

Eel River Monitoring and Water Quality Awareness Pilot Project Final Report



The Eel River Recovery Project

Funded by the CA Water Resources Control Board *Grant Agreement 14-679-550*

Administered by the Institute for Fisheries Resources

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Acknowledgements

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ERRP is also grateful to its volunteers who provide access to stream reaches on private land, assist in field monitoring, and carry information about our findings to their neighbors. Additional thanks to our other partners in the realm of water temperature monitoring, including the University of California Berkeley (UCB), California State Parks, Pacific Gas and Electric Company, Salmonid Restoration Federation, and the Native Fish Society who all shared data with ERRP. Eli Asarian of Riverbend Sciences did an extraordinary job in analyzing temperature data that will serve ERRP for years to come.

UCB doctoral candidate Keith Bouma-Gregson continued cooperative monitoring with ERRP of cyanotoxins, which is greatly appreciated. Our project is in the third year of this partnership, which is supported in part by a National Science Foundation Critical Zone Observatory grant. Thanks to the Humboldt Redwood Company for allowing access to the Eel River above Scotia for cyanotoxin monitoring. We would also like to recognize the Redway Community Services District for engaging on the issue of cyanobacteria proliferation and their interest in future trend monitoring of the South Fork Eel River. Thanks also to the Round Valley Indian Tribe’s Tribal Council for co-sponsoring the Salmon Awareness Festival in Covelo and allowing us to assist their Environmental Protection Agency in monitoring of Reservation waters.

We also wish to acknowledge the courage and foresight of cannabis farmers who stepped forward to request technical services to help improve their agricultural practices and to decrease their water use. These pioneers are the forefront of a movement that may create a sustainable cannabis industry compatible with Eel River ecological recovery.

Project Cooperators



Institute for Fisheries
Resources



Humboldt Redwood
Company



Salmonid Restoration
Federation

ERRP Volunteers



Bill Eastwood
Dan Carpenter
Mickey Bailey
Sharon & Dean Edell
Sunshine & Erick Johnston
Karen & Scott Walsh
Heron Hilbach-Barger
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Background

As a result of monitoring the Eel River and its tributaries since 2012, ERRP discovered that several tributaries of the Eel River were dry or disconnected in late summer and fall when they were historically perennial even in wet years. This confirmed concerns raised by citizens at ERRP meetings about tributary flow depletion. ERRP is also finding significant problems with erosion in some basins resulting in loss of pools, degraded spawning and rearing habitat for threatened and endangered salmon and steelhead species, and in some cases reduced surface water availability.

Cyanobacteria studies conducted with the University of California Berkeley since 2013 clearly showed that the most significant problems with toxic blue-green algae are in the South Fork Eel River between Myers Flat and Piercy. Cyanobacteria thrive in warm waters that results in part from flow depletion and are fueled by excess nutrients that are thought to be linked to pollution associated with cannabis farming. During inspections of cannabis cultivation sites, the NCRWQCB staff has found large areas of bare soil, de-stabilized slopes, filled stream beds, in-stream dams, in-stream pumps and hoses, improperly stored fuels and fertilizers, and litter and refuse.

The SWRCB recognized the need for immediate action to slow or reverse the impacts of cannabis cultivation within the Eel River watershed resulting from pollution and excessive water withdrawal in conjunction with, and exacerbated by the recent severe drought. In January 2014, the State Board passed Resolution 2014-004, which called for an “Eel River Monitoring and Water Quality Awareness Pilot Project”, and ultimately led to the May 2015 award of SWRCB #14-679-550 to ERRP, and Institute for Fisheries Resources that administers the grant.

There are two distinct elements in the project: 1) agricultural best practices outreach and education, and 2) monitoring, data collection, and analysis. The first element includes holding public meetings, providing technical assistance on water conservation and pollution prevention to cannabis cultivators at their farms, accumulating and posting best practices information in all forms on the ERRP website, and using social media and YouTube videos to motivate changes in management practices.

The monitoring element of this grant included assisting dozens of citizens in measuring water temperature at more than 100 locations and cyanotoxins at 12 locations within the Eel River Basin. All previously collected electronic water temperature data were also acquired from various archives and cooperators, and ten million data points were analyzed to discern trends from 1980-2015. Electronic maps were constructed to display water temperature patterns and to show where stream reaches went dry in the summer and fall of 2015 and results shared on the ERRP website. Google Fusion Tables were also used to construct maps of photo points at more than 100 locations in the Eel River basin and posted to the Internet. Time lapse cameras were placed at ten locations and photos taken over several months compiled into Vimeo videos and posted to the ERRP website. More than 100 documents and historic photos were captured from the California Department Fish and Wildlife the U.S. Forest Service in Eureka, and Humboldt State University and posted to an Eel River Library that was created using Omeka web-tools.

Agency and ERRP Coordination

The NCRWQCB staff worked with ERRP beginning in April 2013 to shape the work plan for the *Eel River Monitoring and Water Quality Awareness Pilot Project* (Grant Agreement 14-679-550) and carried it forward to the SWRCB. While agencies had been focusing on enforcement efforts related to environmentally damaging cannabis grows, none were working actively to promote best practices within the cannabis industry. This outreach project was also needed because the NCRWQCB was also creating a Waiver of Waste Discharge for cannabis cultivation (Order No. 2015-0023) in anticipation of legalization in California in the near future. ERRP explained the Waivers to cannabis growers who enrolled in the technical services program and sent sub-contractors to participate in several NCRWQCB meetings related to the new rules during the course of this project. NCRWCB staff also participated in seven ERRP public meetings held throughout the Eel River watershed required by this grant.

SWRCB Division of Enforcement staff was in frequent contact with the ERRP team in the early phases of the project, including participation in a planning meeting on May 26, 2015 (Attachment #1) via conference call as well as at other public meetings throughout the project. Information to properly inform cannabis growers about water rights and required water permitting was jointly developed by the SWRCB staff and the Salmonid Restoration Federation (SRF) and disseminated by ERRP.

