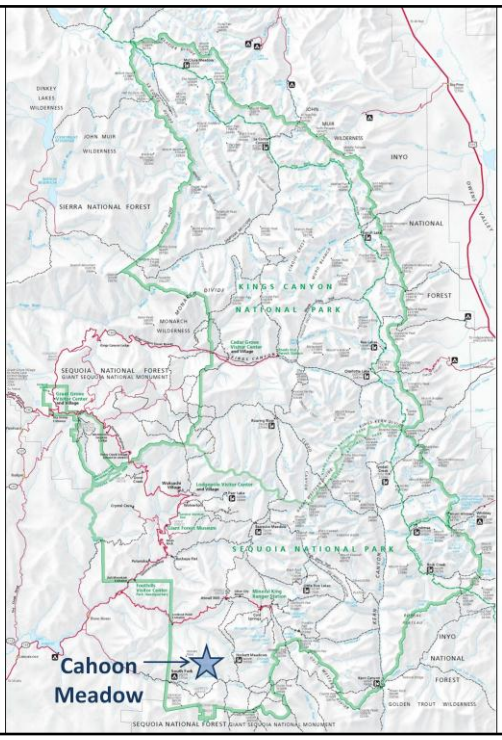
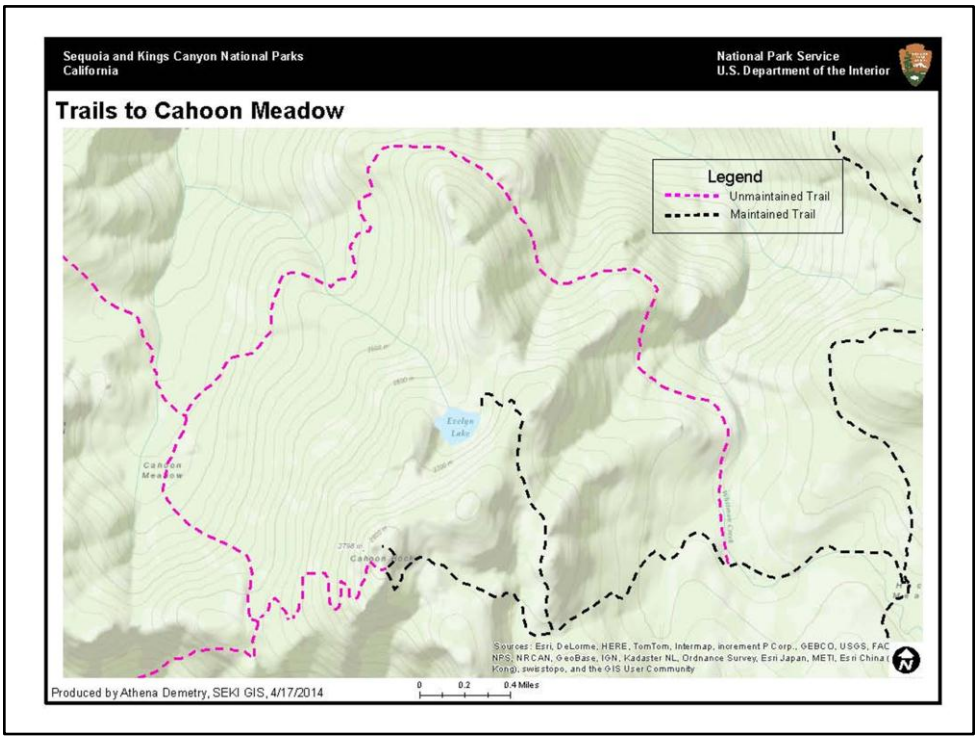

Create a Restoration Plan for
Cahoon Meadow

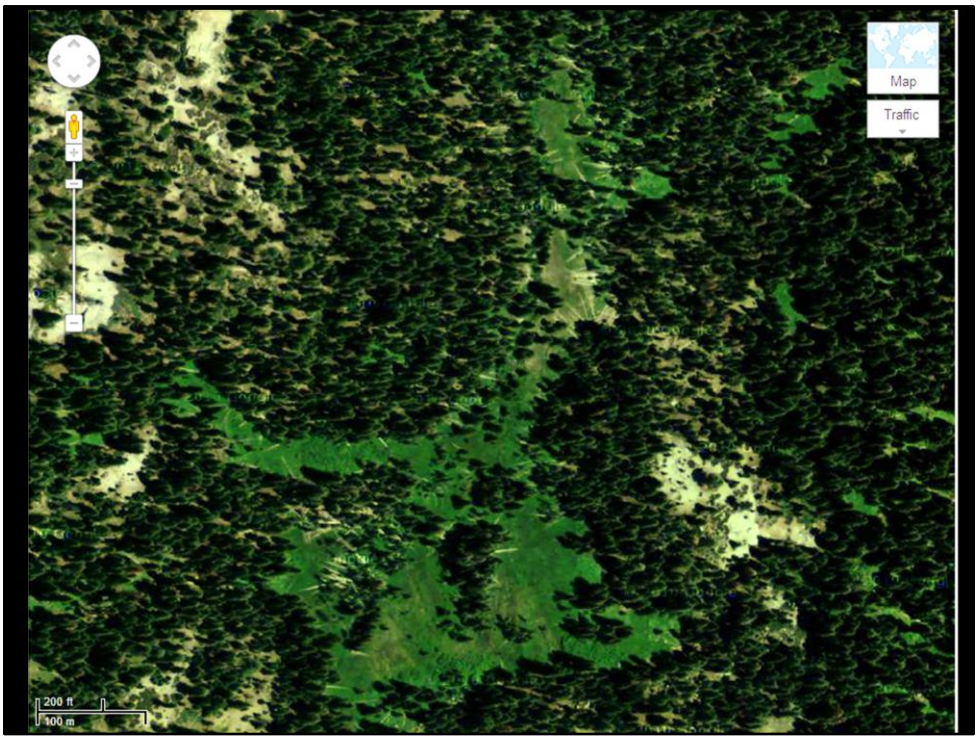
Introduction



Project Location. Note that there are two Cahoon Meadows in Sequoia National Park. This Cahoon Meadow is located in the East Fork of the Kaweah, west of Hockett Meadow, and is most easily reached from Mineral King. It is located within the John Krebs Wilderness. The other Cahoon Meadow is north of Lodgepole.



To reach Cahoon Meadow, you take maintained trails to Cahoon Rock (approximately 13.5 miles from the Mineral King trailheads), then descend about 1.5 miles (and 2,000 feet elevation) off-trail to Cahoon Meadow. There is an unmaintained trail along this route, but little of it remains as a visible trail.



