Section 5: Project Description

1. Project Objectives:

This project meets the objectives of the SONCC-MatR.1.2.11.3, which states “to Implement the Mattole estuary restoration plan”.

The BLM Mattole Estuary Restoration Plan 2012-2017 (see attachment B at end of proposal) calls for several types of treatments to directly benefit salmonids. This DFW project implements several elements of the BLM Estuary Restoration Plan.

This DFW proposed project will place a significant quantity of very large wood (200 whole trees with root wads and crowns) in the estuary and lower river. Currently, very little large wood exists, although this is changing. Existing large wood was installed by Mattole Salmon Group since 2004, with placement of 200 whole trees during phase 1 of the heliwood work in 2013. The BLM Estuary Restoration Plan 2012-2017 calls for placement of up to 400 whole trees in various locations throughout the lower 3 miles of the river.

This project will increase the amount of large wood in this lower river area to 400 whole trees, plus several other complex wood structures. This project aims to use the largest helicopter available for the task to place as large a whole tree as possible. This will increase the longevity of the wood. An additional benefit and objective of this project is to provide immediate suitable winter rearing, and adult holding and refuge habitat for coho salmon, Chinook salmon and steelhead. These habitat benefits will increase over the longer-term, as the overarching goal of the project is the reduction of Greenhouse Gases and increased carbon storage and to restore natural ecosystem process to the estuary and lower-river through the following:

* Increase instream habitat complexity
* Promote and protect riparian vegetation colonization and growth
* Create a mosaic of varying streambed sediment sizes
* Promote more variable topographic diversity in the reach
* Increase connectivity to existing sloughs, alcoves, and other off-channel habitat
* Increase stream nutrients available to native species
* **The increased riparian growth and protection of existing riparian woodlands will reduce GHG and increase carbon storage.**
* **Planting of deep-rooted perennial bunch grasses will increase carbon storage on nearby native prairies**

This large-scale project will cover much of the un-wooded aquatic areas of the Mattole Estuary and increase habitat complexity more than individual LWD projects. The whole trees and structures are expected to have a long life span of presence in the estuary, and can be considered long-term recruitment. The riparian plantings are expected to provide long-term benefits to fish and wildlife and birds, while also reducing Greenhouse Gas (GHG) Emissions and increasing carbon storage.

2. ***Background and Conceptual Models:***

Background: The Mattole River Watershed is a 304 square-mile basin located in coastal Humboldt and Mendocino Counties of Northern California. The river is flanked on its western edge by the BLM's 64,000-acre King Range National Conservation Area. Although remote, the watershed has not been spared the negative effects of past land uses, including extensive wide-scale logging and associated road building between 1945 and 1970, with over 90% of the watershed's coniferous forest cover harvested at least once during this period. These activities, combined with naturally occurring steep slopes, high rainfall rates, and erosive geology, have resulted in altered watershed processes and an extreme reduction in fish habitat quantity and quality. The watershed is listed as an "impaired waterbody" for sediment and temperature on the Clean Water Act §303(d) list. The impaired water quality of the Mattole River impacts two Critical Coastal Areas: the Mattole River (CCA#7) and the King Range National Conservation Area, (CCA#8), the latter of which is also an Area of Special Biological Significance (ASBS).

The Mattole is home to three independent populations of Federally listed salmonids: California Coastal (CC) Chinook salmon, Southern Oregon/Northern California Coast (SONCC) coho salmon, and Northern California (NC) Steelhead. SONCC coho salmon are listed on the California state Endangered Species list, as well. Although the Mattole River is home to one of the last wild (non-hatchery) runs of Salmonids on an un-dammed river, today's populations are less than 1% of historic levels.

Need for the Project:
This project meets the objectives of the SONCC-MatR.1.2.11.3, which states "to Implement the Mattole estuary restoration plan".