The NCRWCB also helped arrange for the Mendocino County Resources Conservation District (MCRCD) to acquire a grant to produce a watershed best management practices guide for cannabis growers, an effort that was supported by ERRP. MCRCD staff attended the May 26 coordination meeting and expressed willingness to follow up with clients in potential need of their services, previously identified by ERRP technical service providers. MCRCD has the ability to organize groups of land owners (such as those who form road associations) acquire grants for pollution prevention and restoration efforts, and is expected to play a key role as cannabis growers organize. For example, coping with erosion related to legacy roads will likely exceed the capacity of small land owners, and grants such as Clean Water Act (319H) abate water pollution and help restore watershed hydrology. After completion of their Best Practices guide, MCRCD attended the last ERRP outreach meeting in Laytonville to further disseminate it.

Hosted Public Outreach Events (Task 1.1 & 1.3)

Several public meetings were held to engage cannabis growers in an effort to offer free technical assistance related to water conservation and prevention of water pollution. Five events were held initially to introduce the project to the public. All five meetings in the first phase of the project were recorded through detailed minutes that are available on the ERRP website and as Attachments (#2-6). The last two meetings in March 2016 reported the results of the grant proposal and queried the public as to the need for continued assistance as required under Task 1.1.2 of the grant. Reports covering the last two meetings are also being submitted and provided as Attachments (#7-8).

Emandal 6/3/15 (Task 1.3)— The first public meeting under this grant was held on June 3 at Emandal, CA, a classic organic farm along an upper reach of the Eel River. The meeting had the dual purpose of 1) allowing coordination between ERRP and NCRWQCB staff, and 2) acquiring our first clients (such as members of the Round Valley Indian Tribe [RVIT]) for technical services. Notes from the meeting (Attachment #2) provide a record and the following excerpt summarizes results:

“The Emandal event was very valuable in that it helped the Eel River Recovery Project get clients in the area, the RVIT EPA attended (Figure 1) and is motivated to help get best practices implemented in Round Valley. Public feedback provided insight into the types of questions potential clients may have and their previous knowledge of best practices. ERRP consultants worked smoothly with NCRWQCB staff. Questions from the audience were respectful and constructive. Attendees seemed to enjoy the organic farm tour and tips on gardening from Malanian Adams, who is one of the owners of Emandal and their master gardener.”



Figure 1 RVIT EPA staff and ERRP subcontractors at Emandal kick off meeting.

Fortuna 6/23/15 (Task 1.1.1) A Best Practices Outreach meeting was held on the evening of Tuesday, June 23 at the Fortuna River Lodge. A complete record of the meeting is available for review as Attachment #3. While attendance was modest, (24 people) ERRP did receive leads for technical services from cannabis growers who attended. Patrick Higgins of ERRP, Dan Mar of Hightide Permaculture, and Adona White of the NCRWQCB made presentations.

They were also joined by consultants Hollie Hall, a water rights expert, and Jesse Dodd, a soil fertility specialist, who volunteered and made great presentations at the event. The interaction with the audience was informative and those in attendance found the meeting highly useful.

Heartwood Institute 6/27/15 (Task 1.1.1) The Heartwood Institute is an important entity because it has long been a spiritual center in southern Humboldt County, and more recently a training center for organic gardening and sustainable agriculture (<http://www.heartwoodinstitute.com>). Several days prior to the Saturday June 27 ERRP Best Practices meeting, there was a large law enforcement operation that became known locally as the Island Mountain Bust. Although this may have dampened attendance because farmers leave during enforcement operations, there were 26 in attendance and ERRP was able to get appointments in neighboring watersheds. Except for the absence of Hollie Hall and the addition of ERRP Round Valley Outreach Coordinator Bruce Hilbach-Barger, who gave a brief presentation entitled Mitigating Impacts of Rural Living in the Eel River Basin, the speaker roster was the same as in Fortuna. A complete transcription of the meeting is available as Attachment #4 and includes thoughts from locals on the scale of a sustainable cannabis culture.



Figure 2 Dan Mar of Hightide Permaculture (right) explains how to promote groundwater recharge at Heartwood Institute on June 27, 2015.

Willits 7/18/15 (Task 1.1.1) The fourth ERRP Best Practices Outreach meeting was held on Saturday, July 18, 2015 at the Little Lake Grange in Willits, CA. The intent was the same as previous meetings - to inform cannabis growers how they can conserve water and reduce the amount of water pollution associated with their agricultural activities. Several presenters were the same as at previous events, including Hollie Hall, Pat Higgins, Bruce Hilbach-Barger and Adona White of the NCRWQCB. ERRP best practices experts Anna Birkas of Village Ecosystems, Larry Desmond of Mendocino WaterWorks, and soil fertility specialist Noah Cornell also made presentations. See Attachment #5 for details of the meeting, including public questions and feedback.

Noah Cornell set up a large compost tea system outside the Grange and gave a demonstration to those in attendance. This event led to several appointments for technical services for cannabis farmers, including several in the Woodman Creek basin that is ecologically important. Julia Carrera of the Small Farmers Association (SFA) attended and participated in a panel discussion and planning began at the event for a co-sponsored August 6 group technical assistance and cannabis farm tour in Covelo.

Covelo 10/17/15 (Task 1.1.1) The last introductory public outreach meeting was in accordance with the wishes of the co-sponsoring RVIT Tribal Council on Saturday, October 17 at the Tribe's Hidden Oak Park. ERRP and RVIT hosted an Indian community style educational fair on best practices that integrate watershed care. The culminating event was a traditional ceremonial Salmon Festival to bring people together and focus on the connection between watershed care and community health and economy. The following is excerpted from meeting notes available as Attachment #6.

“Large group sessions, small group demonstrations, educational presentations, and outreach to community members and institutions that provided support formed the backbone of the event. Conversations among participants extended the reach of the ideas presented and allowed for the participants to explore commitment to those ideas. Demonstrations included making compost tea with discussions of soil biology, Tribal EPA fish and stream literature and activities, wilderness and river system maps, aquatic insects, and underwater fish videos. Both NCRWQCB and ERRP sub-contractors providers were available to answer questions about best practices and discuss the Waiver program.