Cahoon Meadow is a 22-acre wet meadow and fen complex located at about 7300 ft elevation. Water flows from the south to the north. It is the headwater meadow for Cahoon Creek, which flows through the Cahoon Grove of giant sequoias, into Horse Creek, and into the East Fork of the Kaweah.

Cahoon Meadow lies within a parcel of land that was acquired by the NPS in 1980. While in private ownership, the meadow was used as summer cattle pasture and the vegetation was heavily damaged by this use. Bare soil created by overgrazing allowed active gully erosion to occur, creating this deep gully running about 75% of the meadow's length. These photos are from 1998, when park staff visited the meadow to assess the damage.

The erosion gully is similar in scale to what was present at Halstead Meadow before restoration began there in 2007. In 1998, park staff measured the erosion gully at up to 15 feet deep, with an average depth of 9 feet. In the 1999 Resource Management Plan, Halstead Meadow and Cahoon Meadow were considered the two most heavily damaged meadows in the park and were called out for restoration.

The gully has a sheer, vertical headcut in several locations at the head of the gully. This headcut is actively advancing up the meadow.

The maximum height of the vertical wall in the headcut area is 10 feet. In this photo, water is seen cascading off the edge onto the person below.

The erosion gully has lowered the water table from its natural level at or near the surface to as much as 15 foot deep, causing drying of wetland soils, conversion of vegetation from wetland obligates to dry, upland species, and loss of wetland functions such as flood attenuation, water filtration, water storage, carbon sequestration, and provision of wildlife habitat. This photo shows a dewatered, former wetland area adjacent to the gully, which is to the left.

Another view of the edge of the erosion gully and the dried-out, former peat wetland (or fen) adjacent to the gully.

This purpose of this project is to create a restoration plan for Cahoon Meadow. The scope of work will include:

- Collect topographic, hydrologic, and vegetation information and create a base map for restoration plans
- Assess the success of past (1940's and 1950's-era) efforts to restore similar erosion gullies using hand crews, to evaluate whether hand-work (check dams) is likely to succeed in meeting restoration goals for Cahoon Meadow.
- Formulate a range of feasible restoration goals and alternatives.
- Create a set of concept plans for the restoration alternatives, including plan views, cross sections (if necessary), and draft details of any restoration structures.
- Write a NEPA/CEQA document and complete the NEPA process.

In December 2011, Sequoia and Kings Canyon National Park staff proposed a planning project, to be funded by a $74,500 grant from the Sierra Nevada Conservancy (a CA state agency), with this scope of work (more on 1940s and 50s-era efforts to follow). The grant was funded and the site visit was conducted in June 2014.

In considering our treatment options when we proposed this restoration plan for funding, we knew how to fix gullies like this using heavy equipment, such as at Halstead Meadow.

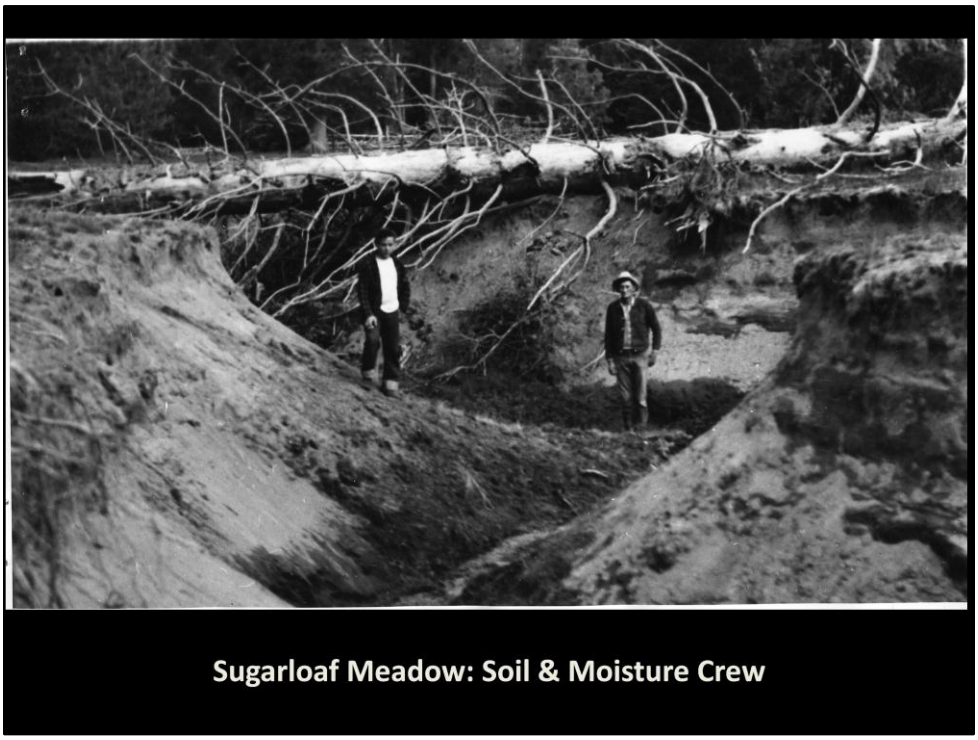
This is looking down the Halstead Meadow erosion gully in June 2011, before bridge construction and restoration. The water is concentrated in a single channel (in this case, caused by water channelization through culverts at the road crossing of the Generals Highway, where the photographer is standing). The former wetland is dried out by the lowering of the water table and wetland vegetation has died.

In July 2012, during the earthmoving phase of restoration. Water is diverted around the site in pipes. The erosion gully is being filled with layers of sediment imported from other construction projects within 10 miles of Halstead Meadow and capped with two feet of native Halstead Meadow sediments and topsoil.

In September 2012, immediately after restoration. Water is beginning to spread out across the entire surface of the meadow. The site is partially planted with native wetland plants (the remainder of the plants were installed in June 2013) and coconut-fiber erosion control blanket and wattles protect the soil from erosion until plants establish and spread.

In July 2014, two growing seasons after restoration. The water table has been raised to near the surface throughout the growing season, wetland plants have established and spread to hold soils in place, and wetland invertebrates are repopulating the meadow.

The Halstead Meadow example shows that we know how to restore ecosystem function to a wetland when we have frontcountry staging and road access for heavy equipment. But are there more wilderness-appropriate means that could be used for wetlands located deep in the wilderness?