The 250 acre estuary at the mouth of the Mattole River has long been a focus of watershed restoration practitioners. See photos of the estuary over time in the end of this proposal. As flows decline in late spring, a sandbar closes off surface flow from the river to the Pacific Ocean, forming a lagoon, which persists until flows increase in the fall. Prior to major land disturbances, the Mattole estuary/lagoon was notable for its deep, thermally-stratified pools and numerous functioning north and south bank slough channels that flushed sediments from the river and received marine water. These areas nourished and provided a stable habitat for a variety of avian, terrestrial, and aquatic species, including salmon and steelhead, which used it for winter rearing and refuge and during summer rearing.

Land-use impacts from logging and road construction, however, followed by an extreme 1964 flood, dramatically altered the estuary. The estuary filled in with large volumes of sediment from upslope and upstream sources, burying the once-healthy slough channels and destroying the pristine habitats. The Mattole estuary is now poor habitat for all salmon and steelhead species: it is a mostly homogenous zone characterized by warm water during the summer, little habitat cover and riparian vegetation, a lack of slackwater and off-channel habitat, low levels of instream wood, and overall low habitat complexity.

The proposed project aims to counter these current poor habitat conditions by following recommendations set forth in the Mattole Watershed Assessment Report (Downie et al. 2003), and the BLM Mattole Estuary Restoration Plan 2012-2017 to increase pool depth, cold water available to juvenile salmon, cover, and habitat complexity for the restoration of the estuary/lagoon. The project will result in a significant increase of instream wood throughout the estuary and lower mainstem, not only immediately creating habitat for juvenile coho salmon, but also aiding in the restoration of estuarine processes over the long term. Restoring and enhancing Mattole wetlands will reduce GHG emissions and store more carbon.

Restoring the natural estuarine processes and increasing channel complexity will provide a greater buffer for salmonid response to potentially negative effects of climate change and irregular weather patterns, such as drought and flooding. The Project involves the placement of large wood structures in the estuary and lower river. This restoration method is a well-documented practice designed to increase and enhance habitat for juvenile coho, Chinook salmon, and steelhead. When placed directly in the channel, whole trees provide optimal cover habitat for juvenile fish, as branches, logs and roots, offer increased shade in the summer, winter and spring-time flow refuge, feeding opportunities, and refuge from predators. When trees are placed so as to encourage channel complexity and anabranching, there is a resulting increase in the amount of wetted channel in contact with riparian vegetation, thus increasing the availability roughness elements and food for juvenile salmonids from these sources. Additionally, from a management perspective, larger wood – especially whole trees with attached rootwads and limbs– tends to be more stable and longer lasting than logs when placed in the river, thus making the overall outcome more cost-effective and sustainable.

As of summer 2013, there were approximately only 5 pools with a residual pool depth of 6 feet or greater, 2 of these being the result of complex wood structures installed by the Mattole Salmon Group in 2007. This proposed Project aims to increase the number of pools >6 ft in depth to 12, thus contributing to the overall goal of 15 of such pools by 2017, or the end of the 5-year collaborative restoration plan for the estuary. Increasing the frequency of pools in the estuary will aid in increasing overall habitat complexity, which will have year-round benefits for salmonids of all life stages. While at least 5 of the complex wood structures will serve to increase pool habitat, other structures and trees will serve to facilitate island stabilization or encourage channel formation. This will create a multi-channeled estuary with increased cover and edge habitat.

Currently, only 2% of estuary and lower river in the project area provides complex habitat for rearing salmon. Through the direct actions of this Project, we will increase the amount of complex habitat by 3%. Longer-term effects of the project, in addition to other efforts outlined in the 5-year plan, aim to increase the amount of cover to 15% of the estuary by 2020 (some elements of the 5-year plan will not be implemented until 2017). While some of this will be through direct placement of wood, other increases will come through the growth of planted cuttings in association with wood, and planted riparian and island vegetation along the edges of the stream channel/s. These latter plantings will serve to increase the overall edge habitat by 30% by the end of the 5-year restoration effort.

While the need for creating more juvenile coho salmon habitat is immediate, there is also a need to begin to restore estuarine function now for all threatened salmonid species, so that suitable year-round rearing habitat for all salmonids can be naturally created and sustained. A significant component of the Project is the strategic placement of large wood to restore hydrologic function to the estuary. The sooner this can be done, the sooner the estuary can naturally begin to offer suitable habitat and the longer-term effects of our restoration can be realized.