There is a very high enrollment of Native American children at RVES and RVIT had requested that outreach also target youth. Most of the input from school staff and students were that they were excited by and benefitted from the school outreach day, Friday October 16. Each teacher who commented emphasized that hands on demonstrations and interactive learning about watershed health have the strongest impact on both academic skills and the students' ability to connect those with care for the natural world. Five participating teachers (out of a staff of 11) asked for additional information from presenters, or for specific improvements when we return next year. Students made the connections of salmon with aquatic insects, wildlands with watershed health, land use practices with stream health, and Traditional Native stories and practices with changes over time in salmon and other wildlife populations. Several students participated in the community event the next day, and showed an interest in Tribal EPA educational materials.”

Carlotta/Swain's Flat 3/12/16 (Task 1.1.2) This first of two closing meetings was held at the Outpost Garden Center on Highway 36 with the local business co-sponsoring the event. A poster was created and posted (Attachment #42), a press release disseminated (Attachment #43) and the ERRP website and FaceBook page updated to promote the event. This business is very popular with cannabis farmers from throughout the Van Duzen River basin and the format and time of the event differed from project opening meetings to better suit the life style of the sub-culture targeted. The presentations and community scoping were scheduled from 2 PM to 5 PM and the plan was to have a feed afterwards and to have a band to entertain, the Knights of the Van Duzen.



Figure 3 ERRP water conservation expert Larry Desmond (left) converses with attendee at the Salmon Awareness Festival.

Because the store did not have to interior space to accommodate the meeting, a 40 foot by 40 foot hexagonal tent was rented. The tent was set up Friday, March 11 by the Party Place company, but unfortunately the intense overnight rains and high winds caused the tent to collapse. Luckily the Outpost Garden Center staff was resourceful and capable of erecting a tarp that sheltered attendees and presenters and the meeting proceeded as planned.

Presentations included Hollie Hall of Hollie R. Hall Associated on water rights and conservation, Dan Mar of Hightide Permaculture on watershed conscious property management, Tom LeRoy of Pacific Watershed Associates on cannabis farm planning, Adona White of the NCRWQCB on Waivers of Waste Discharge required for cannabis farming, and ERRP Board Member and sustainable cannabis farmer Sunshine Johnston on why growers need to consider improving their agricultural practices and apply for appropriate permits. ERRP facilitator Vivian Helliwell presented a summary of the grant performance being completed and recorded comments from those present on the utility of the project and future activities needed by the community to help them come into compliance (Attachment #7).

[Laytonville 3/26/16 \(Task 1.1.2\)](#) The final meeting for this grant was held at Harwood Hall on Saturday, March 26 and was co-sponsored by the California Growers Association. Similar to the Swain's Flat meeting, the start time was 2 PM and presentations and attendee scoping was followed by dinner and live music. Presentations were made by Casey O'Neil, CGA Secretary, Stormer Fieler of the NCRWQB, Pat Higgins and Bruce Hilbach-Barger of ERRP and Deborah Stenger-Edelman of the MCRCD. Deborah brought and disseminated copies of the just-released best practices manual also produced in under this grant. Because of the preference of the co-sponsor and those attending, quite a bit of the meeting was focused on how cannabis growers can obtain water rights. Vivian Helliwell captured public input on flip charts and subsequently summarized the meeting (Attachment #8).



Figure 4 Casey O'Neil of CGA (second from upper right) presents to attendees at Harwood Hall on March 26, 2016.

Outreach to Round Valley Indian Tribes (Task 1.2)

This grant required extensive outreach to the community of Covelo and for our members to work with the RVIT to monitor water temperature and cyanotoxins. Deliverables fall under Task 1.2 and were inserted in the grant agreement by the NCRWQCB because the RVIT has authority to maintain water quality on the Reservation and increased technical assistance helps build their capacity. The four areas of focus for this task are: 1) provide technical assistance to cannabis growers in or around Covelo, 2) consult with the RVIT Tribal Council and following their guidance, 3) work with the RVIT EPA to monitor waters on or around the Reservation, 4) provide best practices outreach and develop appropriate educational materials and scope the community regarding possible future projects to meet local needs.

Round Valley Best Practices Outreach (1.2.1) Our organization was able to reach more than 40 cannabis growers at an outreach event just outside Covelo on August 6, 2015 at a farm tour organized in cooperation with the Small Farmers Association (SFA). A report on the meeting is available as Attachment #9. Eight RVIT Tribal members also attended the August 6 event where they learned about implementation of best management practices with regard to conserving water and preventing water pollution. In total, 18 small cannabis farmers were provided technical services in or around the Reservation.

Tribal Council Coordination (Task 1.2.2) ERRP staff wrote a letter to Round Valley Indian Tribe Chairman (Attachment #10) requesting cooperation with our SWRCB outreach grant, co-sponsorship of the Salmon Awareness Festival in October 2015, and allowance of monitoring of Reservation waters. On May 21, 2015 the Tribal Council voted unanimously in favor of cooperation as previously reported (see Attachment #11). The Tribal Council further directed our group to work with other RVIT departments to better understand the community's needs. Coordination with the Tribal Council, the EPA, Roads and Water Departments has continued throughout the project and has resulted in requests for needed additional technical services. ERRP members conducted scoping of needs of the RVIT Water Department, the RVIT Roads Department and Tribal EPA to discern additional needs in the realm of water conservation, preventing erosion from roads and promoting infiltration and continuing water quality trend monitoring. Our group also closely coordinated with Round Valley Elementary School to arrange the school education day preceding the Salmon Awareness Festival (Attachment #12).

Contact was established with RVIT EPA Director and Tribal Council Member Eloisa Britton immediately at the opening of the grant to coordinate on monitoring. ERRP provided water temperature gauges and went into the field with RVIT EPA staff to place and retrieve them. UC Berkeley continued its cyanotoxin monitoring project in the Eel River basin and supplied Cyanotoxin concentrations solid phase adsorption toxin tracking (SPATT) samplers. Protocols for deployment of SPATTs (Attachment #13) were shared with the RVIT EPA and ERRP sub-contractors assisted with their placement in the field. These samples were sent to UCB by ERRP where they were prepared for analysis by UC Santa Cruz as part of a cooperative arrangement. Results from the cyanotoxin study will be available to the RVIT in the March 2016, as will full results of the 1980-2015 ERRP water temperature trend analysis being conducted under this grant. The latter includes data from twenty water temperature gauges deployed in the Middle Fork and North Fork Eel River watersheds (RVIT Reservation). In addition, ERRP members also assisted with a heavy metal study to determine sources of aluminum, a known contaminant.