Sugarloaf Meadow: Soil & Moisture Crew

Fortunately, we have some past actions that can guide us. Beginning in the early 1940s and through the 1970s, the park had an annually-funded “Soil and Moisture Crew” to work on repairing just these sorts of problems, such as this gully in Sugarloaf Meadow caused by historic overgrazing.

The Soil and Moisture Crew built fencing, constructed check dams, removed encroaching lodgepole pines, and planted willows to attempt to raise water levels and halt soil erosion in these meadows.

As you can see in this contemporary photo of Sugarloaf Meadow with a remnant check dam, Soil and Moisture Crew efforts have widely been perceived as successful, but their techniques and results have never been formally evaluated. From an initial look at the records in the park archives, you see things like “1950 Sugarloaf Meadow: built 9 log check dams. 1951: replaced 3 check dams washed out over the winter. 1952: replaced 2 log check dams and relocated 1.” There was a lot of annual rebuilding and maintenance work over the long term to keep the check dams functional. A key component of the Cahoon Meadow Restoration Plan is to search the park archives for these records, find locations where the erosion damage was similar to Cahoon Meadow, document the techniques that were used, and revisit these locations to evaluate their long-term success.

CNG supports Mount San Jacinto restoration project

By Sgt. Jon Guibord
Joint Force Headquarters Public Affairs

Pilots and crew from Company B, 1st Battalion, 126th Aviation Regiment, supported Mount San Jacinto State Park personnel in restoring a uniquely picturesque meadow that was threatened by erosion in September.

The heavy-lifting CH-47 Chinook aircraft and skilled crew delivered an earth mover, a tractor with backhoe and two boxes filled with 40,000 pounds of other equipment needed to restore Round Valley Meadow. The meadow is an exceedingly uncommon and fragile wetland habitat, made all the more rare by its isolation high above the southern California desert, said Doug Rischbieter, an environmental scientist with Mount San Jacinto State Park.

The project restored a beautiful southern California landscape and provided an opportunity for California National Guard pilots to increase their proficiency in high-altitude equipment-lift scenarios.

"It is rare to jump off a 9,000-foot mountain at maximum gross weight with an external load and descend at maximum rate of descent to land into a parking lot in a box canyon," said Chief Warrant Officer 4 William D. Craig, a pilot with Company B, 1-126th. "This requires extensive pre-mission planning, briefing and rehearsal to ensure all goes according to plan with the parties involved.

"A fair amount of skill was needed as two of the loads displayed unstable flight characteristics," he added. "Even in combat in Afghanistan we did not encounter such a demanding use of the aircraft in these conditions."

For pilots in the California National Guard, who are also citizens of this great state, flying missions at home is special.

"Any time we provide support for our fellow Californians you feel as though you are giving back to your local community and supporting those folks at home who supported us overseas," said Craig, who lives in Stockton, Calif. "This also affords us the opportunity to interact with [the] local populace and give back to our beautiful state."

Maj. Dan Anderson, CNG aviation operations officer, said the mission enhanced Company B's readiness by providing an opportunity to practice lifting non-standard loads, utilizing high-altitude flying skills and planning for a mission. This type of mission is also key to preserving the organization's valuable relationships with other state agencies, he said.

"It was a unique opportunity … to meet a critical need for [the State Parks Department] in protecting our environment, which is a major priority for the National Guard," Anderson said.

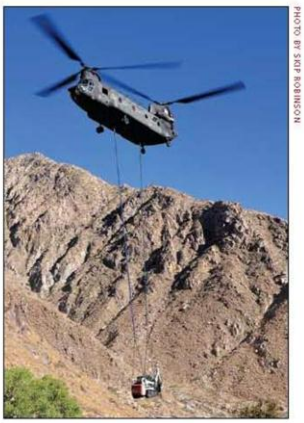


PHOTO BY SSP ROBINSON

A CH-47 Chinook helicopter and crew from Company B, 1st Battalion, 126th Aviation Regiment, move equipment to the 9,000-foot peak of Mount San Jacinto, Calif., on Sept. 9. The unit moved a tractor, earth mover and other equipment so State Parks Department employees could repair erosion.

15

Check dams built with hand crews was envisioned in 2011 at one end of the range of alternatives. At the other end of the range was limited use of earthmoving equipment, such as what was done to restore remote wetlands at Round Valley Meadow in Mount San Jacinto State Park. A California National Guard Chinook helicopter was used to deliver "an earth mover, a tractor with backhoe, and 40,000 pounds of other equipment."

In June 2014, park staff and cooperating wetland scientists from Colorado State University completed a week-long site visit to Cahoon Meadow to: (1) collect topographic, hydrologic, and vegetation information and create a base map for restoration plans, and (2) begin to formulate a range of feasible restoration goals and alternatives.

This is a photo of the intact meadow above the erosion gully. The team found that this upper portion of the meadow (14 acres) was a very high-quality wetland-fen complex with highly productive vegetation, peat-accumulating soils, and a diverse species assemblage. A fen is a type of wet meadow in which the rate of decomposition of plant material is slower than accumulation, which allows organic material (peat) to accumulate. Fens are very rare habitat types in the Sierra Nevada.

The team found a population of insectivorous *Drosera rotundifolia* (sundew) plants in the intact portion of upper Cahoon Meadow. It is one of 20 or fewer locations where sundew is known to exist in Sequoia and Kings Canyon National Parks, and this finding suggests that the meadow may support other uncommon taxa that occur in fens. Also note the standing water on the surface of the meadow.

Some of the diverse plant and animal species the team detected in the intact portion of upper Cahoon Meadow included the Pacific fritillary butterfly, sphagnum moss, sedges and bulrushes, *Oxypolis occidentalis* (western cowbane), and *Dodecatheon jeffreyi* (Sierra shooting star), which are all present in this photo. These are species that thrive in very wet meadows and fens.

Upper Cahoon Meadow also contained several large patches of willows, which this Wilson's warbler is using for habitat.

A beauty-shot of Sierra shooting star (background) and *Bistorta bistortoides* (western bistort, foreground) found in the intact portion of upper Cahoon Meadow.

In contrast to the photos of intact wetland (above the gully headcut) shown previously, this photo shows the dewatered wetland adjacent to the erosion gully. Wetland plants have died and been replaced with a sparse cover of dry-site plant species. Bare mineral soils are eroding from between the dried-out hummocks of peat.

This shot looks downstream from the gully's headcut. The area is active, with shelves of vegetation caving in from the edge of the gully. The former meadow surface is seen at the upper right edge of the gully.

