, landscape context)	**KA**	**Indicator**	**Indicator Ratings**			
				Poor	**Fair**	**Good**	**Very Good**
Forest Ecosystems	Condition	Connectivity	Number of new corridors created between intact forest patches		0	1	
			Current Status		X		
			Desired Future Status			X	

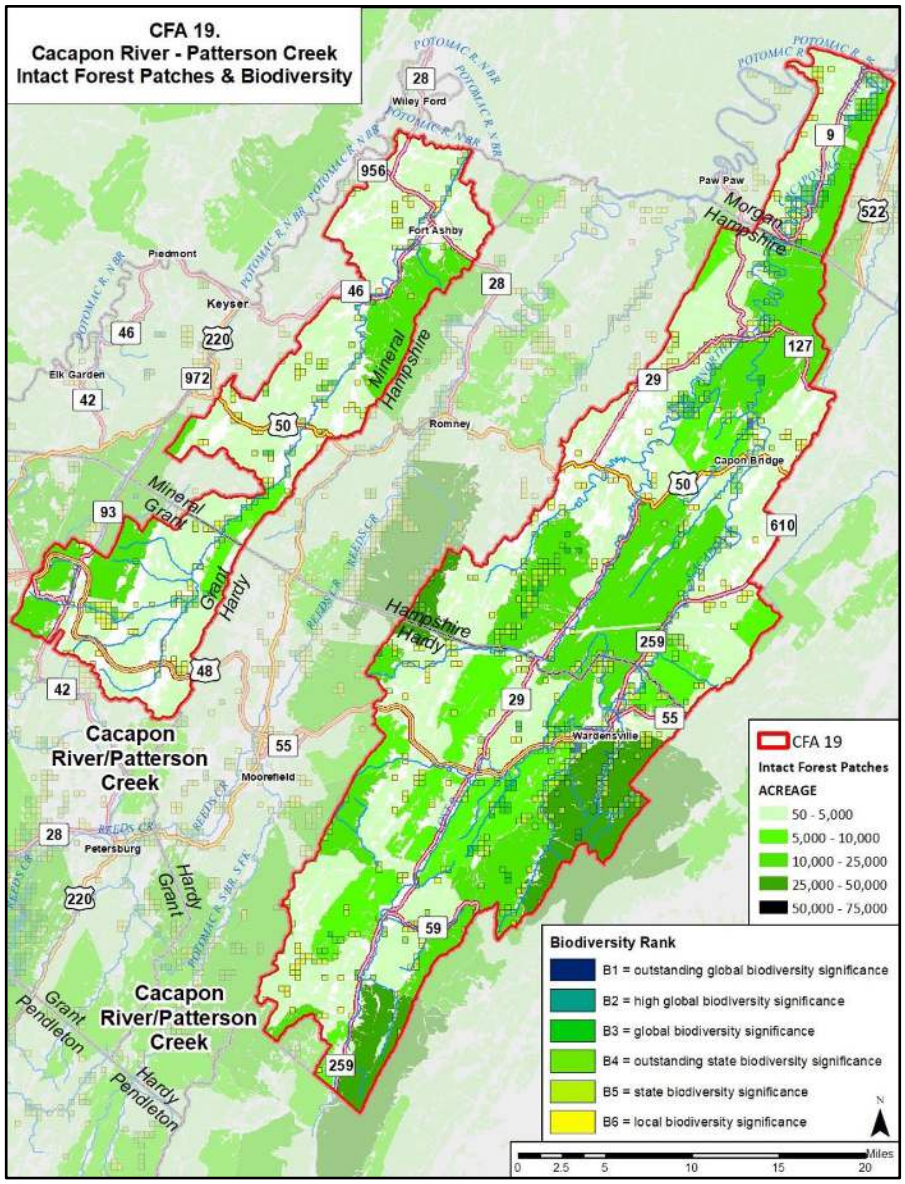


Figure 7. Map of Intact Forest Patches within the right red outline (the Cacapon Watershed). CFA 19 is defined as the 19th conservation focus area in West Virginia (West Virginia DNR, 2021).

KA: Age Diversity within Forests

A diverse distribution of tree age classes is important for determining "timber growth and yield, the occurrence of specific wildlife and plant communities, the presence of other non-timber forest products, and the forest's aesthetic and recreational values" (Nelson, 2022). The team consulted with Jarred Kinlein from the West Virginia Division of Forestry) (J. Kinlein, personal communication, October 17, 2023), who identified stand age diversity as an accurate measure of forest health. In the face of climate change, mature trees will be more resilient to increased temperatures and increased precipitation events (West Virginia DNR, 2021, 25). The current status, determined by CWC's sources, is fair, as there is a good balance between young and old trees, but the forests are lacking middle-aged trees. By 2030, the goal is to increase the stand age diversity ranking, measured through the diversity of tree ages in a particular area, of the Cacapon Watershed from "fair" to "good".

Table ?. KA: Stand Age Diversity

Target	Category (size, condition, landscape context)	KA	Indicator	Indicator Ratings			
				Poor	**Fair**	**Good**	**Very Good**
Forest Ecosystems	condition	Age diversity (mosaic) of forest	Stand Age Diversity	Poor ratio of diversity	Fair ratio of diversity	Good ratio of diversity	Excellent ratio of diversity
			Current Status		X		
			Desired Future Status			X	

APPENDIX C: Threat Assessment Methods

The CWC team created a list of potential threats and ranked them based on the extent of their impact to each target, their severity within that extent, and the level of effort and resources it would take to restore a target if the threat were removed. Each threat that impacts one or more targets was ranked Low, Medium, High, or Very High for each target, and a summary threat rating was calculated that took into account the number of targets affected by each threat. In this way, the team was able to visualize impacts of threats to individual targets and also consider which threats were most critical to address given their impact across multiple targets within the watershed. The core principle and purpose underlying this prioritization process was as follows: To maximize effectiveness, CWC interventions should be focused on reducing the greatest threats that affect the greatest number of targets.

The methodologies used for this analysis are described in the Foundations of Success Guide (2020) and in the GIZ-CMP Conservation Standards Applied to Ecosystem-based Adaptation (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH & Conservation Measures Partnership, n.d.). Criteria utilized for the conventional threat assessments included scope, severity, and irreversibility, ranked on a 1 - 4 scale, as follows:

Scope: The extent of the area that is expected to be impacted over 10 years
Scope ranking:
4 = Very High: pervasive in its scope, affecting the target across 71-100% of its occurrence.
3 = High: widespread in its scope, affecting the target across 31-70% of its occurrence.
2 = Medium: restricted in its scope, affecting the target across 11-30% of its occurrence.
1 = Low: is likely to be very narrow in its scope, affecting the target across 1-10% of its occurrence.