Press Coverage and RVIT Outreach Materials (Task 1.2.3) Our grant required two each of the following: press releases related to Covelo/Round Valley, brochures and posters tailored to RVIT needs, YouTube videos, and website updates. Press releases were issued prior to the Salmon Awareness Festival (Attachment #14) and afterward to report success (Attachment #15). A third and final press release was issued in February 2016 to address problems caused by the driving of motor vehicles in Reservation streams and throughout the watershed (Attachment #16). A brochure was developed on the best practices outreach theme inviting Tribal members to apply for services (Attachment #17). A second general brochure for RVIT EPA was also created explaining the role of the EPA department, as well as providing contact information (Attachment #18).

Posters for the outreach event in Willits were modified for use in Round Valley by removing the picture with cannabis and replacing it with another best practices photo because some traditional Tribal members find cannabis use undesirable and its promotion offensive (Attachment #19), whereas posters in other locations had prominent cannabis plants to draw our target audience.



Figure 5 ERRP Round Valley Outreach Coordinator Bruce Hilbach-Barger (l) checks heavy metal sample level as RVIT EPA Director Elosia Britton (right) asks a question at Mina Bridge on the North Fork Eel River.

Posters for promoting the Salmon Awareness Festival were created, printed, and widely distributed (Attachment #20). Full size posters developed for promotion of best management practices were supplied to the RVIT EPA. As a last deliverable, ERRP assisted RVIT EPA in using content from the brochure (described above) and adapting it to a 3 X 4 foot Power Point poster that was for display at the Salmonid Restoration Federation conference in April 2016 in Fortuna, CA (Attachment #21).

The two Round Valley videos posted to the Internet use a service called Vimeo instead of YouTube (<https://vimeo.com/eelriverrecoveryproject>). The first was put together by Ron Lincoln Jr. and highlights the Round Valley Elementary School visit and the Salmon Awareness Festival (<https://vimeo.com/155334223>). His father Ron Lincoln Sr. explains traditional ecological knowledge and practices and ERRP Managing Director Pat Higgins tries to inspire the students to pursue careers in natural resources to help the Eel River recover. The second video is of RVIT Tribal Elder Ernie Merrifield (<https://vimeo.com/155333893>) talking about why people should not drive in creeks and how fish populations and streams will improve, if we help watersheds recover. In addition, 15 ten minute radio segments were recorded for airing Monday mornings on KYBU radio in Covelo and available for streaming on Sound Cloud (<https://soundcloud.com/eelriver-recovery-project/>).



Figure 6 Ernie Merrifield (right) discussed problems with driving in Mill Creek with ERRP and RVIT EPA staff.

Requested Additional Services by RVIT (Task 1.2.4) Our grant required exploration of additional ways to assist the RVIT and its departments to conserve water and to reduce water pollution. Two projects emerged from discussions and will be implemented upon the granting of our Phase II SWRCB project in 2016.

RVIT housing stock continues to expand and yet there are limited water resources in Round Valley. Therefore, the RVIT Water Department has requested that ERRP assist with design and installation of five graywater systems to be installed at Reservation homes. These projects will demonstrate the benefits to the community of increased garden productivity and reduction in costs of waste water treatment. ERRP will also teach and train in system design and installation, including providing text books and other guides to help trainees prepare to implement wider adoption of graywater systems for Tribal housing stock. As a result, RVIT will pursue full funding to make graywater systems a feature of all houses on the Reservation. The second project was requested by the RVIT Roads Department and entails improving road drainage on the Reservation to increase infiltration and to minimize erosion. Professional watershed scientists will teach and train Tribal road maintenance operators, including those from different agencies in the vicinity of Covelo and/or nearby sub-basins in Mendocino County. ERRP will work in cooperation with RVIT and other agencies and entities to attract targeted equipment operators. A combination of classroom and field training will take place at locations on the Reservation and nearby by U.S. Forest Service lands where there are examples of problems and/or model practices.

Technical Assistance for Small Cannabis Farmers (Task 1.4)

NCRWQCB staff encouraged ERRP to engage the cannabis growing community in the Eel River Basin to help them improve their agricultural practices, including implementing water conservation and pollution prevention measures, which became Task 1.4 of this grant project. Since subscriptions for technical services were slow at the start of the project and attendance at ERRP hosted events modest, sub-contractors also extended outreach to events hosted by pro-legalization cannabis groups and businesses.

When considering funding for this project, SWRCB members expressed concern that outreach activities be properly evaluated. Consequently, ERRP followed up with clients to discover if any action has been taken, and survey results are described below. ERRP staff also employed group visits of cannabis farmers to a model farm in summer and winter and the results of the Fools Farm tours are also reported below. Although not required by the grant, ERRP published an *Eel River Best Practices Outreach Mid-Program Evaluation* (Attachment #22a) that provided in depth analysis of activities through October 2015. Technical assistance visits extended through February and final evaluation was completed by the last week in March 2016.

On-Farm Technical Assistance Visits: The technical services delivered by ERRP during two hour visits per farm were aimed at giving property owners a list of things to fix and a list of professionals with the capacity to deliver more services on a paid basis. ERRP sub-contractors developed permission forms to access private lands as required under our grant document (Attachment #22b). The form used for field assessments was derived from that used by Hightide Permaculture and accompanies this report (Attachment #22c & 22d). Although subscriptions for technical services were difficult to secure in the first half of the project, with just 18 site visits completed by October 31, the project completed 70 visits over-all. Subscriptions were much easier to secure after California legislation passed in September 2015 that sets the stage for legalization in 2018. ERRP's increased success is also in part due to support from pro-cannabis groups, specifically the Emerald Growers Association (now the California Growers Association or CGA) and the Small Farmers Association (SFA). Many clients said that they had been previously reluctant to hire professionals to counsel them on actions needed to acquire permits, which indicates that ERRP may have accelerated activities geared towards coming into compliance with water rights law and the NCRWQCB Waiver of waste discharge for cannabis growers.