This is a view of one of the wider, deeper sections of the erosion gully, with a person visible at the bottom of the gully (wearing an orange vest). The team's immediate impression was that it would be difficult to accomplish meaningful improvements using hand crews in these wide gully segments.

At the lower end of the erosion gully, the gully is narrower and less deep.

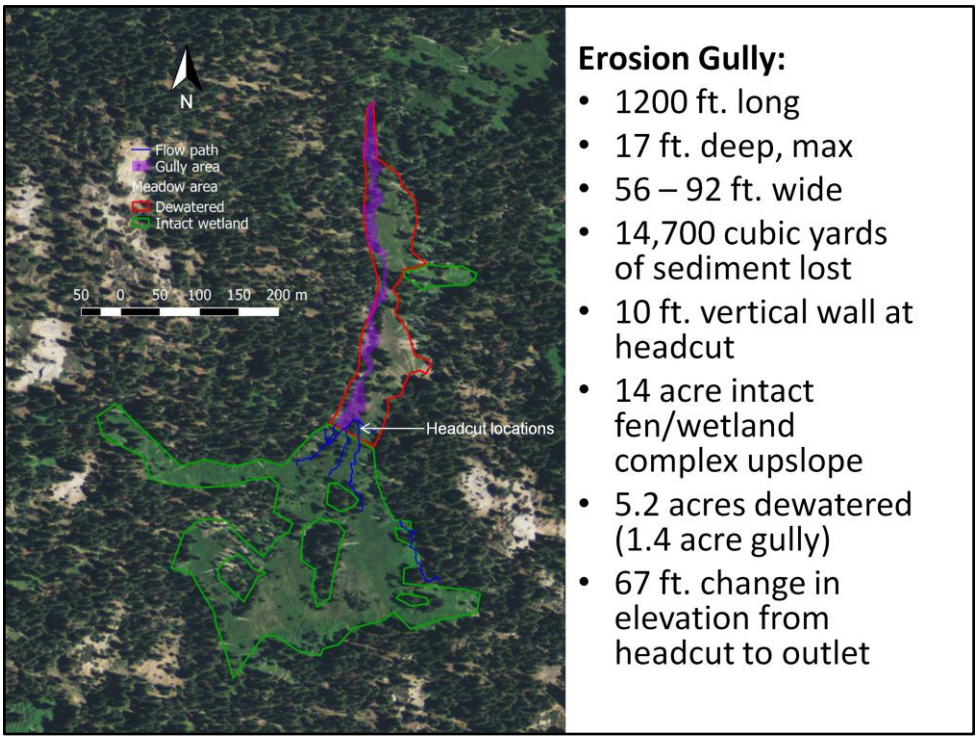
Cooperating wetland scientists from Colorado State University sampled soil cores, measured groundwater levels, and sampled vegetation throughout the intact and dewatered portions of Cahoon Meadow.

They confirmed that the site had a long history (thousands of years) as a saturated, peat-accumulating wetland. This photo shows the organic peat material that came out of the soil core in the intact meadow. These organic peat soils only form under perennially-saturated soil conditions.

Peat soils, indicating long periods of saturated wetland conditions (peat layers accumulate very slowly, but decompose quickly when drained), were layered with coarse sand and gravel layers, indicating periodic large sedimentation events. Several of the sand layers contained pieces of charcoal, suggesting that some sedimentation events may have followed forest fires.

Soil cores sampled in the dewatered portions of Cahoon Meadow contained peat layers throughout the depth of the core. Peat layers form only in saturated soil conditions, confirming that these currently-dewatered areas were previously wetlands for thousand of years before present. The hummocks visible in the photo are pedestals of dried-out peat. The mineral soil has eroded from between the pedestals and the peat is decomposing.

Park staff used a total station to collect detailed topographic data of the headcut and valley cross-sections along the entire length of the gully and meadow.



After the site visit, this map of the intact wetland (green outline), dewatered wetland (red outline), erosion gully (purple area), and shallow channels (blue lines) was produced. Summary numbers are shown to the right.

Need for Action

- Threat to remaining 14 acres intact wetland: gully continues to migrate upstream with each large runoff event.
- Loss of valuable wetland ecosystem function
  - Actively eroding gully sending sediments downstream, impacting water quality
  - Gully conveys water more quickly than intact meadow, increasing flood flows downstream
  - Loss of ecosystem services provided by wetlands

Project purpose: protect remaining intact wetlands and restore wetland ecosystem function to Cahoon Meadow

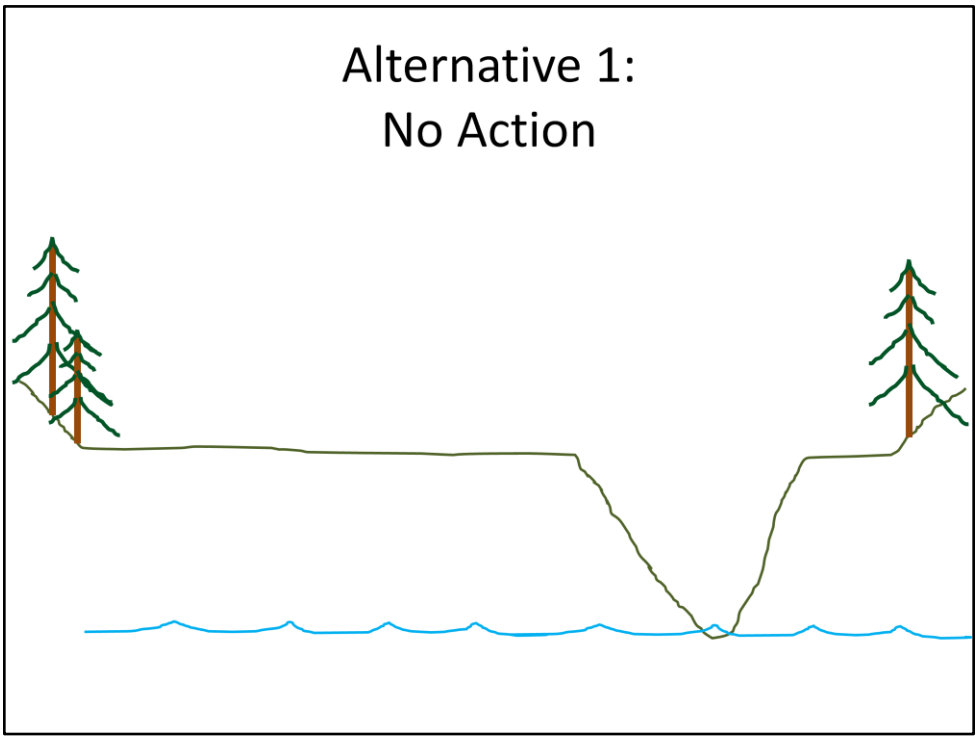
Four management goals span the range of actions that could be taken. Together with two possible tools, there are six preliminary draft alternatives:

1. No action.
2. Stabilize the gully and headcut in its present state to protect the currently-intact wetland.
   a) Implement using hand crews and draft mules.
   b) Allow limited use of small earthmoving equipment
3. Promote long-term improved wetland ecosystem function by blocking the erosion gully with check dams.
   a) Implement using hand crews and draft mules.
   b) Allow limited use of small earthmoving equipment
4. Fully restore wetland ecosystem function by filling the erosion gully with on-site sediments using earthmoving equipment.

