# Progress Report Final

*CFDA # 11.482*

## Enhancing the Effectiveness of Restoration Efforts in Honokowai and Kapunakea Preserve

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## Accomplishments 11/01/2019 – 4/30/2021

The project was focused on the continuation of reducing sediment transport within the Honokowai watershed. The focus particularly is on the impact of dirt roads and the resulting transport of sediment from these roads during rainfall events to the adjacent gulches. The project's goals included: 1) implementing vegetative sediment best management practices developed by Ridge to Reefs and its partners in 8-10 kickouts; 2) removing invasive species within test plots associated with kickouts in order to increase the effectiveness of vetiver kickouts through reducing shading created by invasive species adjacent to the kickouts; and 3) to pilot the use of keylining and chitosan in kickouts to increase the sediment trapping ability of these practices. The project implemented vetiver sediment traps successfully within 11 kickouts; developed new methods locally of controlling invasive tree species without poisonous chemicals (using removal and stump treatment methods that included drilling holes in the stump and killing the stump using Epsom salt and by covering with thick plastic); and finally developed promising methods of using a natural chitosan flocculant product with biodegradable deployment methods that are now undergoing laboratory testing in partnership with USEPA and West Maui Ridge to Reefs.

# A Summary of Outcomes Based on the Scope of Work

## 1. Identify, implement and maintain Vetiver sediment traps in 8-10 kickouts that trap fine sediment that would otherwise impact nearshore reefs

The team was able to perform stabilization efforts and sediment removal for 11 kickouts and has performed vetiver planting on 10 kickouts that receive higher amounts of rainfall. Sediment monitoring was established in a subset of the kickouts and was used to estimate sediment trapped within the vetiver sediment traps (Fig. 1). Additional monitoring and maintenance occurred in February/ March 2021 and April of 2021. The amount of sediment trapped was sampled at three kickouts and averaged 1.2 tons of sediment per year. There appears to be some variation based with elevation (whereby kickouts at higher elevations have higher sediment transported to them and ones at lower elevations with less rainfall have less sediment transported. As part of this effort, the team also worked to control invasive species and performed plantings and seeding to facilitate native species including Uluhe ferns, ʻAʻaliʻi and ʻOhiʻa.

*Figure 1. Sediment monitoring posts at Honokowai kickout site (Uluhe ferns on right side)*

*Figure 2. The team monitoring one of the kickout sites prior to invasive species removal.*

*Figure 3. Ohia an understory native tree/ shrub (left), ʻAʻaliʻi an understory shrub (right).*

## 2. Identify and remove invasive trees and maintain removal areas to reduce erosion from these areas. Invasive species removed from 4-6 plots.

In February and October 2020, RTR and partners removed and controlled invasive species within and adjacent to eight kickouts (8 plots). Our contractor partner used equipment to remove flagged invasive trees. Maintenance and monitoring was performed again in December 2020 and February 2021. Efforts to control invasive species have been successful and we have developed a new method for control of invasive trees in Hawai'i – where trees are cut down and removed, holes are then drilled

in the stump with an electric drill, followed by pouring Epsom salt into the holes and pouring water on the stump then applying additional Epsom salt, and covering the stump with heavy black plastic to completely kill the aggressive invasive tree species which includes: iron wood (type of juniper), strawberry guava, lemon eucalyptus and java plum. Each of these species can sprout from the stump and come back aggressively if not controlled. This method worked very effectively (9 of 10 times) except for one large eucalyptus tree that was harder to cover with plastic and whose stump has been harder to kill despite multiple treatments with Epsom salt. Vetiver performance is improved by increasing the amount of sun reaching the vetiver grass and we have seeded natives and controlled the invasives as they have attempted to come back – especially at sites where trees were cut down. Another technique we used was girdling invasive trees – this technique has been slower to kill the trees though the health of these trees appears weakened and on some species branches have begun to die. This method appears to be slower but results in less disturbance than cutting down trees and hauling them away but has not been very effective with eucalyptus and iron wood (further experimentation with this method may be warranted where the invasive trees would be girdled more deeply). This is important as disturbance can be an opportunity for invasive species to expand their populations.