Table 1 provides a list of the 70 clients visited including the basin and sub-basin, ERRP subcontractors providing services, and a summary of highlights of property conditions and client motivation. The conditions on the sites visited ranged from ones where best agricultural practices were fully implemented, with no water pollution and water rights permits either in place or applied, to those on other farms with major issues like lack of water conservation measures, unpermitted water use, ponds without permits, and varying types of pollution. Erosion from roads was also a pervasive problem.

Table 1 Technical assistance visits from ERRP sub-contractors by date and sub-basin with summary note.

Date	Team	Sub-Contractor	Basin	Sub-Basin	Note
17-Jun	S	Birkas, Cornell, Desmond	Outlet	Willits Cr	Wants to get permitted
17-Jun	S	Birkas, Cornell, Desmond	Outlet	Sherwood Cr	Water issues
18-Jun	S	Birkas, Cornell	Middle Eel	Woodman Cr	Applied for water right. Wants to get permitted.
18-Jun	S	Birkas, Cornell	Middle Eel	Woodman Cr	Problems with roads, trails
17-Jul	S	Birkas, Cornell	Middle Eel	Woodman Cr	
5-Aug	N	Dan Mar	Middle Eel	Chemise Cr	Best Practices implemented. Float valve needed
5-Aug	N	Dan Mar	Middle Eel	Chemise Cr	Need water meter & float valve. Road erosion
5-Aug	N	Dan Mar	Middle Eel	Chemise Cr	Need water meter & float valve. Road erosion
6-Aug	S	Birkas, Cornell, Desmond	Middle Fork	Mill Creek	Small Farmers Association organized
6-Aug	S	Birkas, Cornell, Desmond	Middle Fork	Mill Creek	Small Farmers Association organized
6-Aug	S	Birkas, Cornell, Desmond	Middle Fork	Mill Creek	Small Farmers Association organized
17-Aug	S	Desmond, Cornell	Outlet	Bloody Run Cr	Model of good water storage. Roads need work
17-Aug	S	Desmond, Cornell	Ten Mile	Cahto Cr	Bio Swale to catch nutrients
25-Aug	N	Dan Mar	South Fork	South Fork	Needs winter cover cropping
25-Aug	N	Dan Mar	South Fork	South Fork	Needs water meter
August 26	N	Dan Mar	South Fork	Bear Canyon Cr	Flow meter and float valve needed. Road erosion
August 26	N	Dan Mar	South Fork	Bear Canyon Cr	Flow meter and float valve needed. Nutrient loss
September 26	N	Dan Mar	South Fork	Sproul Cr	Flow meter and float valve needed. Road erosion
October 18	S	Cornell	Middle Fork	Mill	Fine management practices.
October 18	S	Cornell	Middle Fork	Mill	Common Road Issues. Interest in follow up.
November 2	S	Birkas, Cornell	Middle Eel	Burns Creek	Water system needs. Erosion. Cultivation good
November 2	S	Birkas, Cornell	Ten Mile	Streeter	Tier 0 model
November 9	S	Cornell	Outlet	Long Valley	Pond erosion. Roads
November 9	S	Cornell	MF/SF	EBSF	Bioswale to improve nutrient retention. Model
November 9	S	Cornell	Rattlesnake	Cummings	Water rights. Ponds
November 9	S	Cornell	Middle Eel	Bell Springs	Water rights. Wetland. Roads
November 9	S	Cornell	Middle Eel	Blue Rock	Close to Creek. Roads. Pond
November 9	S	Cornell	Outlet	Long Valley	Protect spring. Culvert
November 10	S	Cornell	Middle Eel	Middle Eel	Roads. Soil. Slope, vegetation. Water storage.

Date	Team	Sub-Contractor	Basin	Sub-Basin	Note
November 10	S	Cornell	Middle Eel	Middle Eel	Roads. Water storage. Grey Water
November 10	S	Cornell	South Fork	Cedar	Pond. Roads. Water rights
November 10	S	Cornell	Outlet	Outlet	Water rights. Wetland
November 16	S	Cornell	Tenmile	Tenmile	No water. Legacy stream needs.
November 16	S	Cornell	Tenmile	Tenmile	Water rights. Stream protection
November 21	S	Cornell	Outlet	Outlet	No problems. Experienced, thoughtful.
December 9	S	Cornell	Mainstem	Bucknell	Tier 3 garden. Stream. Road in stream. Stream diverted. Nutrient, sediment delivery.
December 9	S	Cornell	Mainstem	Bucknell	Outhouse near creek. Road on property is good. Shared road has ALL the major issues. Steep slopes.
December 9	S	Cornell	Mainstem	Bucknell	Arch. Site. Mini dam. Pond, permit. Well. Road on property is good. Shared road has ALL major issues.
December 11	S	Cornell	Outlet	Outlet	Minor culvert. Surface erosion, cover crop.
December 11	S	Cornell	Mainstem	Davis	Compliant farm. Well. Diverse plantings. Flat.
December 11	S	Cornell	Mainstem	Moore	Well. Little pond, permit. Septic, permit. Reasonable erosion control. Heavy equipment use. Unstable terrace. Legacy logging in stream stored sediment. Undersized culvert.
December 29	S	Cornell	Tenmile	Cahto	Undersize culvert. Good ground cover, practices. Well. Permitted wastewater. Improve containment.
December 29	S	Cornell	Tenmile	Cahto	Garden located in a wetland. Flat.
December 29	S	Cornell	Tenmile	Cahto	Small garden close to stream (not an obvious issue)
December 29	S	Cornell	Tenmile	Cahto	Excellent practice. Diversified planting.
December 29	S	Cornell	Tenmile	Cahto	Needs wetland delineation. Standing water caused by neighbor's dam.
January 3	S	Cornell	Outlet	Outlet	Poor ground cover. Ditch gullyng. Pond, permit (not instream).
January 6	S	Birkas	Middle Fork	Goforth	Pond with class III. Good ground cover. Good road conditions.Spring. No float valve. Landslide from road. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.