Severity: How much damage can be caused by the threat within the scope
Severity ranking:
4 = Very High: destroy or eliminate the target, or reduce its population by 71-100% within 10 years or 3 generations.
3 = High: seriously degrade/reduce the target or reduce its population by 31-70% within 10 years or 3 generations.
2 = Medium: moderately degrade/reduce the target or reduce its population by 11-30% within 10 years or 3 generations.
1 = Low: slightly degrade/reduce the target or reduce its population by 1-10% within 10 years or 3 generations

Irreversibility: How well can the damage caused by the threat can be reversed
Irreversibility ranking:

4 = Very High: cannot be reversed and it is very unlikely the target can be restored, and/or it would take more than 100 years to achieve this.
3 = High: can technically be reversed and the target restored, but it is not practically affordable and/or it would take 21-100 years to achieve this.
2 = Medium: can be reversed and the target restored with a reasonable commitment of resources and/or within 6-20 years.
1 = Low: easily reversible and the target can be easily restored at a relatively low cost and/or within 0-5 years.

For climate-related threats, scope and severity were used as criteria as described above. Management challenge replaced irreversibility, with the following ranking categories.

Management challenge: How challenging it will be for targets to adapt to climate threats
Management challenge ranking:
4 = Very High: Likely that there are adaptation strategies that could help conservation targets adapt to the threat within a given time frame, and it would require a relatively small amount of resources
3 = High: There is some possibility that the target can adapt to the threat but adaptation strategies have low feasibility because they require moderate to high amounts of resources, require actions by many partners, or are politically or technically challenging.
2 = Medium: There is some possibility the effects of the threat can be addressed and addressing them would be feasible with moderate resources
1 = Low: It is likely that there are adaptation strategies that could help the targets to effectively adapt to the threat within a given time frame and a relatively small investment of resources would be needed.

APPENDIX D: Situation Analysis

In order to understand what is driving and exacerbating threats in the Cacapon Watershed, the team conducted a situation analysis. The **situation analysis** is a process that allows the team to come to a common understanding of the project's context – such as describing the relationships between the biological, environmental, and social factors that affect the conservation targets the team aims to improve (see Glossary) (Conservation Measures Partnership, 2020). The **situation model**, also known as a **conceptual model** (see Glossary), visually depicts the relationships between the different factors identified in the situation analysis (see Glossary) (Conservation Measures Partnership, 2020). The situation model in Figure 10 depicts three **conservation targets (green ovals)**: riparian/aquatic ecosystems, forest ecosystems, and farms (agricultural landscapes), along with the corresponding factors that contribute to their degradation.

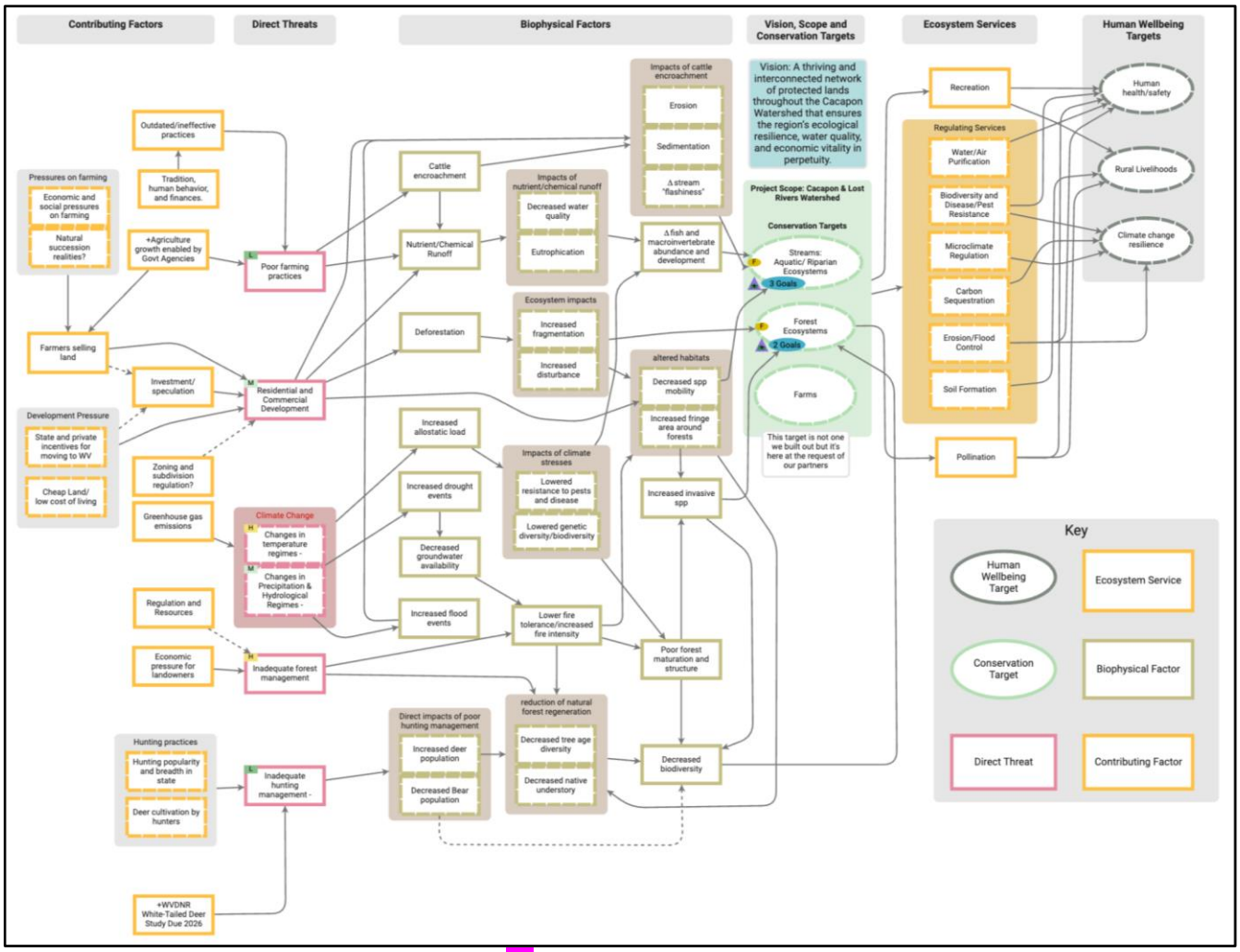


Figure 10. Situation Analysis Model

7.2.1 Human Wellbeing Targets and Ecosystem Services

There are three human wellbeing targets related to the Cacapon Watershed: human health, rural livelihoods, and climate change resilience. Collectively, riparian/aquatic ecosystems, forest ecosystems, and farms (agricultural landscapes) provide eight **ecosystem services (yellow boxes on the right)** that are connected to the three **human wellbeing targets (gray ovals)**: water and air purification, biodiversity and disease/pest resistance, microclimate regulation, carbon sequestration, erosion/flood control, soil formation, and pollination.