*Figure 4. Two techniques are shown for controlling invasive species. Drilling holes in the invasive stumps after cutting down the tree then filling the holes with Epsom salt and covering with plastic – were successful at killing strawberry guava and other invasive species); (right) shows girdling the pine in the back of the picture and the 1st technique of Epsom salt and covering with heavy black plastic secured to the stump.*

*It is important to note that while weakened the girdled trees particularly iron wood and eucalyptus have not died after 9 months – so it remains to be seen whether this technique will be effective or not and warrants additional experimentation.*

## 3. Pilot the use of keylining for infiltration of water to reduce erosion and sediment transport to the gulch and nearshore reefs. Two pilot keyline areas associated with Vetiver sediment traps in two road kickouts.

Keylining took place in December of 2020 and monitoring was initiated and repeated again in February of 2021. Infiltration rates were measured at the two plots and then again after the rainy season. The plot with the broadfork and biochar showed a 2x increase in infiltration rates as compared to the broadfork only in the follow up monitoring. Both techniques had much higher infiltration rates when compared to the control This pilot data remains preliminary and warrants additional exploration and sampling over a longer duration to see if infiltration rates hold up over a longer time horizon.

*Table 1. Infiltration Rates as measured using a single ring infiltrometer (in/hr)*

| Dates | Biochar Amendment | Broadfork only | Control |
|---|---|---|---|
| Dec-20 | 33.7 | 33.9 | 6.2 |
| Feb-21 | 29.5 | 14.7 | 6.4 |

*Figure 5. Keylining efforts utilizing a broadfork to attempt to increase infiltration rates in kickouts to reduce the potential for sediment transport by infiltrating runoff. On the right is the plot where we were testing the incorporation of biochar into the broadforking and keylining efforts.*

## 4. Pilot the use of chitosan flocculation bags within vetiver sediment traps to enhance settling out of fine sediment from stormwater. Two kickouts treated with chitosan floc bags behind vetiver rows. Reduced transport of fine sediment; estimates of increased sediment capture using soil particle analysis

During the spring of 2021 we installed chitosan flocculation bags and performed monitoring. The flocculation bags were packed with chitosan and bags were crafted from burlap coffee bags and twine the data (Table 1) demonstrated the chitosan (a product made from waste crab and lobster shells) is a very effective flocculant and may have utility within these treatments as well as within larger sediment basins. The data from the study is as follows: there was a 2 order reduction in concentration from using the chitosan “floc bag.” USEPA is following up on this preliminary study with Ridge to Reefs and West Maui R2R and testing chitosan in the laboratory to better characterize its flocculation potential and also to look at any possible toxicity impacts to sensitive species.

*Table 2. Turbidity in NTU of Flocculant vs Control (no flocculant)*

| **Minutes** | **Flocculant Turbidity (NTU)** | **Control Turbidity (NTU)** |
|---|---|---|
| 0 | 263 | 4255 |
| 1 | 143 | 4125 |
| 2 | 100 | 3895 |
| 3 | 55.5 | 3680 |
| 4 | 46.6 | 3450 |
| 5 | 49.6 | 3275 |