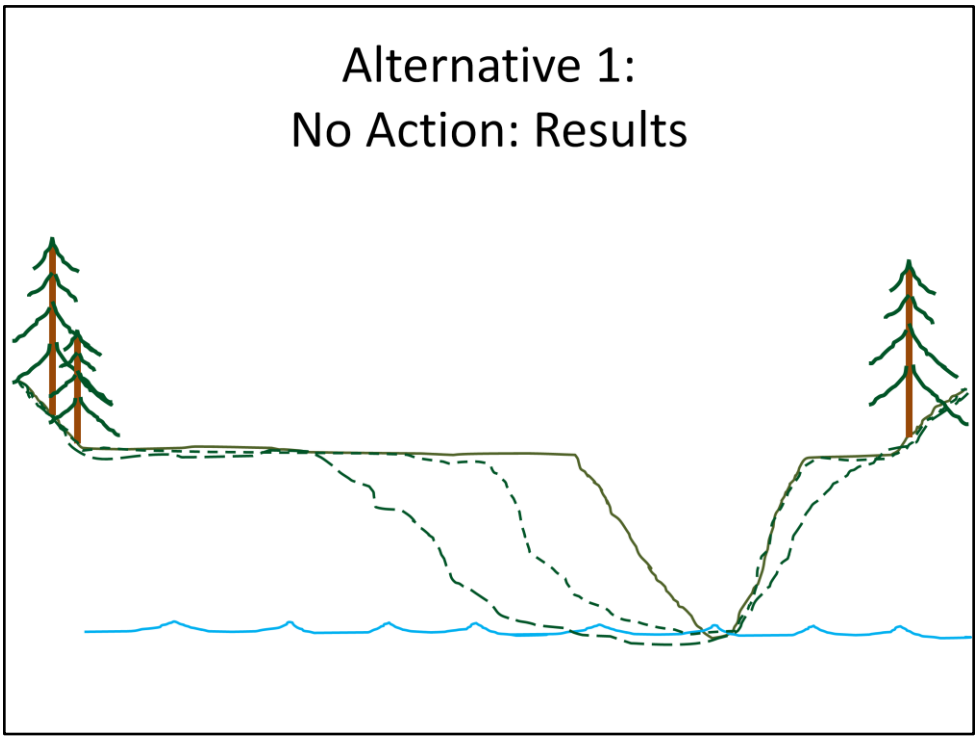
See the supplemental information document posted in PEPC for more details on these preliminary draft alternatives.

Actions Common to All

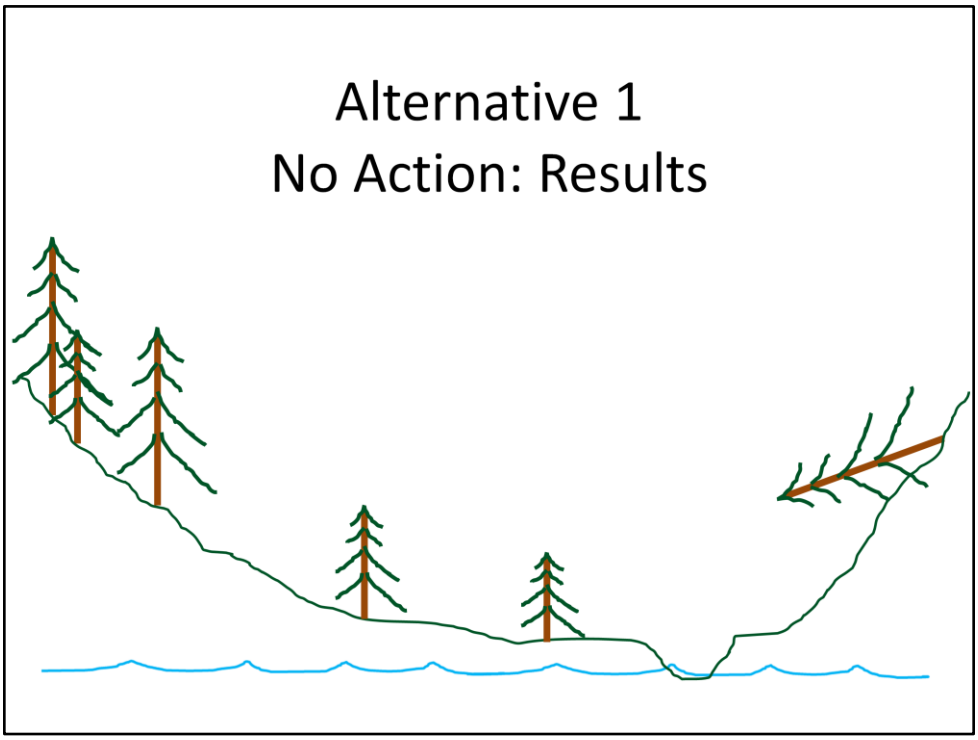
- Reestablish trail from Cahoon Rock for stock supply access
- Establish crew camp
- Supply crews by pack stock from Hockett Mdw (prefer not to graze Cahoon)
- Some chainsaw use
- Some helicopter support