Rural Livelihoods

Healthy forests and streams provide numerous recreational opportunities to both residents and visitors to the watershed. Consequently, many residents within the watershed rely on these recreational opportunities for their livelihoods. Much of the watershed is designated as National and State Forest land, which provides employment opportunities to people in the watershed.

Streams help to create and maintain productive soils when water levels are high. Water infiltrates the ground, introducing new sediment and minerals that form the basis of soils (Beem, 2017). Additionally, forests aid in the creation and conservation of soils by weathering rock material with their roots, decomposing organic matter, and holding the soils in place (Clawson, 2023). According to Marika Suval, the Deputy Director of the Cacapon & Lost Rivers Land Trust, soil formation is essential to farmers. Healthy soil has high levels of microbial activity and organic matter, which are both important for crop success. If the soil practices that farmers use in the Cacapon Watershed were improved, it would result in reduced greenhouse gas emissions, an increase in carbon fixation, and overall higher water quality through decreased nutrient and sediment pollution (Bowman et al., 2016).

The Cacapon Watershed's forests and streams are also essential for the survival of a wide array of valuable insects and other animal pollinators. Pollination is necessary for food production– roughly 35% of global crop production is dependent on pollination by insects and animals, connecting pollination to livelihoods (USDA, 2020).

Human Health/Safety

The forests and streams in the watershed are vital in supplying the clean water and air purification that are essential for human health. Forests contribute to clean air by filtering pollutants, and to clean water by capturing rainwater and acting as a natural filter that removes pollutants before they enter waterways. Streams provide clean water by filtering organic and inorganic matter, and riparian buffers also intercept pollutants and remove excess nitrogen and phosphorus that can pollute drinking water (*The Science Behind the Need for Riparian Buffer Protection: ConservationTools*, n.d.). Conservation and restoration of aquatic and forested habitat in the Cacapon Watershed would protect water quality and, in turn, the source of drinking water for communities that rely on them (West Virginia DNR, 2021, 30). Restoring riparian ecosystems in the Cacapon Watershed also contributes to stabilizing river and stream banks, preventing erosion, providing flood control, and decreasing the severity and frequency of floods, which in turn impacts human safety (WeConservePA, n.d.).

The Cacapon Watershed supports a wide variety of plant and animal species. The data shows many species of greatest concern and rare plant communities in areas of the watershed (West Virginia DNR, 2021, 16). A healthy ecosystem with high biodiversity contributes to human health by preventing the spread of pests and disease (COHAB initiative, n.d.). Additionally, The Cacapon Watershed's forests and streams are essential for the survival of a wide array of valuable insects and animal pollinators. Pollination is essential for food production. As stated previously, around 35% of global crop production is dependent on pollination by insects and animals, connecting pollination to human health (USDA, 2020).

Forests and streams in the Cacapon Watershed are important for human recreation. They are used for hiking, fishing, hunting, swimming, kayaking, and other outdoor activities. These services have been proven to support

human health by reducing stress and anxiety. Studies show that people who spend two hours a week in natural environments are more likely to report good health and psychological wellbeing than those who don't (Robbins, 2020).

Climate Change Resilience

A healthy Cacapon Watershed ecosystem provides microclimate regulation. Trees in forests create microclimates by providing shade and cool the air by evaporation of moisture from their leaves and branches. Action to protect big forest patches that have diverse topography and microclimates and action to maintain forest connectivity will allow for the forest to better adapt to climate stress (West Virginia DNR, 2021, 26). Evidence also shows that when we restore and protect wildlife habitat, those areas may be more resistant to the impacts of climate change (West Virginia DNR, 2021, 57). Forest trees sequester carbon by pulling it out of the atmosphere via photosynthesis, storing it, and depositing it into the soil, providing climate change resilience. Forests take up about 12 percent of the carbon dioxide that Americans emit each year (*How Forests Store Carbon*, 2023). Forests also help mitigate the impacts of climate change and increase climate resilience with their ability to retain water and limit the amount and timing of water that enters nearby streams (Bastrup, 2020). Aquatic/riparian habitats also help create increased climate resilience, as riparian vegetation helps to stabilize soil near streams and control the amount of soil erosion that occurs (Association for Temperate Agroforestry, n.d.).

7.2.2 Threats, Contributing Factors and Biophysical Impacts to Targets

The situation analysis depicts various **contributing factors (yellow boxes on the left)** that lead to **direct threats (red boxes)** and the **stresses/biophysical factors (tan boxes)** that represent the biophysical impact of the threat on the target ecosystems. **Contributing factors** (see Glossary) include the economic, political, institutional, social, and cultural influences that affect the conventional threats (Foundations of Success, 2020).

Residential and Commercial Development

Residential and commercial development has been identified by the CWC as one of the highest priority threats to the watershed. It causes deforestation, habitat fragmentation, and forest disturbance, negatively impacting species mobility and increasing forest edges. Forest edges, due to their proximity to anthropogenically altered habitat, often serve as entry points for invasive plants to move into forest interiors. Invasive plants are detrimental to forests by crowding out seedlings and negatively impacting forest structure. The result is a degraded forest with lower species richness. Many residential homes are developed on waterfront property, affecting water quality and leading to an increase in erosion and sedimentation in streams, which increases stream flashiness. This will ultimately lower fish and macroinvertebrate abundance and development (West Virginia DNR, 2021, 23).

Development pressure in the Cacapon Watershed is due in large part to residential and second home construction (West Virginia DNR, 2021, 15), driven by the affordability and beauty of the land (Weaver, 2023), and interest is growing. In fact, land use for development in West Virginia doubled between 1982 and 2017 (National Association of State Foresters, n.d.). In conversations with the team, Marika Suval pointed to strong pressures in the real estate market evidenced by a flurry of unsolicited requests to land owners from realtors and solar and wind developers awash with money from the recently approved Inflation Reduction and Infrastructure Acts. Another contributing factor to increased development in the area is the incentives of up to $20,000 that were offered to any new WV residents in an attempt by the state government to stanch a population loss of 3.2% between 2010 and 2020 (Renn, 2023; State of West Virginia, 2022). Suval also mentioned that farmers have been hit hard by inflation and natural succession realities as younger generations are not as interested in working the land, which might prompt farmers to sell to developers.