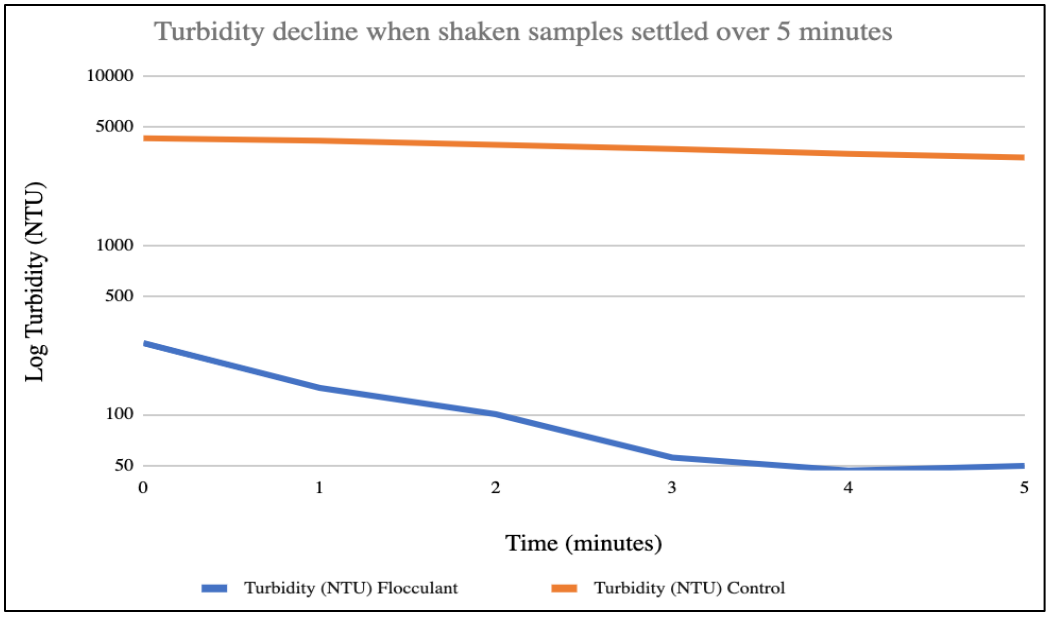


*Figure 6. Turbidity declined when samples were shaken and allowed to settle over 5 minutes (note scale of graph is Log and from 50 to 10,000) Reduction in turbidity is almost two orders of magnitude. These samples were taken on the plots during our testing – the control with no floc bag and the treatment with a floc bag.*


*Figure 7. (Upper left) Turbidity sock in place for testing; (upper right) floc bag during test; (lower left)– Floc sample versus non-floc control; (lower right) water flowing into kickout for test.*

## 5. Monitor the sediment deposition in the kickouts/sediment traps

Monitoring was initiated in December of 2020 and follow up monitoring took place in April 2021. Three representative kickout were chosen for monitoring and we measured deposition in front of each vetiver row and computed annual loading estimates in tons of sediment per year. The upper site measured 2 tons/ deposition per year, the middle side measured 1.0 ton/ deposition per year and the lower site 0.6 tons/yr.

*Figure 8. - Evidence of sediment deposition by vetiver grass in a kickout. Vetiver grass is shown on the left side, with several inches of sediment on the right (the side nearest the road).*

# Challenges & How we addressed them

- Covid-19 resulted in restricted travel from early March 2020 through October/ November 2020 and has delayed several trips that were going to happen in spring and summer of 2020. RTR was able to complete all the aspects of the project although some of the activities happened later than anticipated due to travel delays due to COVID.
- RTR has used essential worker status as well as pre and post arrival COVID testing to ensure we do not impact colleagues and the general public in Maui and as a result has been able to travel in October 2020, December 2020 and February/March

of 2021. Project partners have also assisted in the project and monitoring/ maintenance to help us complete the effort and get the project back on track.

- Rain is an important factor in keeping vetiver grass alive and also in helping the team monitor how well the kickouts and other strategies are working, however rain is sparse in West Maui other than a few major events each year. This unpredictability and inconsistency can make monitoring difficult. Fortunately, vetiver grass is very resilient to all types of weather, including extreme dryness. The vetiver grass was still alive during the February/March 2021 trip even in kickouts with little rainfall (weather stations and field work shows that rainfall increases with elevation in this area). While these kickouts did not experience much growth of vetiver, there also seemed not to be as much water flowing to these kickouts due to weather patterns. The kickouts with more precipitation were generally more lush with taller vetiver plants, which is to be expected.

## Lessons Learned

1) Sediment transport seems to be significantly less in the lower half of the section (See pink rectangle in Figure 9) that we worked on due to lower rainfall. Road improvements in those areas including rolling dips may be appropriate strategies to reduce erosion from the roads and reduce runoff entering the gulches.
2) Using Epsom salt is a favorable approach over using herbicides to poison invasive tree species and in 9/10 cases was able to kill the tree.
3) Whether girdling these highly invasive species works fully is still being investigated; at the very least we have determined it is important to girdle the highly invasive trees well into the xylem of the tree for eucalyptus and
4) During our initial monitoring for this project, there is less sediment transport in this portion of the watershed than in some of the higher elevation areas and sediment transport tends to decrease from the top to the bottom of the segment that was the focus for the project.
5) Chitosan appears to be an effective flocculant made of natural materials/waste streams of crab and lobster shells. We are interested in testing it further for its longevity as well as testing it in larger sediment basins for helping reduce brown water events particularly after US EPA completes further testing.
6) In total, we estimate at least 12 tons per year of sediment will be prevented from entering the gulches as a result of this project.