The recent drought further drives the point home that in some years due to low flows spawner and rearing access can be severely limited to the lower river. This means efforts to add complexity and restore habitat in these areas are critical to salmonid survival. Protecting riparian woodland loss through terrace margin treatments along retreating stream banks will keep soils wet thus reducing the release of GHG. Planting more riparian woodlands on bare terraces will store more carbon and reduce GHG. Removal of encroaching Douglas Fir trees on nearby upslope prairies and placing them in contact with the river will store this carbon for a long time. The areas where trees are removed will be planted with native bunch grasses to increase carbon storage on these native prairies.

While climate change and sea level rise (SLR) is a big problem along the coast of California, in the estuary area of the Mattole the geologic processes lead to uplift neutralizing the effects of SLR. In fact the uplift is so severe that this is a primary reason for the disconnection of the estuary slough channels we are now excavating to reconnect to the river.

The Mattole is a rain dominated watershed and as such is expected to have little change due to climate warming. Its summer water temps can be a decisive factor in salmonid survival. A recent paper by Jeanette Howard of The Nature Conservancy (1) found that the Mattole has the greatest chance of success with fish population supplementations of any coho stream in California.

Conceptual Model: An increase in groundwater bank storage capacity almost certainly increases sequestration of carbon dioxide in riparian plant species and soils. Most wetland types naturally emit methane resulting from anaerobic decomposition of organic matter. However, because anaerobic decomposition processes are much slower than aerobic decomposition processes, any measure that reduces the flux of oxygen into the subsurface will almost certainly result in better carbon sequestration rates. Studies also indicate that nitrous oxide emissions from wetland soils decrease when they are saturated.

The typically high soil organic carbon content in these soils is a result of carbon sequestration by plant roots and detritus at rates that exceed the anaerobic decomposition rate for organic matter. Specifically, methanogenesis from the saturated zone is typically much slower than carbon sequestration resulting from the growth of vegetation. Saturated groundwater conditions in riparian soil horizons not only maintain native hydrophytic plant communities, but also reduces the rate of oxygen transport into the subsurface. Because the dissolution of oxygen into groundwater is slow and the rate-limiting step in oxidation of soil carbon below the water table, any measure that increases groundwater bank storage should also serve to reduce emission of organic carbon aerobic decomposition products including CO^2 and N^2O.

This project proposes to study carbon cycling and sequestration rates in restored versus the unrestored areas before treatment. We will collect and analyze soil samples for total organic carbon from the vicinity of existing large woody debris (LWD) structures and previously constructed features to estimate the rate of carbon sequestration resulting from construction of new

LWD structures. Methods that will be employed to assess carbon sequestration include chemical analysis of soil organic carbon and soil gas samples for CO^2, CH^4, and N^2O. Samples will be submitted to a certified laboratory for analysis of these analytes and/or measured using a real-time gas monitor. The estimated flux of GHG will be compared between new and existing structures to assess trends in GHG emission for structures of varying ages. The oldest structures are about 10 years old and the newest will have been constructed immediately before the monitoring stage of the project is initiated. We estimate that the monitoring period for GHG will be about one calendar year.

For the 25,000 square feet of slough excavation removing soils from those areas that get wet and then dry releasing GHG will be removed and used to place around deep trenched riparian plantings to increase their growth. These soils will buried to aid in root growth of the planted riparian species. This will decrease emissions from these soils and increase storage of even more carbon. Once the soils are removed from the buried old slough channels, then the coble and gravel is removed to create an open water back-water slough refuge for endangered salmon and steelhead. Eight summer steelhead 24-36 inches in length took up residency in the brand new slough channel (built in 2014) during this drought low flow summer.