Detrimental Farming Practices

Farming activity considered for this analysis consists of livestock production farms, which often also include pasture, hay fields, and corn production. Hay and corn crops are currently harming the Cacapon Watershed. Corn is a water-intensive crop that can reduce groundwater levels during summer droughts and contributes to high levels of fertilizer pollution. High usage of fertilizer causes nitrogen and phosphorus runoff into streams resulting in eutrophication and subsequently leading to decreased macroinvertebrates and fish populations as well as altering their development. Regarding hay production, early haying has a negative impact on ground-nesting birds (West Virginia DNR, n.d.).

Unsustainable management of cattle is also a concern. Cattle impact the physical, chemical, and biological properties of water in the Cacapon region. They are given unrestricted access to rivers and streams and degrade the water with manure and by grazing on riparian plants leading to increased erosion and sedimentation which leads to increased stream flashiness, and ultimately a reduction of fish and macroinvertebrate abundance and development (Friends of the Cacapon River, 2012).

According to CWC partners, tradition is one of the contributing factors to detrimental farming practices. The reasons farmers use unsustainable farming practices are complex and may also include goal alignment issues, cost, time, and geographic location. According to researchers at Ball State University, there is strong evidence that external social, geographic, and economic factors shape regional farming systems (Grover, S., & Gruver, 2017). Some farmers use practices that allow for poor nutrient management and chemical use (West Virginia DNR, 2021, 24). This issue is exacerbated by the fact that farmers face social and structural challenges to adopting sustainable agriculture practices (Leffer et al., 2021). According to the *Cornell Chronicle,* "current research shows that with the right management practices, farmers could effectively grow crops while maintaining, and in some cases even enhancing ecosystem services". While some producers have incorporated more holistic practices in the Cacapon, many are not yet interested in or equipped to do so.

One area of opportunity is collaboration with the NRCS. According to Rebecca Royal, Acting District Conservationist for the Potomac Valley Conservation District, the agency works directly with farmers to develop conservation plans; it is a free service, not regulatory. They also offer financial assistance for implementation, with no current funding constraints, making it an attractive option particularly if they broadcast their services more widely through outreach and education (R. Royal, personal communication, October 10, 2023).

Inadequate Forest Management

Inadequate forest management in the Cacapon Watershed leads to low fire tolerance due to fire suppression and increased invasive species causing higher fire intensity, which in turn leads to more invasives and higher mortality of trees, especially old-growth trees critical for carbon sequestration and the maintenance of microclimates. Higher mortality of trees and increased invasive species reduces habitat for important biodiversity. Prioritizing logging over creating habitat and invasive removal can result in crowded-out tree seedlings, poor tree regeneration, and unfavorably altered age mosaics.

A primary contributing factor to inadequate forest management is economic pressure on landowners. Some landowners work directly with logging companies which are focused on their bottom line. According to the WVDOF, "with over 260,000 non-industrial private woodland owners in West Virginia, the Division of Forestry places importance on providing landowner assistance for management and protection of woodlands" (West Virginia DOF, n.d.).

The National Association of State Foresters mentions that other factors that may be contributing to inadequate forest management are regulatory barriers and lack of resources, which are an issue across the country for

forestry agencies (National Association of State Foresters, n.d.).

Inadequate Hunting Management

Inadequate hunting management has led to the overpopulation of deer and the Cacapon Watershed cannot support current deer densities due to overgrazing, which results in a reduction of understory and altered stand age diversity. This causes a reduction in forest health and a decrease in biodiversity. According to the CWC's prior situation analysis, inadequate forest management also reduces bear populations.

Hunting demand is the primary reason for deer population growth and CWC partners report that deer are being cultivated by hunters, further increasing the population in the watershed. Proximal research reveals that White-tailed Deer is one of the most sought-after big game species in West Virginia (West Virginia DNR, 2023). Every year, more than 200,000 resident and non-resident hunters participate in the whitetail deer hunting season (West Virginia DNR, n.d.). Rural culture in the Watershed is thought to potentially contribute to the threat of inadequate hunting management, although this is relatively unsupported by any strong evidence.

Currently, the WVDNR is leading a study of the white-tailed deer population in three areas of the state including Hampshire County, the largest in the Cacapon Watershed. The study, which is due to be completed in 2026, includes an objective to develop an integrated population model. This work represents an opportunity for the CWC to influence how ideal population density is calculated and managed (West Virginia DNR, 2023).

Climate Change

Among climate change's most profound effects are changes in precipitation and temperature. Changes in precipitation and hydrological regimes result in increased drought events in summer and fall in West Virginia, which stresses trees, reducing forest resilience and increasing susceptibility to forest pests and diseases (State of Connecticut, 2021). 20 million acres of forest land are projected to be lost over the next three decades nationally due to this reason (Tooke, 2018). Drought causes significant harm to stream ecosystems as well by reducing water levels and leaving less water to dilute pollutants.

Higher temperatures cause increases in eutrophication. Increased frequency of droughts also lowers fire tolerance resulting in the reduction of natural forest regeneration and increasing the threat of native vegetation while endangering biodiversity. Increased spring and winter precipitation leads to flooding, causing landslides and erosion, washing out roads and changing soil patterns. All of this increases erosion and sedimentation in streams, negatively affecting fish and macroinvertebrates (Cacapon & Lost Rivers Land Trust, 2023). Increased temperatures increase allostatic load, which is the cumulative burden of chronic stress and life events. Allostatic load affects both stream and forest ecosystems, putting negative pressure on species that are unable to adapt, and impacting biodiversity by lowering species resilience and genetic diversity.

Greenhouse gasses are the major contributing factor that leads to climate change. The global average atmospheric carbon dioxide was 417.06 parts per million in 2022 and the increase in carbon dioxide emissions between 2021 and 2022 was the 11th year in a row that carbon dioxide increased by more than two parts per million (Lindsey, 2023).

APPENDIX E: Strategy Selection

After identifying the key contributing factors to threats the team began to develop evidence-based strategies to target **key intervention points** (see Glossary), which are places within a situation model where implementing a strategy could maintain or improve the conservation targets (Foundations of Success, 2020). For example, the Cacapon Watershed's forest ecosystems are fairly intact and need to be protected from the threat of residential or commercial development causing fragmentation or deforestation. Based on this decision, the team determined that this threat would constitute an **intervention** point where a strategy would have a potential impact (see Glossary), defined by Foundations of Success, as "the likelihood that the strategy (if implemented) will contribute to the achievement of the goal." The team utilized the strategic ratings as listed below (Conservation Measures Partnership, 2020):

4 = Very High The strategy is very likely to completely mitigate a threat or restore a target.