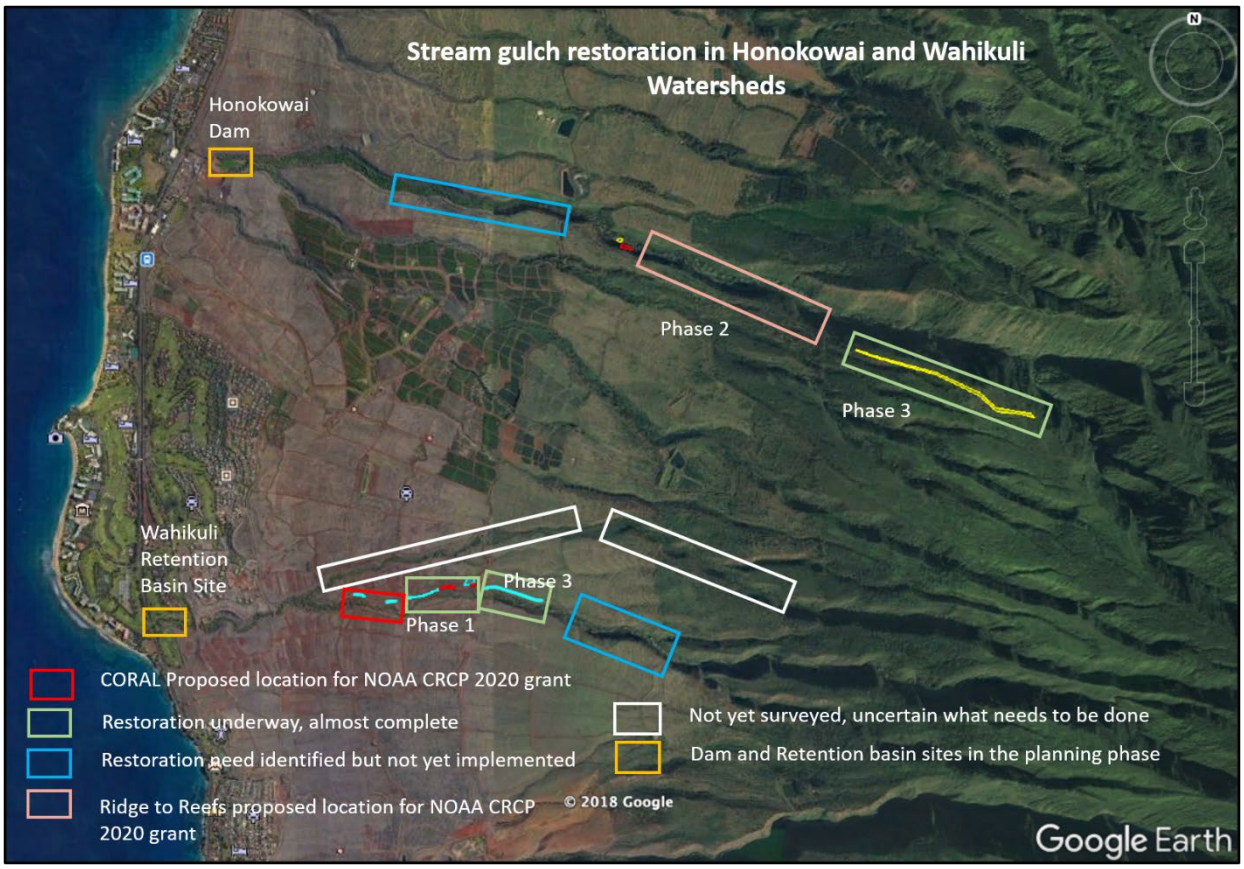


*Figure 9. The upper portion of the pink rectangle in the Honokowai watershed was the area of focus for this project and there seemed to be a gradient of reduced rainfall and sediment transport as one proceeds down the mountain*