Encroaching tree removal (200 whole trees) from prairies over about 2 acres will store carbon as we place these removed whole trees as instream structures for fish. By placing these trees in contact with water they will decompose slower releasing less GHG. Many examples of this relationship exist in the literature. After tree removal the 2 acre prairie areas are to be planted with native deep-rooted bunch grasses that will store even more carbon, while increasing infiltration and water storage.

Planting of about 1.5 acres of open terrace to create a riparian woodland will reduce GHG emissions for the soils in those areas. The soils will stay wetter with woodland cover and deep roots to groundwater. This will also increase carbon storage.
Construction of the whole tree stream barbs with deep trenched willow plantings over a 0.5 acre area will increase bank resistance and protect existing riparian woodlands thus reducing GHG emissions and increasing carbon storage. Over 2 acres of riparian woodland were lost in two years due to bank retreat (see Figure 2). This terrace margin treatment will help save 2-4 acres of existing riparian woodland (see Figure 1).

We estimate that we will conserve about 500 tons of carbon terrestrially and a similar mass in soil carbon. Over the long-term, the "new construction" portions of the project will become a carbon sink as the trees mature and root networks become denser, potentially sequestering several hundred more tons of carbon. It is accepted by the Intergovernmental Panel on Climate Change that wetland conservation is a significant step toward reducing GHG emissions because these changes are steady over the long term and in alignment with another paramount need, conserving biological diversity. Climate change is the most recently identified risk to aquatic ecosystems. The noted reduction in coastal fog over the last decade means that more sunlight is being cast on the water surface, likely increasing water temperatures and algal growth. This project mitigates changes to the climate locally by preserving cool deep pools in the lower estuary where this habitat is precious.

3. ***Detailed project description, including all tasks to be performed:***

The proposed Project is part of a larger 5-year restoration effort that is being undertaken by the Mattole Salmon Group, the Mattole Restoration Council, the California Department of Fish and Wildlife, The State Coastal Conservancy, the California Department of Water Resources, The Nature Conservancy, the U.S. Bureau of Land Management, NOAA-NMFS, the National Fish and Wildlife Foundation, and the U.S. Fish and Wildlife Service, and private landowners.

The goal of this large coordinated effort is to restore ecosystem processes to the estuary and lower river, while reducing GHG emissions. This will be done through the placement of large wood at key sites to facilitate stable island formation, multiple channel formation (anabranching), and scour (where appropriate), treatments to eroding terrace margins to protect existing riparian woodlands, and extensive plantings of cottonwood, willow, and other native species on established, unvegetated islands and along edges of stream channels to increase riparian woodlands.

There are three phases of the Project proposed herein: (1) pre-project planning, design, permitting, and monitoring, (2) implementation, and (3) post-implementation assessment and monitoring. This proposal seeks funds for implementation (2) primarily. Other costs for 1 and 3 are covered by partners and volunteers.

Phase 1: Pre-project planning, design, and monitoring
This Phase 2 is underway through the 5-year restoration planning effort coordinated by a technical team of BLM, DFW, and USFWS personnel, with assistance from MSG and the Mattole Restoration Council (MRC). The BLM has taken the lead on permitting the tasks in the plan and permits are now in place. BLM is committed to doing the permitting for the next phase of slough channel excavation and due to the success of last years work these permits will be easily acquired. Additionally, with CA DFW funding last year for the Phase 1 Heliwood, all of the tasks in the BLM 5 Year Plan are now also fully state permitted, including a 1600 permit that is in place for all tasks proposed in this project. This is a SHOVEL READY PROJECT.

General site selection for Heliwood placement has already been determined by the TAC team (see map in attached BLM Plan –Attachment B), and final site selection will take place each summer before placement occurs. All final site locations will be recorded with GPS, assigned a specific station number in sequential order from river mile 0, and mapped. Every tree gets pit tagged as well. Specific access to site locations will also be determined during this phase, and some existing roads along the bank (see Conceptual Plan) will be suitable. Additional access routes to other sites will be chosen to minimize water crossings or the need for flow diversions.

See Figure 1 Site Map for the location of the proposed riparian planting, slough channel excavation, and terrace margin treatments with riparian planting. Last years work is also shown on this Figure. Figure 2 shows the area of bank retreat and riparian woodland loss that this project is designed to address.