3 = High The strategy is likely to help mitigate a threat or restore a target.

2 = Medium The strategy could possibly help mitigate or restore a target.

1 = Low The strategy will probably not contribute to meaningful threat mitigation or target restoration.

Feasibility is defined as "the degree to which your project team could implement the strategy within the time, financial, staffing, ethical, and other constraints." (Foundations of Success, 2020). The Open Standards classified feasibility ratings as follows (Conservation Measures Partnership, 2020):

4 = Very High The strategy is ethically, technically, AND financially feasible.

3 = High The strategy is ethically and technically feasible but may require some additional financial resources.

2 = Medium The strategy is ethically feasible, but either technically OR financially difficult without substantial additional resources.

1 = Low The strategy is not ethically, technically, OR financially feasible.

APPENDIX F: Theories of Change for each Strategy

Results Chains

A results chain is a way to demonstrate a **theory of change**, which is defined as "a series of causally-linked assumptions about how a team thinks its actions will help it achieve both **intermediate results** and longer-term conservation and human wellbeing goals" (see Glossary) (CMP, 2020). **Assumptions** (see Glossary) are statements that the team assumes are true. Intermediate results are the results that must be achieved to accomplish the final goal (see Glossary). Figure 12 illustrates a legend for a results chain. Strategies are represented by a **hexagon shape (in yellow)**. A strategy requires a series of **activities (yellow box)** to accomplish, along which **intermediate results (blue box)** can be measured. In addition, these contribute to **threat reduction results (pink box)** and finally the **target goal (green oval)** of the plan. Some **activities** should be measured during the project for efficacy, and those have corresponding **monitoring activities (purple box)**.

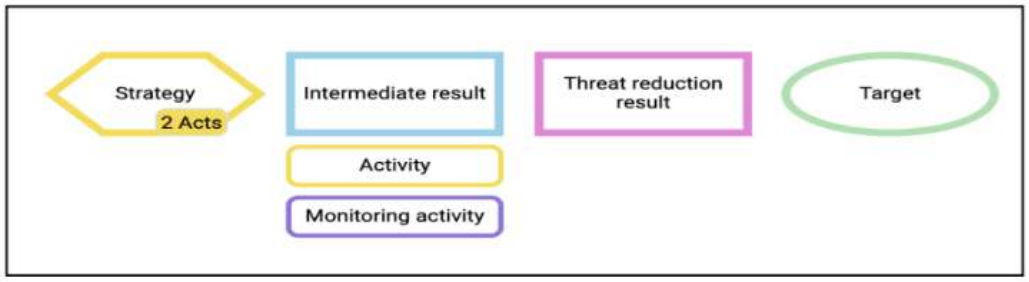
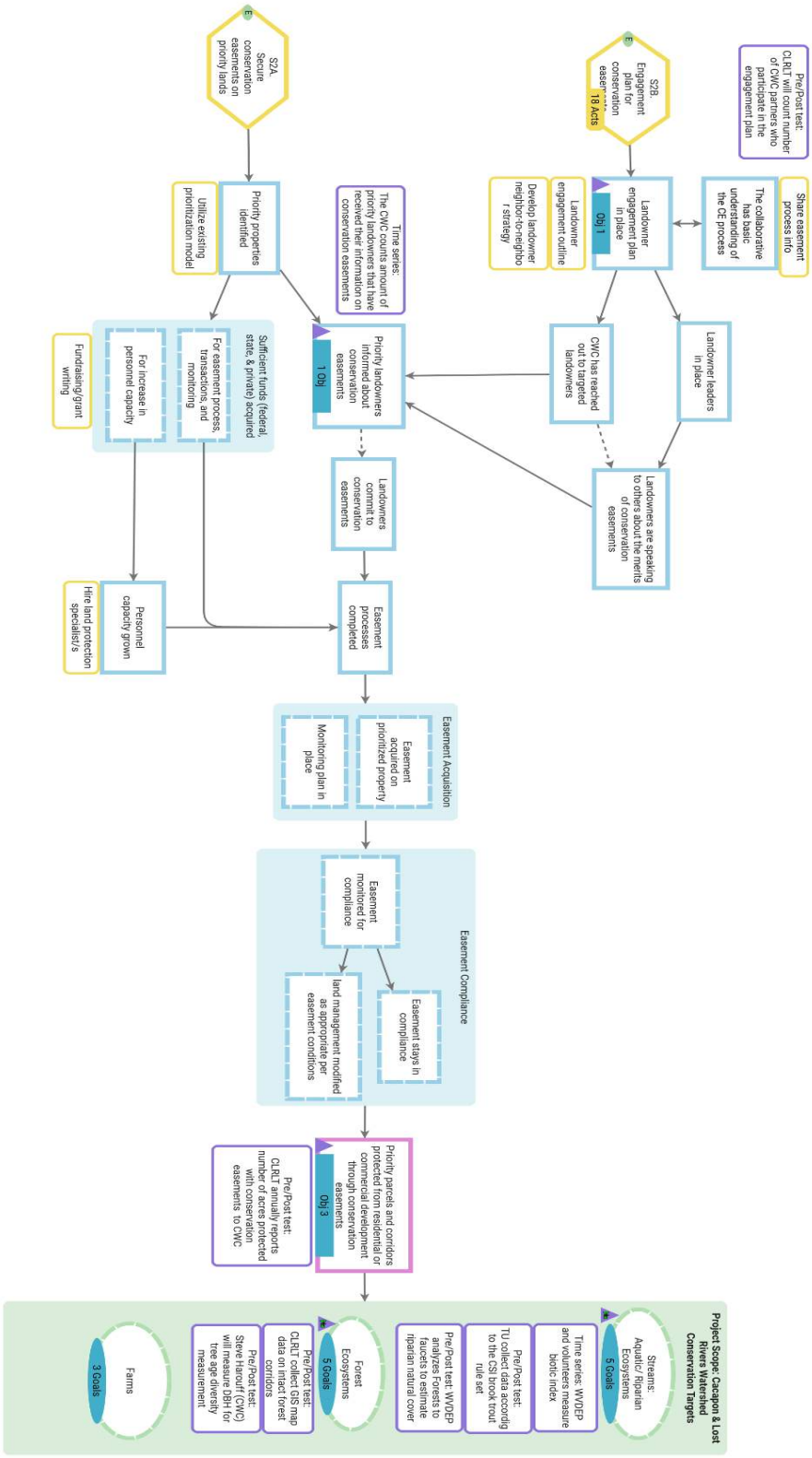
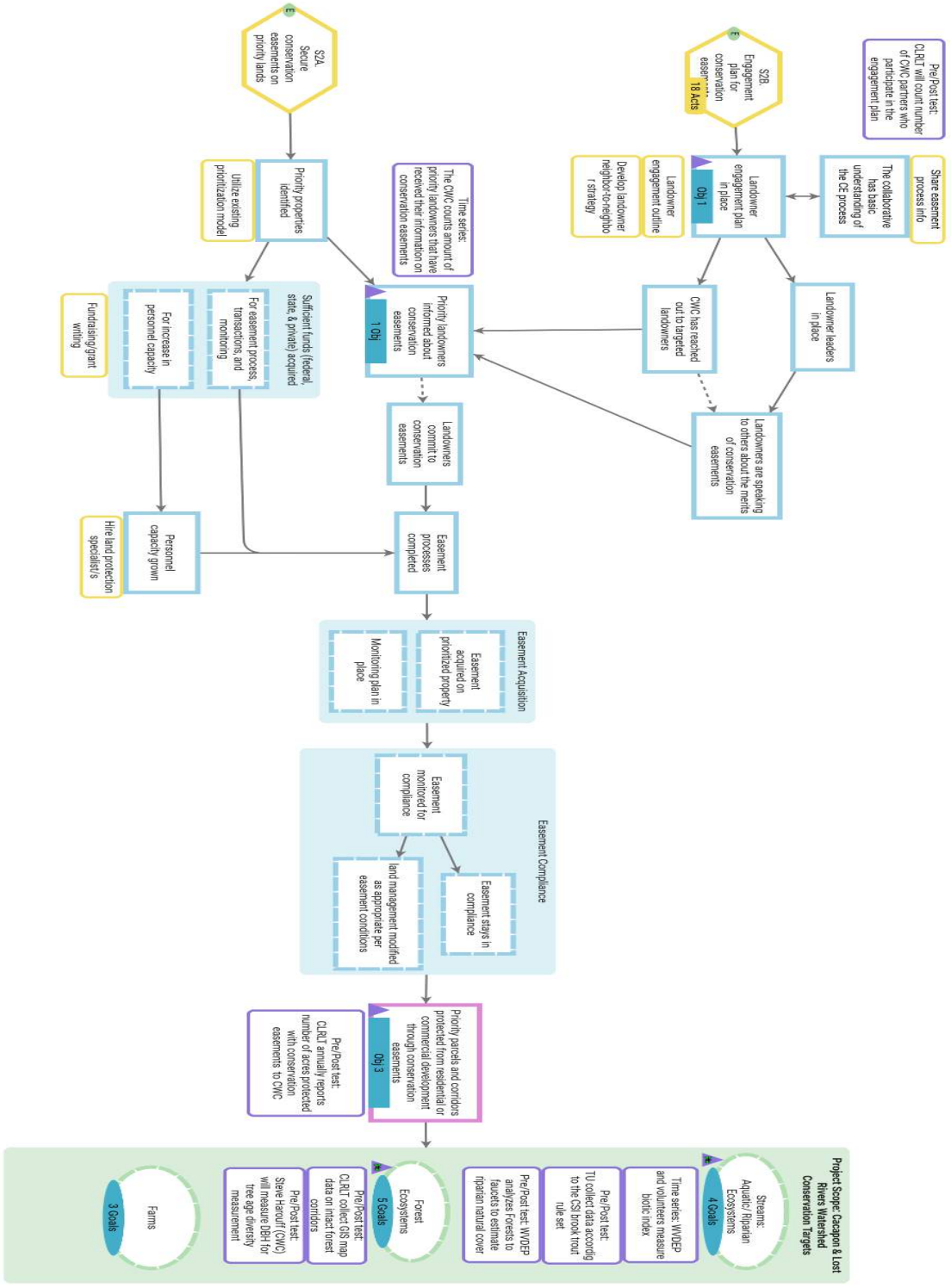