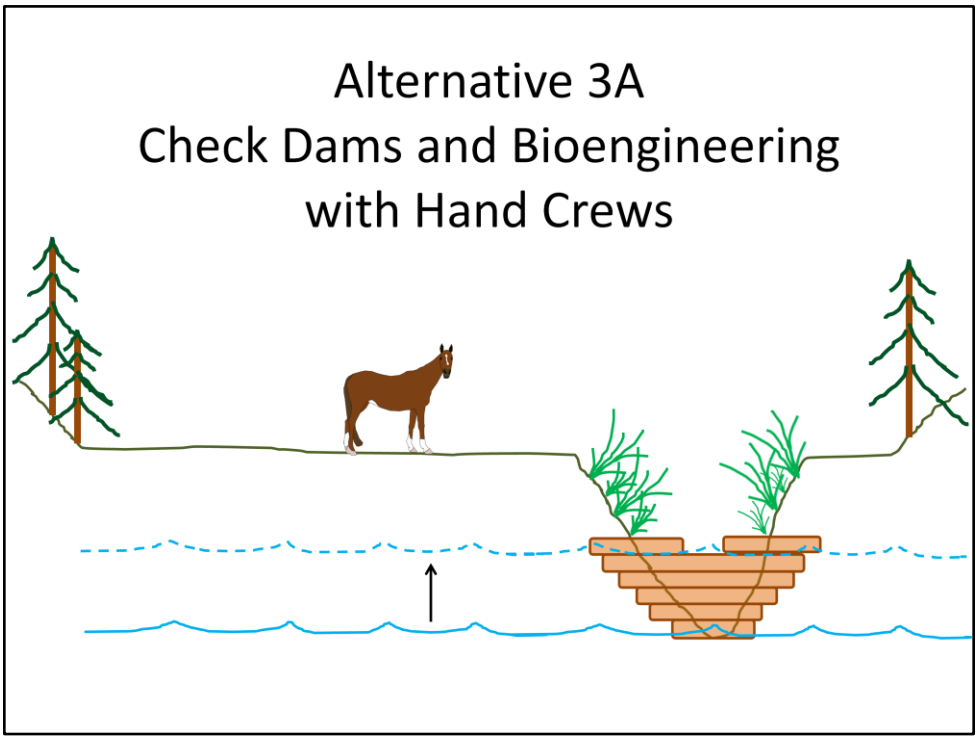
These simple graphics illustrate a cross-section of the gullied portion of Cahoon Meadow, showing (from left to right) the forest slope, the historic meadow surface, the erosion gully, and the forest slope. The blue line at the bottom is the water table. **Only a subset of preliminary draft alternatives are shown. See the supplementary information document in PEPC for more details on stabilization goals 2A and 2B.**



If no action is taken, the gully will continue to deepen and widen over time. The existing dewatered meadow adjacent to the gully would continue to degrade as peat soils decompose and erode. In addition, the intact fen and wet meadow above the headcut would be threatened by further headward erosion of the gully.

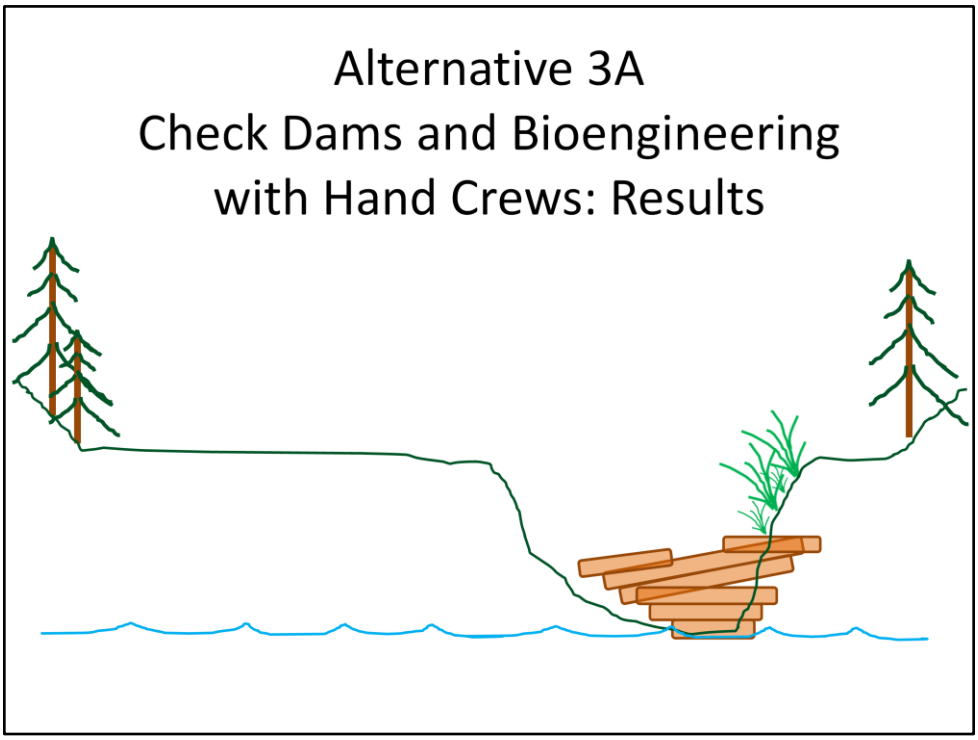


Eventually, the wetland loss may be complete and the wetland may convert to a forested valley bottom.