There are no required listed species surveys to be done for this work. Tree removal sites are covered under existing landowner management plans, Non-Industrial Timber Management and Timber Harvest plans, and restrictions listed under those plans will be followed. Pre-project monitoring of estuary and lower river sites and feature locations will consist of measuring physical habitat characteristics, such as residual pool depth, and snorkel survey for fish presence, as well as Total Station Mapping and Id'ing every tree placed with pit tags and GPS locations.

Pre-project GHG measurements will be taken at treatment sites and monitoring sites will be set up to take after samples as well.

Phase 2: Implementation
Slough Excavations will remove the fill materials from up to 500 feet of buried slough channel in layers. The soils on top will be placed deep in the deep trenched willow plantings nearby to aid in riparian woodland growth. The gravels under the soils will be removed and used in the willow planting areas as furrowed hummocks to reduce erosion of the terrace. Existing riparian woodlands surrounding the slough will be protected and large woody debris will be placed in the excavated slough for fish habitat. This work will happen in the summer when water levels are at their lowest.

Tree placement in estuary locations will not occur prior to June 15th. A minimum of 200 whole trees will be used for this project. Up to 100 whole trees will be used in the terrace margin treatment as stream barbs to slow bank retreat and protect the existing riparian woodland along 500 feet of retreating bank. The remaining whole trees will be placed in various locations as described above. The large wood (24 min DBH) and whole trees with attached crowns and root wads for this project will come from private properties with active forest management plans within a few miles of the project area. These trees are part of an encroaching Douglas-fir forest that has invaded native prairies for the past 60 years since fire suppression came into favor. The tree removal is part of a native prairie restoration effort being implemented by the private landowners, BLM, and the local Fire Safe Council that will allow the local landowners to initiate burning practices in efforts to bring back native perennial grasses. Maintaining these prairie openings also creates a significant firebreak that will assist the Fire Safe Council, the Petrolia Volunteer Fire Department, Cal FIRE, and the landowners in managing threatening wild fires in this area. This reduced fire danger will add to the reduction in release of GHG and will increase carbon storage. Once the trees are removed, they will be staged in preparation for transport. A large helicopter will be used to transport the trees, which will be placed at the final selected sites within the lower-river and estuary. This project seeks to use the larger Chinook Helicopter with twin blades as it can carry a larger payload.

While a helicopter uses allot of fuel, when compared to the alternate way of building instream structures, the carbon footprint is less. The standard practice involves cutting trees with chainsaws up into pieces so that they can be transported to the treatment sites. Lots of trucking is then involved for the trees and for rock rip rap to secure the wood structure to, so as to minimize movement downstream. There are carbon costs to making the rock at a quarry and it has to be hauled from over 2 hours away from the site using even more fossil fuels. Once the rocks and cut up trees are at the site then an excavator works for weeks to place these pieces into an Engineered Log Jam. Lots more chainsaw work occurs and a tremendous amount of drilling of the wood and rocks to connect everything together with metal cable and rebar to help unitize and stabilize the structure. This involves even more fossil fuel use in addition to the carbon footprint of the manufacture of all of the metal. Finally, there is lots of metal in the river that is not natural, like whole trees are.

Last year we were able to place as much large wood in the river in 11 hours of helicopter use as compared to 10 years of fossil fuel intensive construction of ELJ's. Furthermore, the helicopter allows for placement of whole trees with root wads and crowns. These whole trees closely mimic natural processes and materials.

Construction activities will take place in the channel bed and along the banks (see below for description of activities). Staging areas for equipment and materials will be located on previously disturbed areas near each site. Any perennial vegetation removed for temporary access routes will be replanted. All disturbed areas will be mulched with native straw following construction.