Figure 12. Legend of Results Chain Diagram

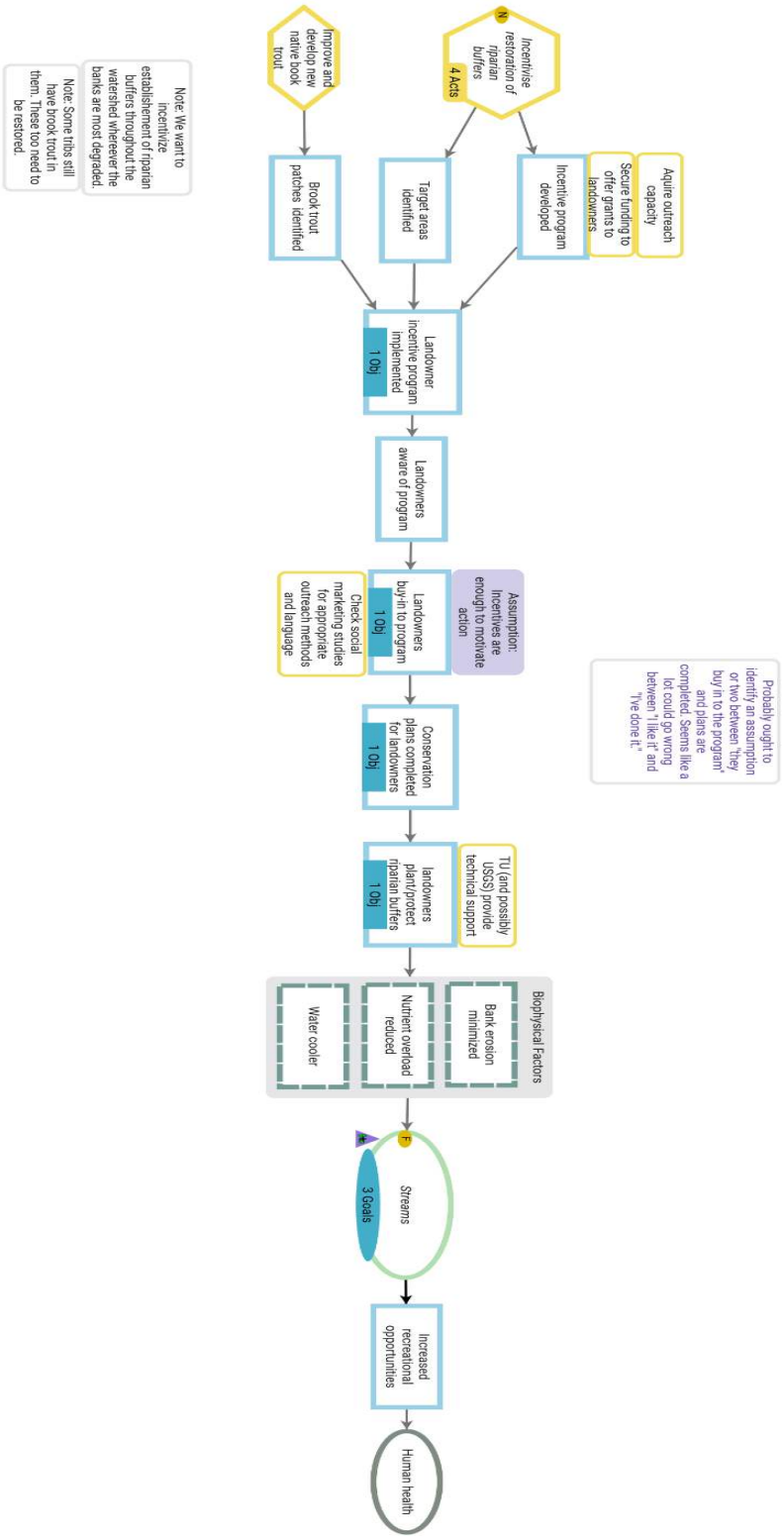
S1. Develop and expand Farmer Information and Financial Aid Programs