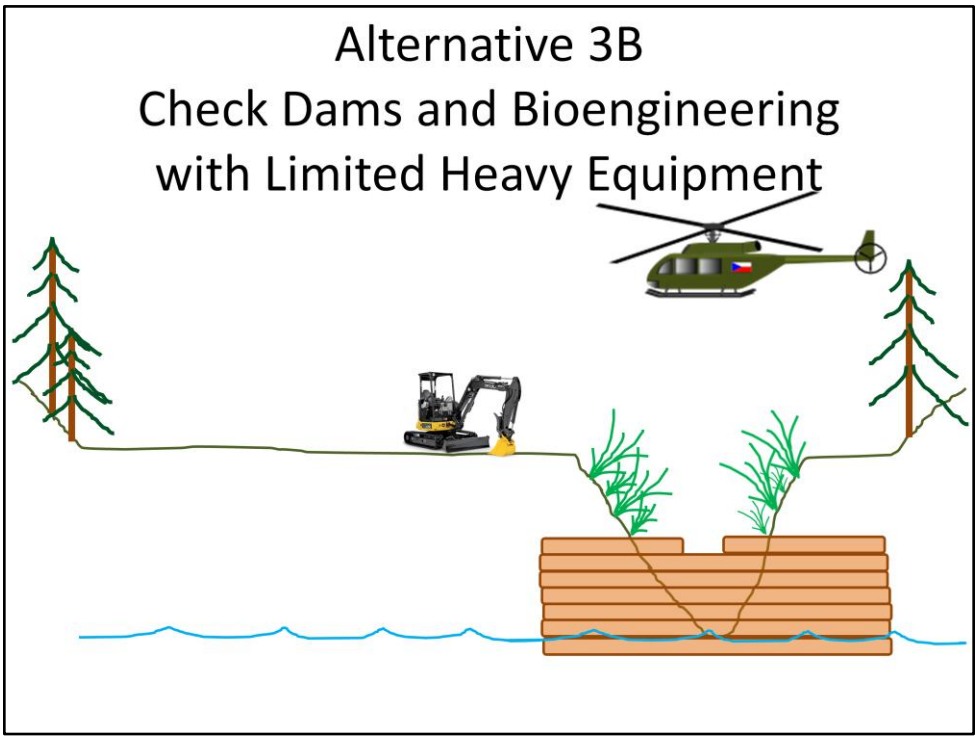


In draft preliminary alternative 3A, the goal is to promote improved wetland ecosystem function over the long-term by blocking the erosion gully with check dams over the entire length of the gully to slow water flow, trap sediment, and raise the water table in the adjacent degraded meadow. Dams would be constructed by hand-crews with the possible assistance of draft mules, possibly using non-motorized equipment such as "Fresno scrapers." This work would likely be done over a period of 10 to 20 years, with long-term maintenance and repair (25 or more years) needed.

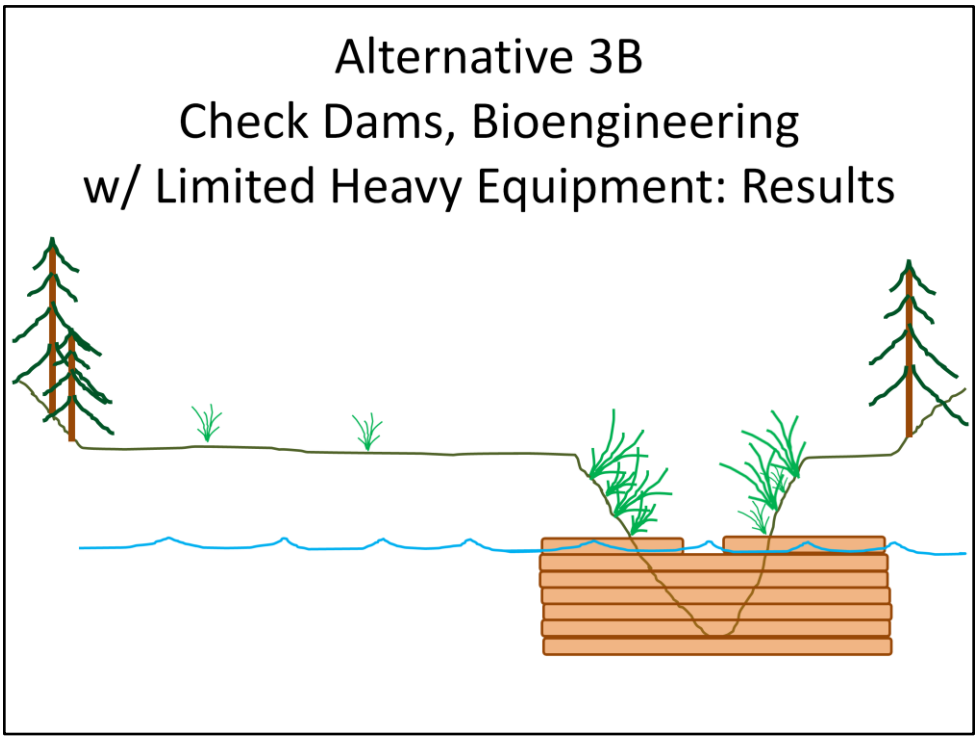
Note: See supplemental information document in PEPC for more details of the draft alternative stabilization goals 2A and 2B.



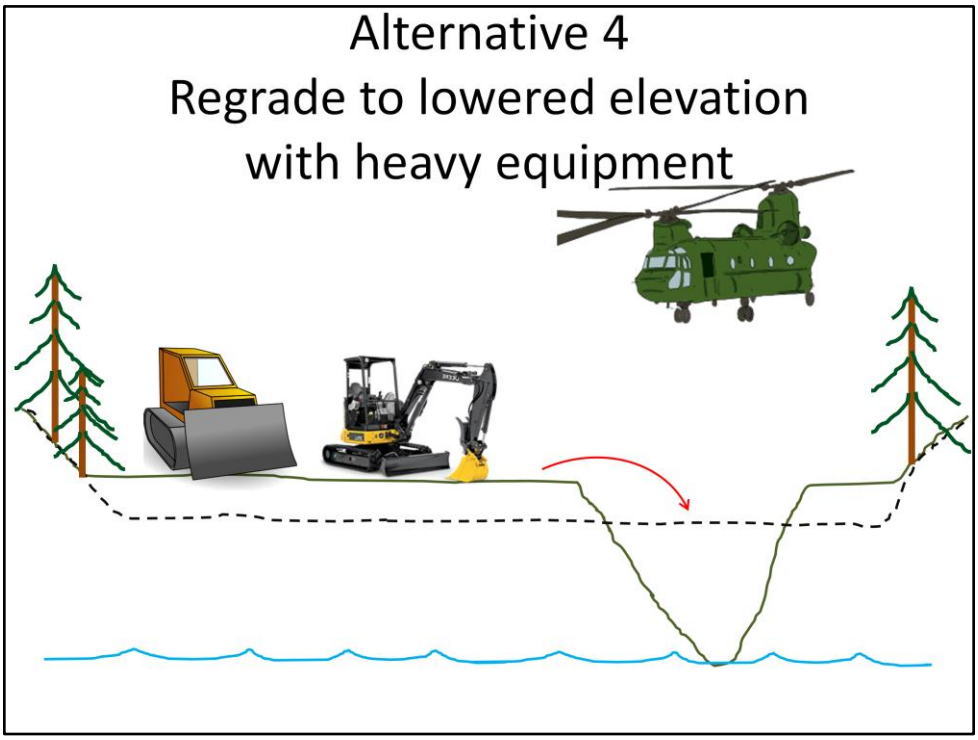
Because it is difficult to deeply anchor log check dams into the bottom and sides of large erosion gullies using only hand-labor, there would be a high risk that check dams would be damaged or side-cut during large flood events. Once one or more check dams failed, they would need to be repaired or replaced, or the gully may begin to re-form and any improvements in ecosystem services would be lost.