Specific treatment location types and treatment features are discussed below and in more detail in the attached BLM Plan. Treatment location types include intermediate-elevation islands, bar apices and terrace margins. Intermediate-elevation Islands: Several islands are present in the project reach. Generally, the elevation of these islands is less than bankfull stage in height, rising approximately 4 to 8 feet above the summer low-flow water surface. They are characterized by partially vegetated surfaces with broad patches of fine sediment suitable for plant colonization. A combination of wood structures and plantings would be installed on these islands. Structures will typically be located at the upstream end of the island or along the margins to increase stability of the feature, promote deposition of finer-grained sediment for vegetation colonization, contribute to instream habitat complexity, promote development and connection to side channel and alcove habitat.

Bar Apices:
The upstream extents of alternate and mid-channel bars are proposed for various treatments. Through the project reach, these surfaces slope gradually from near bankfull elevations to the channel thalweg. Treatments would occur near the heads of bars to promote stability and increase habitat complexity at low flows. Specific treatments will include bar apex jams and vegetated baffles. In some instances, the objective of the structure may be to create instream habitat features such as scour and cover around an individual log. In other cases, a combination of larger log and vegetated baffle installations would be used to create a more persistent topographic feature in the channel.

Terrace Margins:
Alluvial terraces above bankfull stage are present through the reach. Most notable is the large terrace in the lower half of the reach along the south bank, which is where this project is. Terrace margin treatments would be more extensive consisting of wood structures and possibly larger arrays of vegetated baffles. Treatments along terrace margins would not encompass the entire length, but rather be focused on specific areas (see Conceptual Plan for more detailed objectives). Treatment feature types include engineered log jams and bar-apex jams, along with bio-technical bank treatments.

Engineered Log Jams:
The term "Engineered Log Jam" (ELJ) was developed by Tim Abbe and colleagues, (Abbe et al. 1997) and refers to in-stream structure built by stacking whole trees and logs in crisscross arrangements to emulate natural log jam formation. An ELJ creates diverse physical conditions

such as deep scour holes along the edge and the trapping of additional debris. Flow stagnation (flow refuge) is created in the shadow. Design of ELJ's will be based on DFG's California Salmonid Stream Habitat Restoration Manual and published guidelines (Abbe et al. 1997, Braudrick and Grant 2000). ELJs may be anchored into banks and ballasted with large rocks as needed. Key pieces of ELJs may be pinned or cabled to large rock as necessary to offset buoyancy and flow velocity forces during high flow events using standard cabling and pinning techniques described in DFG's California Salmonid Stream Habitat Restoration Manual. The cabling and pinning would be placed in a location where it would be permanently submerged or hidden from view by woody debris and sediment. Construction of some of the structures would require the use of a large excavator for excavations prior to wood placement.

Bar-Apex Jams:
The bar–apex jams would be constructed on islands and at the upstream extent of active river bars. Trenches would be excavated (using an excavator) at the head of bars. Then 6-15 large whole trees and boles will be placed in the trench along with other organic material and/or willow and/or cottonwood cuttings. The woody material will be partially buried with the excavation spoil. The root boles or tops will be left protruding above ground level depending on site conditions. The woody material will extend a short distance above the bed, but will be sufficiently anchored by the fill to prevent removal during high-flow events. The angle of the protruding trees would vary from nearly horizontal to nearly vertical depending on site conditions.

Bio-Technical Bank Treatments:
These treatments would be constructed from whole trees, root wads, tree logs, rooted willow clusters, willow and cottonwood cuttings, and soils from nearby slough channel excavations. The objective is to increase bank resistance and slow the turn over of terraces and islands.

Phase 3: Post-implementation monitoring and assessment
Monitoring of implementation sites will include pre- and post-project photo documentation and vegetation, topographic and/or bathymetric mapping, as well as surveys to document fish use.

Follow-up GHG emissions monitoring and measurements of carbon storage will be done at all treatment sites. All trees placed will be pit tagged and GPS locations will be taken and they will be surveyed into the topographic map.

Staffing for the project:
Mattole Salmon Group-The Mattole Salmon Group (MSG) will be the implementation contractor for this project and will use a local subcontractors for heavy equipment and engineering services for the project. We will use the most cost effective helicopter company available at the time.