Date	Team	Sub-Contractor	Basin	Sub-Basin	Note
January 6	S	Birkas	Middle Fork	Goforth	Unused springs. Undeveloped, no garden. Pretty good roads. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies
January 6	S	Birkas	Middle Fork	Goforth	Pretty good roads., 5 acres of bulldozed land with surface erosion. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 6	S	Birkas	Middle Fork	Goforth	Eroding terraces. Spring. High stream diversion potential on road. Greywater system. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 6	S	Birkas	Middle Fork	Goforth	Gardens close to creek. Rills in road surface. Compost tea. Pond.Site in good condition. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 7	S	Birkas, Cornell	Middle Fork	Goforth	In stream pond. Excellent fuel containment. Road erosion/gully issues. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 7	S	Cornell	Middle Fork	Goforth	Class III diversion. Possible nutrient delivery/connectivity. Excellent roads. Infrastructure and septic. Needs water right. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 7	S	Cornell	Middle Fork	Goforth	Stream diversions. In stream pond. Other pond. Gullies. Outhouse. Typical road issues. Springs. No float. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies,
January 7	S	Cornell	Middle Fork	Goforth	Springs poorly developed. Water rights. Wastewater. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 7	s	Cornell	Middle Fork	Goforth	Well sited gardens, infrastructure. Well. Good ground cover. Close to compliance. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.

Date	Team	Sub-Contractor	Basin	Sub-Basin	Note
January 7	S	Cornell	Middle Fork	Goforth	Taking lots of water from creek. Nutrient delivery. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 7	S	Birkas	Middle Fork	Goforth	In stream pond class III. Springs. Water rights. Culvert and road crossing issues. Road rilling. Poonkinny Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 8	S	Birkas	Middle Fork	Mill	Bad terraces. Horizontal spring bore is probably legal due to no surface expression. Needs float. Needs ground cover. Road General Conditions: undersized culverts, little ditch relief, rilling, gullies.
January 8	S	Cornell	Middle Fork	Mill	Perfect land use practices. Ground cover. Well.
January 8	S	Cornell	Middle Fork	Grist	Flatland. Well. No problems. Use ground cover.
January 8	S	Birkas	Middle Fork	Mill	Well. Pond. Slough with tribal water rights related issues that need sorting. Need float.
January 11	S	Cornell	Middle Eel	Burns	Pond. Road upgrades. Spring diversions. Gardens close to creek. Water rights. Need fuel containment. Possible fuel delivering.
January 11	S	Cornell	Middle Eel	Burns	Wetland road crossing issue. Pond, permit. Wetland consideration for site placement.
January 11	S	Cornell	South Fork	Tenmile	Flat. Diversified plantings. Spring, pre-1914 creek diversion in ditch. Ground cover.
February 1	S	Cornell	Mainstem	Mainstem	High delivery risk. Solid practices. Could be wetlands, gradually sloped to river bank. Pumped from river, water rights.
February 11	S	Cornell	Middle Eel	Burns	Many little needs. Much water on land.
February 11	S	Cornell, Higgins, Hilbach	Middle Eel	Burns	Road drainage. Pond. Wetland.
February 12	S	Cornell	Mainstem	Moore	Well. Good BMPs. Ground cover. Far from waterways. Good roads. Flat land.

Recommendations Made to Clients: Table 2 is a more detailed look at measures recommended for implementation to help clients attain best practices as well as compliance with California water law and permitting requirements and with NCRWQCB waivers of waste discharge for cannabis farmers.

Very few clients had water meters, which is an impediment to understanding patterns of water use and getting land owners more in touch with how much they are using. This also affected ERRP's ability to precisely calculate the amount of water saved by our project. ERRP contractors stressed the importance of installing water meters that allow assessment of domestic and agricultural water use. All clients were also encouraged to calculate a water budget and the amount of water storage needed. Any grower diverting water from a stream was informed that they could only legally do so before May 15 and after October 15 and that they needed to add storage to meet their needs during the restricted period. In addition, cannabis farmers with a water meter can test whether they get the same plant growth rates and equal or improved plant health by using less water, which is often the case. Some clients were advised to install grey water systems to help conserve water, where waste water from the kitchen and bathroom sinks and showers is shunted directly into a garden or an orchard. Preliminary results indicate that most cannabis farms do not have float valves in their storage tanks that stop water from spilling when the tank is full. Clients were encouraged to install such valves and to leave as much water at the source both to meet other beneficial uses and prevent destabilization of slopes below their tanks due to over-saturation of soils.

ERRP consultants made recommendations to clients to plant vegetation or to excavate bioswales to trap surface erosion and nutrients in settings where gardens posed risk of polluting nearby streams. Bioswales are filled with organic matter that decays slowly and can help enhance growth of riparian vegetation that in turn helps cool the stream and provide additional wildlife habitat. Planting winter cover crops in gardens with this potential was also recommended to prevent soil loss and to help avoid soil compaction that compromises subsequent garden productivity. ERRP contractors are also experts in building living soils through composting, and clients using artificial fertilizers or buying topsoil were informed of ways they might avoid annual costs and improve plant growth by adopting more sustainable methods. Plants in living soils benefit from delivery of water from fungal mycorrhizae, which can substantially reduce water use and the need for water storage.

Improvement of road systems was also recommended to prevent sediment pollution and increase water infiltration. Cannabis farmers often have parcels with steep slopes and road networks originally constructed for logging, and not intended for permanent use. These roads may tend to concentrate water in in-board ditches that can cause erosion at points of discharge or form gullies that deliver surface erosion to nearby stream. Also, some cannabis farmers have several sites on which they grow connected by trails. Quad-runner vehicles are commonly used to access these sites and they may create ruts that become gullies with the potential to deliver sediment. Under-sized culverts can cause road failures with catastrophic results. To remedy these problems, ERRP contractors recommended use of water bars, outsloping roads into vegetated areas, replacing under-sized culverts, and getting rid of inboard ditches where possible.