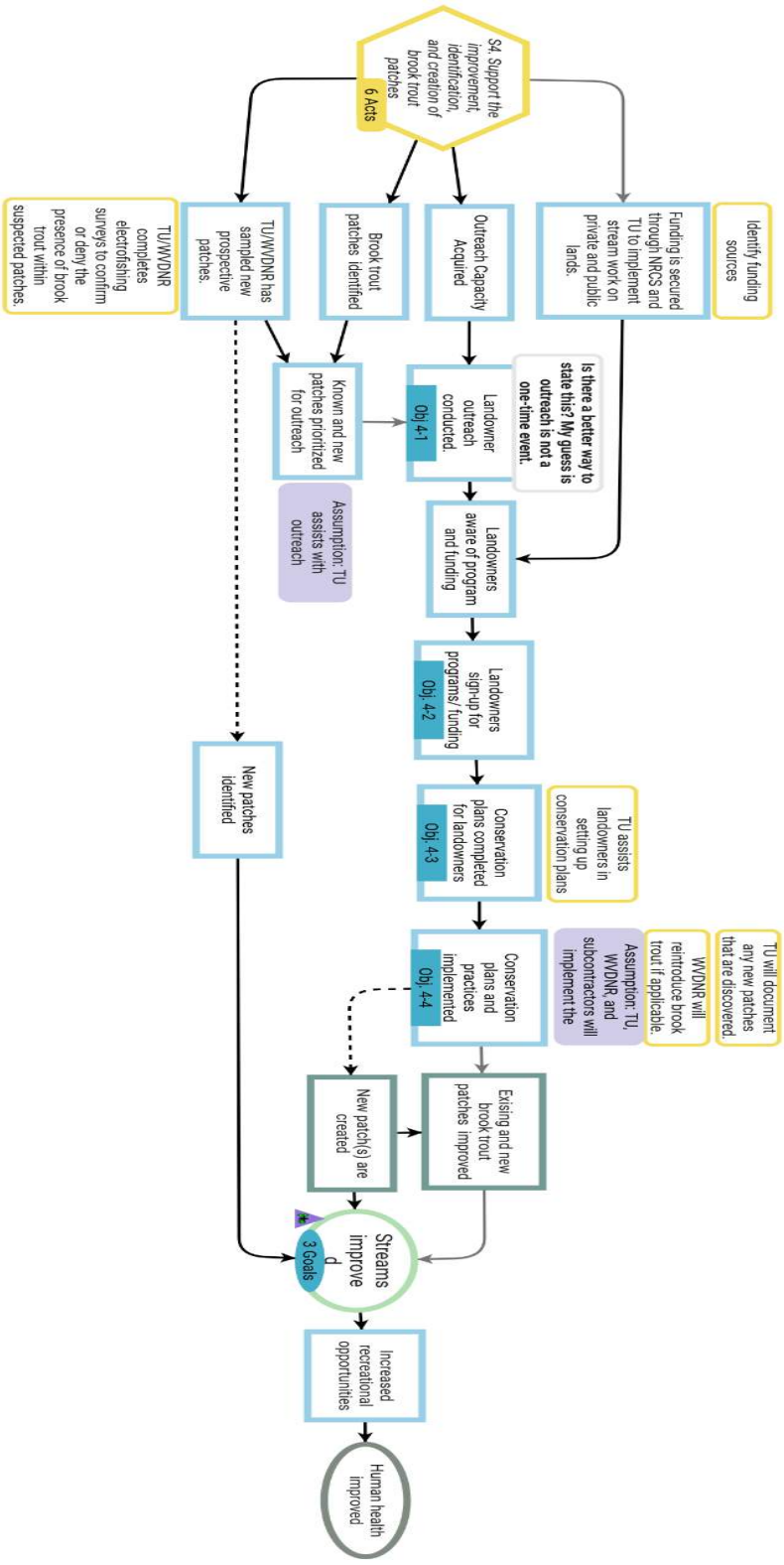
S2: Secure Conservation Easements on Priority Lands