MSG Project Manager: The responsibilities include management tasks such as subcontracts and budgets and invoicing, personnel management, as well as implementation and overall project management.

MSG Project Coordinator: The responsibilities include day to day supervision of construction activities, including subcontractor communications and oversight, crew supervision, tracking daily costs, maintaining the safety program and protocols, and meeting all permits conditions.

MSG Laborers: Assist with all construction and monitoring activities.

MSG Bookkeeper: The MSG bookkeeper will help create invoicing and track budgets, as well as meet payroll and pay accounts receivable.

MSG Program Assistant: Assist the Project manager with management tasks.

Subcontracted Equipment Operator: The equipment operator will operate all heavy equipment as needed for placement and installation of logs and boulders, including excavator, bulldozer, log skidder, dump truck and trailer, and crane truck and trailer.

Subcontracted Helicopter Crew and Machine: Lifting and placement of whole trees.

Subcontracted Engineering Services: To include set up of base line and followup monitoring of GHG Reductions.

Costs for Tool Rental, 4WD Truck rental, travel, field and office supplies are directly related to the project.

4. ***Timeline:***

June – November 2015: Pre-project monitoring and final site designs complete
June - July 2015, 2016, and 2017: Tree removal and staging
July - October 2015, 2016, and 2017: Helicopter placement of whole trees in estuary
July - October 2015, 2016, and 2017: Ground crews secure tree boles to each other, as needed
September - November 2015, 2016, 2017: project site and wood donor site cleanups complete
December 2015 - June 2018: Post-project monitoring
November 2019: Final Reporting

5. ***Deliverables:***

Deliverables:
#1: The removal of 200 trees from Prosper Ridge or Moore Hill prairie restoration locations and removal site restoration through grading, planting, seeding, and mulching with native species.

#2: The placement of these 200 whole trees in the Mattole estuary and lower river. Individual feature locations include large single tree placement as well as apex jams and complex habitat structures (aka engineered log jams), as well as along terrace margins treatment areas.

#3: Construction of between 400 and 500 feet of terrace margin treatments to include whole trees as stream barbs combined with deep trenched willow baffles to protect existing riparian woodlands.

#4: Construction of up to 2000 feet of deep trenched baffles to include planting of up to 5,000 willows and cottonwoods cuttings over about 2 acres of newly created riparian woodland

#5: A. Insert individual identifier tags into each placed whole tree. B. Site map total station, and with GPS locations and correlated PITT taggs of all placed whole trees.

#6: Monitoring of GHG emissions and carbon storage at project sites.

#7: Final project/contract report containing pre- and post-project topographic and bathymetric information and/or mapping, photo documentation, fish presence information, and GHG Monitoring results.

All Final reports and data will be posted to our website >mattolesalmon.org< and we will publish an article about this project and the GHG component in our semi-annual Watershed Newsletter. We will also present the results of this work at professional watershed conferences.

6. ***Expected quantitative results (project summary):***

Amount of estuarine area treated (acres)	150
Area planted in riparian (acres)	2.0
Instream features installed/modified	100
Length of stream treated for channel structure placement (miles)	2
Pools created through channel structure placement	15
Species of plants planted in riparian: willow, cottonwood, native shrubs	
Total length of instream habitat treated (miles)	2
Overall stream length treated, count one side of stream only (miles)	2
Plants planted (number)	5000 cuttings, 500 shrubs
Length of streambank stabilized, count both sides of stream(miles)	2
Length of riparian stream bank treated (miles)	4
Total amount of riparian area treated (acres)	150

Without this project, ie. a conservative "Business as Usual" approach will see continued loss of riparian woodland at the bank retreat sites; continued GHG emissions from soils that get wet and dry out due to a lack of riparian vegetation on the terrace and in the sloughs; and continued prairie encroachment by Douglas trees leading to increased wildfire threat and the release of GHG's.

This project will reverse these negative possibilities by reducing erosion and growing more riparian vegetation and restoring native prairies while benefiting salmonids and wildlife.