Table 2 : Recommendations to ERRP Clients by Category

ERRP	Basin	Sub-Basin	Meter	Float	Cons/Stor	Grey H2O	BioFilter	BioSwale	Roads	Fertility	Cover	Haz/ Stor
DM	Middle Eel	Chemise Cr		X								
DM	Middle Eel	Chemise Cr	X	X					X			
DM	Middle Eel	Chemise Cr	X	X								X
DM	South Fork	South Fork	X		X		X				X	
DM	South Fork	South Fork	X									
DM	South Fork	Bear Canyon	X	X					X			
DM	South Fork	Bear Canyon	X	X				X	X			
DM	South Fork	Sproul	X	X					X			
AB, LD, NC	Outlet	Sherwood	X		X							
AB, LD, NC	Outlet	Outlet	X		X							
AB, NC	Middle Eel	Woodman	X		X				X	X		
AB, NC	Middle Eel	Woodman	X		X				X			
AB, NC	Middle Eel	Woodman			X				X			
LD, NC	Outlet	Bloody Run							X	X		
LD, NC	Ten Mile	Cahto					X	X				
AB, LD, NC	Middle Frk	Mill Cr	X	X		X	X	X	X	X		X
AB, LD, NC	Middle Frk	Mill Cr	X		X				X	X		
AB, LD, NC	Middle Frk	Mill Cr	X	X	X				X	X		
NC, AB	Tenmile	Streeter	X									
NC, AB	Middle Eel	Burns	X	X	X	X	X	X	X			
NC, AB	MidE/EBSF		X					X				
NC, AB	Rattlesnake	Cummings	X	X	X				X			
NC, AB	Middle Eel	Bell Springs	X	X			X		X			
NC, AB	Middle Eel	Blue Rock	X				X	X	X			

ERRP	Basin	Sub-Basin	Meter	Float	Cons/Stor	Grey H2O	BioFilter	BioSwale	Roads	Fertility	Cover	Haz/ Stor
NC, AB	South Fork	Cedar	X		X				X			
NC	Outlet	Long Valley	X	X	X				X			
NC	Outlet	Long Valley	X	X				X	X			
NC	Outlet	Outlet	X				X					
NC	Tenmile	Ten Mile			X			X				
NC	Outlet	Outlet	X						X		X	
NC	Middle Eel	Burns	X	X	X		X	X	X	X	X	
NC	Middle Frk	Mill	X									
NC	Outlet	Outlet	X									
NC	Middle Eel	Middle Eel	X	X	X			X	X	X		
NC	Middle Eel	Burns	X	X					X			
NC	Middle Eel	Middle Eel	X	X	X	X			X		X	
NC	Middle Frk	Mill	X	X					X			
NC, PH, BH	Middle Eel	Burns	X	X	X				X			
AB	Middle Frk	Goforth	X									
AB	Middle Frk	Goforth	X								X	
AB	Middle Frk	Goforth	X				X	X	X			
AB	Middle Frk	Goforth	X		X	X			X		X	
AB	Middle Frk	Goforth	X	X	X				X			
AB, NC	Middle Frk	Goforth	X		X				X			
NC	Middle Frk	Goforth	X	X			X		X		X	
NC	Middle Frk	Goforth	X	X	X	X	X		X			
NC	Middle Frk	Goforth	X			X		X				
NC	Middle Frk	Goforth	X		X			X	X	X	X	
NC	Middle Frk	Goforth	X		X			X	X			

ERRP	Basin	Sub-Basin	Meter	Float	Cons/Stor	Grey H2O	BioFilter	BioSwale	Roads	Fertility	Cover	Haz/Stor
AB	Middle Frk	Goforth	X	X	X				X		X	
AB	Middle Frk	Mill	X									
NC	Middle Frk	Mill	X								X	
NC	Middle Frk	Grist	X								X	
AB	Middle Frk	Mill	X	X								
NC	Middle Eel	Burns	X	X	X	X	X	X	X			X
NC	Middle Eel	Burns	X						X			
NC	South Frk	Tenmile	X									
NC	Mainstem	Moore	X						X			
NC	Mainstem	Moore	X		X			X	X		X	
NC	Tenmile	Cahto	X						X			X
NC	Tenmile	Cahto	X					X				
NC	Tenmile	Cahto	X									
NC	Tenmile	Cahto	X					X				
NC	Mainstem	Bucknell	X	X	X	X	X	X	X	X	X	X
NC	Mainstem	Bucknell	X						X			
NC	Mainstem	Bucknell	X									
NC	Mainstem	Davis	X									
NC	Outlet	Outlet	X		X			X			X	
NC	Mainstem	Mainstem	X						X		X	

Cons/Stor = water conservation and/or water storage improvement, Biofilter = plant vegetation to trap sediment and filter runoff, Cover = recommend winter cover cropping, Haz/Stor = fertilizers, fuels and pumps not fully contained

Evaluation Survey Results: As a condition of funding, the SWRCB required quantitative evaluation of outreach success. Twenty seven of the 70 or 37% of clients visited responded to an ERRP survey, mostly by phone, and the following information was gathered: best practices measures after site visits, how much water was conserved by actions taken, impediments to implementation, receptivity of neighbors to implementing best practices or receiving additional best practices consultations, the utility and quality of service rendered by ERRP contractors, and what additional resources are needed.

Measures Implemented: Twenty three clients responding to the ERRP survey reported taking initiative on a wide array of recommended actions, which they could accomplish on their own. Three roof catchment systems are being installed and several others planned. Road and trail maintenance included outsloping to improve drainage and infiltration, installing water bars, and culvert replacement. Additional actions taken included:

- constructing appropriate storage facilities for hazardous materials,
- propagation of native bunch grasses to provide bio filtration,
- pond outlet culvert replacement to reduce risk of failure and outlet rocked to prevent erosion,
- brush check dam installed to stop a gully erosion of a slope,
- straw mulching of exposed soil areas,
- moving nutrient rich materials away from streams,
- willow planting in a riparian zone, and
- planting cover crops in winter.

Four different clients started a dialog with their neighbors on watershed protection and organizing through formation of road associations or watershed groups. They found shared interest in organizing for collective action on erosion control and water issues. One client got politically active and is asking that Mendocino County restore permitting of composting toilets because of water conservation benefits.