In draft preliminary alternative 3B, the goal is to promote improved wetland ecosystem function over the long-term by blocking the erosion gully with check dams over the entire length of the gully to slow water flow, trap sediment, and raise the water table in the adjacent degraded meadow. In addition to hand-crews, mechanized earthmoving equipment, such as a small excavator, could be used to dig the key trenches and more deeply anchor the logs over a period of approximately 5 to 10 years. A mid-sized helicopter, such as a Huey or a Blackhawk, would be required to transport the equipment. To minimize the impacts to wilderness character, the use of mechanized equipment would be tightly limited in space and time.

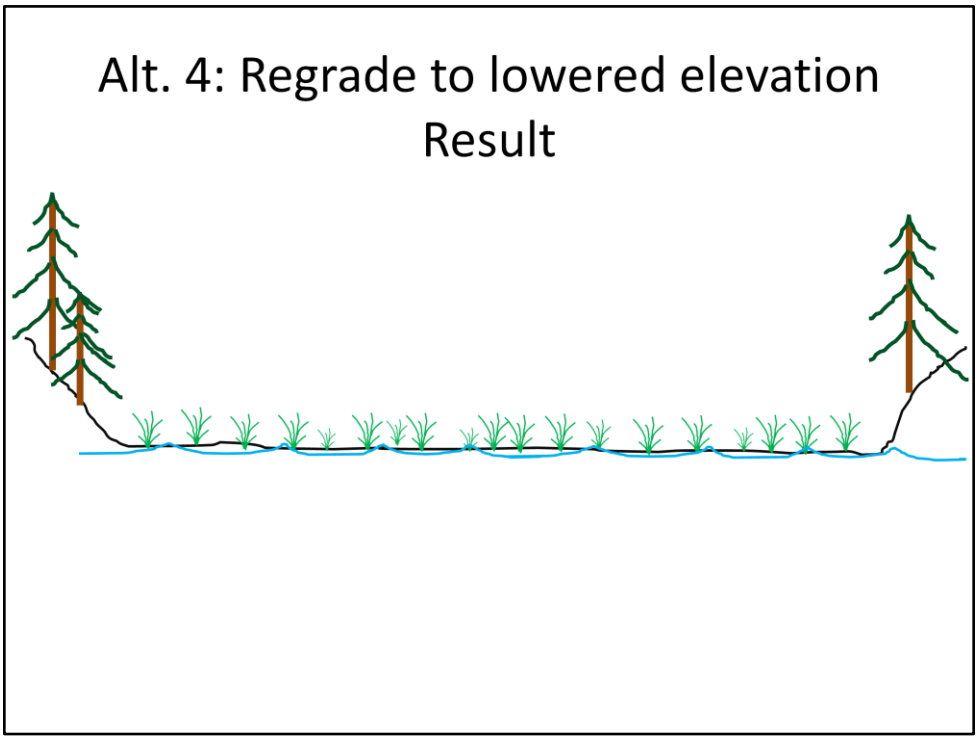


Because the check dams would be more deeply-anchored, the dams would have a lower (but still significant) probability of failure, requiring long-term repair or replacement (15 or more years) to meet the improved ecosystem function goal. The process of sediment deposition and meadow building at Cahoon Meadow took millennia to accumulate the current depth of 10 or more feet of sediment. It is unlikely that the in-stream check dams would retain structural integrity long enough to accumulate sufficient sediment to completely fill in the gully, so full restoration of wetland topography and hydrology is not a realistic goal of this technique. Thus only partial restoration of some ecosystem function is possible, even in the best case: the water table would likely remain at least several feet below the surface of the meadow.



A fourth alternative is to fully restore wetland ecosystem function by filling the entire erosion gully with on-site sediments, converting it back into a vegetated sheetflow system. This would be a more stable and complete form of restoration, since it would reestablish the ecosystem that was present at Cahoon Meadow for thousands of years prior to human impacts that initiated gully formation. The gully could be filled by pushing the top 2 to 3 feet of sediment from the adjacent dewatered meadow into the gully. The meadow would be graded flat in cross-section, eliminating all preferential flow paths, to create sheetflow hydrology and saturated soil conditions.

Full restoration would require use of several pieces of earthmoving equipment, such as a scraper/grader and a small bulldozer, to be used over a period of about 2-3 months across the full 5 acres of dewatered meadow. A large-sized helicopter, such as a Chinook, would be required to transport the equipment. Restoration could be completed in a single summer and would require maintenance and hand-crew repairs for about 3 years until the plants grew to full density. No long-term maintenance would be required.



With the water table at the surface and the hydrology restored, wetland plants would be planted across the entire meadow. The plants would take several years to grow to sufficient density to prevent any re-erosion of the sediment. In the meantime, erosion blanket would stabilize the soil while the transplants spread their roots. Over time, the 5 acres of formerly dewatered wetland would be expected to recover their full level of wetland ecosystem function and to deliver a full range of ecosystem services, such as flood attenuation, water filtration, water storage, carbon sequestration, and provision of wildlife habitat

Importance of Cahoon Meadow?

- Second largest wet meadow in the East Fork Kaweah (exceeded only by Hockett Meadow).
- Only 2 wet meadows in the East Fork have more peat-accumulating area.
- Is the headwaters meadow for the stream flowing through the Cahoon Grove of giant sequoias.
- One of 20 or fewer locations of *Drosera rotundifolia* in SEKI. May support other uncommon taxa that occur in fens.
- Over 90% of California's original wetlands (as of 1780) have been lost.

Meadow Ecosystem Services

Meadows are small on the landscape, yet provide broad-scale ecosystem services

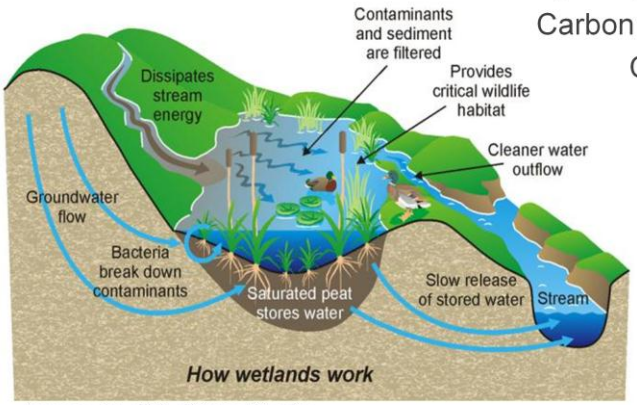


Image courtesy of City of Casper, Wyoming

- Biodiversity hotspots (flora and fauna)
- Carbon and nitrogen storage
- Critical wildlife habitat
- Snowmelt capture
- Flood attenuation
- Water filtration
- Water storage
- Aesthetic
- Forage

64