7. ***Protocols:***

An increase in groundwater bank storage capacity almost certainly increases sequestration of carbon dioxide in riparian plant species and soils. Most wetland types naturally emit methane resulting from anaerobic decomposition of organic matter. However, because anaerobic decomposition processes are much slower than aerobic decomposition processes, any measure that reduces the flux of oxygen into the subsurface will almost certainly result in better carbon sequestration rates. Studies also indicate that nitrous oxide emissions from wetland soils decrease when they are saturated.

The typically high soil organic carbon content in these soils is a result of carbon sequestration by plant roots and detritus at rates that exceed the anaerobic decomposition rate for organic matter. Specifically, methanogenesis from the saturated zone is typically much slower than carbon sequestration resulting from the growth of vegetation. Saturated groundwater conditions in riparian soil horizons not only maintain native hydrophytic plant communities, but also reduces the rate of oxygen transport into the subsurface. Because the dissolution of oxygen into groundwater is slow and the rate-limiting step in oxidation of soil carbon below the water table, any measure that increases groundwater bank storage should also serve to reduce emission of organic carbon aerobic decomposition products including CO^2 and N^2O.

This project proposes to study carbon cycling and sequestration rates in restored versus unrestored areas. We will collect and analyze soil samples for total organic carbon from the vicinity of existing large woody debris (LWD) structures and previously constructed features to estimate the rate of carbon sequestration resulting from construction of new LWD structures. Methods that will be employed to assess carbon sequestration include chemical analysis of soil organic carbon and soil gas samples for CO^2, CH^4, and N^2O. Samples will be submitted to a certified laboratory for analysis of these analytes and/or measured using a real-time gas monitor. The estimated flux of GHG will be compared between new and existing structures to assess trends in GHG emission for structures of varying ages. The oldest structures are about 10 years old and the newest will have been constructed immediately before the monitoring stage of the project is initiated. We estimate that the monitoring period for GHG will be about one calendar year.

This project will calculate an approximate mass balance for carbon in the system by comparing soil organic carbon from previous similar riparian enhancement projects against soil organic carbon from the new riparian features that are proposed herein. These data, when coupled with measurement of GHG emissions, will allow us to estimate the rate of carbon sequestration/depletion in riparian wetland soils.

This project proposes to study carbon cycling and sequestration rates in restored versus unrestored areas. We will collect and analyze soil samples for total organic carbon from areas that have been previously restored and determine the rate of carbon sequestration in the restored areas versus areas that have not been treated. Methods that will be employed to assess carbon sequestration include chemical analysis of soil and soil gas samples for CO^2, CH^4, and N^2O. Samples will be submitted to a certified laboratory for analysis of these analytes.

Draining of soils increases oxidation of soil carbon and the associated emissions of CO2 and N2O. Wetlands generate CH^4 by anaerobic decomposition of soil carbon. The aerobic rate is many times the anaerobic rate, but CH^4 is a more potent GHG than CO2. Anaerobic decomposition happens in wet soils because the transfer of O2 into water and thence into soil is very slow. N2O is a more potent GHG, too. So, our project intended to measure the emission of GHGs before and after to show that wetland construction/enhancement/restoration reduces the overall emission of GHGs in total.

We estimate that we will conserve about 500 tons of carbon terrestrially and a similar mass in soil carbon. Over the long-term, the "new construction" portions of the project will become a carbon sink as the trees mature and root networks become denser, potentially sequestering several hundred more tons of carbon. It is accepted by the Intergovernmental Panel on Climate Change that wetland conservation is a significant step toward reducing GHG emissions because these changes are steady over the long term.and in alignment with another paramount need, conserving biological diversity. Climate change is the most recently identified risk to aquatic ecosystems. The noted reduction in coastal fog over the last decade means that more sunlight if being cast on the water surface, likely increasing water temperatures and algal growth. This project mitigates changes to the climate locally by preserving cool deep pools in the lower estuary where this habitat is precious.

Post-implementation monitoring and assessment of implementation sites will include pre- and post-project photo documentation and vegetation, topographic and/or bathymetric mapping, as well as surveys to document fish use.

8. ***Literature Cited:***

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