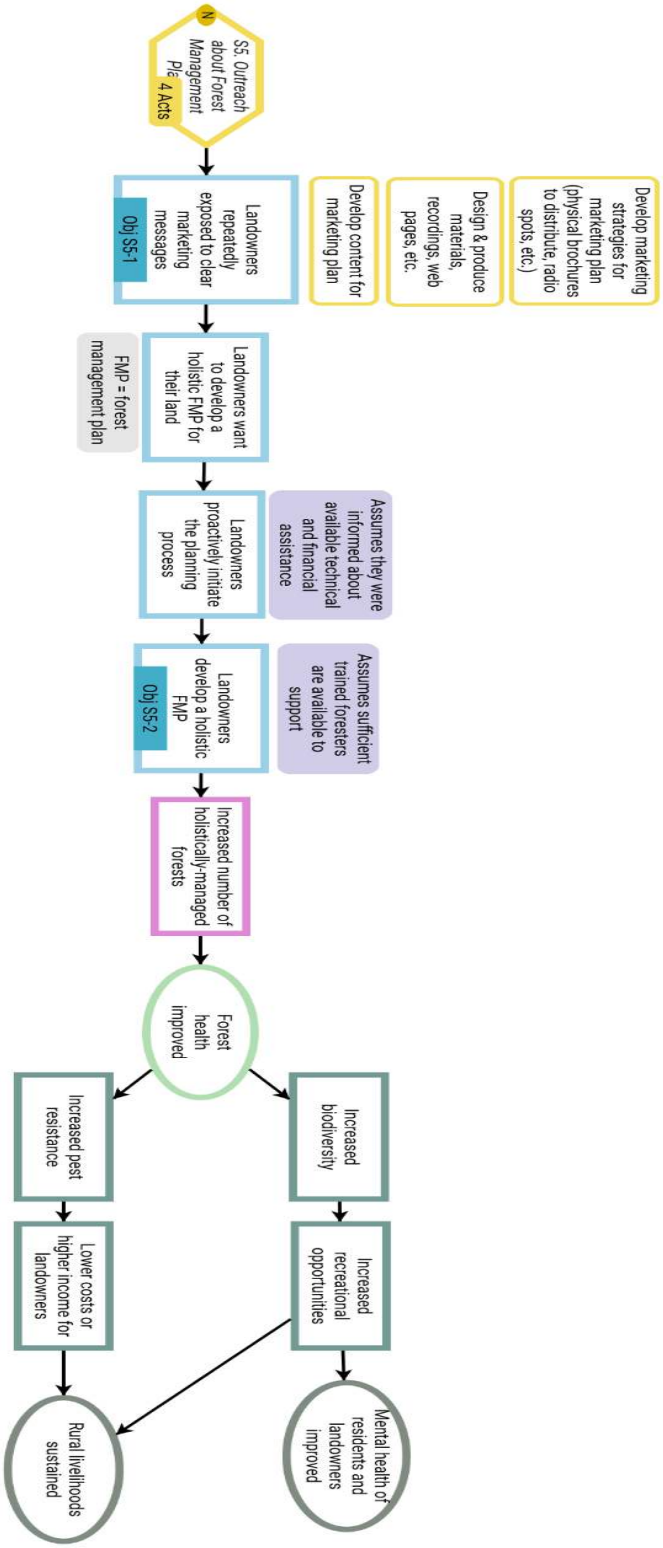
S3. Incentivize restoration of riparian buffers



S4. Improve and develop native brook trout patches



S5. Promote Forest Management Plans (FMPs) focused on long-term forest health



Appendix G: Example of a Quarterly Review Agenda

Quarterly Leadership Team Meeting Agenda

Date:

Conducting: Designated note-taker:

Members Present:

Agenda Items

A. ***Set the tone*** (1-2 min per person):

a. Each person shares three things related to his/her responsibilities: (1) best news or biggest win in the last 90 days, (2) what is working and not working, and (3) expectations for the day.

b. Make note of what is not working on the *issues* list (e.g., on the whiteboard) for discussion later.

B. ***Refocus*** (5 min):

a. Remind everyone about the vision, mission, and conservation targets.

b. Remind them of the strategies being implemented this year.

c. Provide a list of objectives (from results chains) with deadlines approaching in the next 2 or 3 quarters.

C. ***Review Previous Quarter Activities*** (Time TBD)*:* Review 12-month work plan activities and tasks (both work and monitoring activities) that were scheduled to be worked on during the past 90 days. This includes holdovers from previous quarters that were not completed.

a. Each responsible person reports on progress made for each activity or task. Record notes on progress in the appropriate column in the work plan.

b. If a task was completed, note that in the work plan.

c. For tasks that are off track, discuss why. If a complex issue exists, consider putting it on the *issues* list for consideration at the end of the meeting.

d. Record notes on action items and adjustments that the team commits to (may add them as additional tasks or sub-tasks).

D. ***Establish Next Quarter Work Plan Tasks*** (Time TBD)

a. List all activities and tasks that need to be done.

b. Decide which to prioritize, terminate, or postpone. Refer to upcoming objective deadlines.

c. Clarify responsibilities for each team member.

E. ***Solve Issues***

a. Accept that you can't solve all issues now, but you can prioritize and work on the most important.

b. Examine the list of issues (i.e., problems, barriers) created during the meeting. Are there any others that need to be listed? Add issues that were not addressed during the last quarterly meeting.

c. Rank them from most to least important to solve now (may have everyone put a dot next to what they feel are the top 3)

d. Start with the top issue and work on it until a resolution is achieved.

e. Continue to other issues as long as time permits.

F. ***Conclude***

a. Note the general feeling of team members. They should be excited and refocused. If not, plan to adjust the agenda for next time.

Consider asking feedback on how the meeting went. Consider doing one of the following:

Plus/Delta (5-10 min)— On the board or flipchart paper, make 2 columns: one labeled "+", the other labeled "Δ"(delta). Ask them where you list on the board what worked well and what should be changed (delta) for next time.

G. ***Afterward***

a. The note taker should send a copy of the notes, new assignments, and commitments to the group.

INSTRUCTIONS AND FREQUENTLY ASKED QUESTIONS

How do I use this agenda?

This agenda is designed for project teams that have action and monitoring plans based on the *Conservation Standards for the Practice of Conservation* framework. It is assumed that a 12-month work plan has been developed and that the team is using the NaturePlan work planning template.

If an action plan has recently been produced, the work or monitoring plan may not be complete. In that case, the team may wish to use part or all of the quarterly meeting to make progress on those plans.

Remember, your team is made up of human beings, and vast experience indicates humans struggle to stay focused on priorities for 90 days. Thus, teams who hold quarterly meetings with a prepared agenda will stay on track much better than those who only hold annual meetings.

Who is invited?

The quarterly meeting should be held every 90 days by the leadership team of a medium to large project. Smaller projects may include the full core team or invite select core team members. If the annual meeting is held in conjunction with the quarterly meeting, the full core team will be invited.

How long should it last?

Time required for a quarterly meeting is highly variable. It may only take a couple of hours, or you may need a half day or more. Experience, team size, and number of strategies and activities will dictate how much time to schedule.

How should team members prepare?

The person conducting the meeting should ensure each team member is sent the agenda and a copy of the 12-month work plan at least one week prior to the meeting. It is likely that leadership team members will need time to follow up with others to prepare for their report.

Ideally, the note-taker will be designated prior to the meeting so they can come prepared with a laptop and the work plan pulled up and ready to go.