Water Conservation: More than half the clients (14 of 27) responding implemented water conservation recommendations: fixing leaks, installing drip irrigation and drip timers, mulching, deep watering and getting float valves to prevent storage tank over-flow. ERRP estimates savings for clients averaged 4500 gallons/year due to measures taken after consultations, although this number is an extrapolation of results to all clients. More precise calculation was not possible due to lack of water meters and water use data. Eel River rural water use is characterized below and potential water savings through more widespread water conservation implementation discussed.

Eel River Domestic and Agricultural Use: Common levels of domestic use for rural residences in the Eel River watershed range from 50 to 150 gallons per day (GPD). Agricultural water use is higher and may range from 300 to 1200 GPD. Agricultural water extraction typically takes place from April through October, which is a period of about 210 days. Therefore, agricultural use would be a volume of 15,000 to 180,000 gallons per year. Some water users extract even more than these amounts, if they have abundant water and a sense of entitlement. (Source Larry Desmond, Mendocino WaterWorks).



Figure 7 Planter boxes and pots watered with grey water. Fool's Farm 6/20/16.

Kyle Keegan provided data on rural residential water use when water conservation is put into full practice. His family of three uses less than 40 GPD or less than 15 GPD per family member. They achieve savings by taking showers of no more than two to three minutes, which use about a gallon a minute. Dish water and shower water are captured and distributed in a grey water system that waters garden spaces and pots through drip systems and by direct application.

Kyle notes that cannabis plants, or any plants, in living soils, with mulch applied, drip irrigation installed and an appropriate watering schedule need much less water (1-3 GPD). Unfortunately, much more consumptive growing methods are more common at present where water use can be many fold higher. This occurs when cannabis is grown in "smart pots," on windy sites, with little or no mulch, with exposed water lines that heat the water to where it can stress plants, no sun protection on the south and west sides of pots, low or no humus in the soil, with poor irrigation schedules.

Model Farm Outreach Events: One of the foremost authorities on employment of best practices in cannabis farming is Kyle Keegan, who manages a model farm in Salmon Creek in southern Humboldt County along with his wife Dana and daughter Kaliana. Kyle has a severe case of limes disease and could not travel to perform technical services under this grant. Instead ERRP promoted a series of workshops and field tours of the Fools Farm where Kyle gave demonstrations of best practices employed. Farm tours conveyed a lot of information and gave 60 people the opportunity to have "hands on" experiences for full day trainings on June 19 and June 20, 2015, and one featuring winter practices on February 27, 2016.

Although this grant only called for two Fools Farm workshops, a third was added on June 19 because there was more demand than could be met on June 20. The extra workshop was particularly successful in attracting young cannabis growers who do not typically come to organized meetings held by ERRP. ERRP contractor Dan Mar attended the June 20 tour and was not only able to contribute as a presenter, but was also able to secure clients for subsequent on-farm technical services from among attendees. Excellent still photos from the event supplied images for brochures and posters created by this project. Also, video footage captured of the June 20 Fools Farm workshop was edited into two videos that are posted on-line (See Task 1.6).



Figure 8 Collage from Fools Farm field school and workshop.

The February 2016 field workshop focused on off-season, winter best practices. Attendees learned how simple it is to make biochar and the benefits of thinning the forest. Blue berries thrived after his thinning and controlled burn and his family is more fire-safe. All 24 attendees got to help build soils and prepare a garden for the following year by sheet mulching, “like making Lasagna” Kyle explained. They learned how to choose the right contour for a bioswale on a gentle slope in a meadow to create an ideal site for fruit trees or a garden area requiring less watering. Kyle used limbs of Douglas fir trees, cut down to prevent encroachment on grassland, to plug a hillslope gully and talked about how the gully formed and how hillslope hydrology was being restored. Although no follow up survey was possible, inspired trainees likely will take action based on their lessons or even pursue a career in helping more widespread implementation of best practices in the Eel River watershed.

Project Implementation Using Professional Services: When larger scale problems appeared to exceeded land owner capacity, ERRP provided a list of contractors that could render appropriate services to the land owner. In the evaluation, 18 clients said that had engaged professional services for the following:

- road issues,
- water rights and Waiver permitting,
- septic replacement,

- geological services to assess slope stability,
- mapping and farm planning,
- stream riparian restoration, and
- vegetation management and forest health improvement.

Impediments to Implementation: Clients during evaluation calls listed the following as impediments to best practices implementation on their places and in their watersheds.

- Money: Fourteen participants surveyed cited monetary resources as their primary constraint. Smaller scale cannabis farmers reported significant financial limitations.
- Social/Community Issues: Neighborhood issues about shared roads, collective water use, tribal community needs, improper County road management and maintenance, and environmentally destructive forestry and cannabis activities were each mentioned more than once as barriers to both personal and collective improvements.
- Personal Issues: Age, disability, time limitations, and family needs constrained some otherwise willing clients from implementing their BMP goals.
- Changing Cannabis Status: Lengthy passionate discussions or brief mentions of cannabis cultivation uncertainties occurred during many phone and face to face surveys. These included cannabis legal status; water rights changes; lack of clarity about waiver provisions and their application; and changing tax scenarios.
- Capacity of Consulting Firms: In a few instances clients found that professionals they contacted had no time available because of demand from the cumulative demand from the cannabis growing community with legalization pending. Road rebuilding services were oversubscribed. One client is in such a remote location that providers are unwilling to deliver services. Roof catchment systems remain uninstalled.

Water supply issues and competition for scarce water during the recent drought had several ERRP survey respondents concerned. One client had water backing up onto their property because of an impoundment built just downstream. Increasing installation of wells to avoid water rights permitting was also mentioned as a potential problem, with regard to depleting stream flows and interfering with water levels in existing wells on adjacent properties. Three small farmers interviewed were not optimistic about prospects of cooperation within their watershed or recovery of the environment. They cited problems with neighbors damaging the environment and even their property, concern over “mega-grows” and other destructive environmental activities like logging and operation of an asphalt plant on Outlet Creek.

Utility of ERRP Technical Consultations and Materials Provided: Table 3 contains the survey results from clients about the level or service they received and whether it met their needs. On a scale of 0-5, with 5 being the best, clients rated ERRP contractors highly with an average score of 4.5. Twenty five of 27 respondents said they got very clear advice on how to implement best management practices with regard to water pollution prevention and water conservation. Respondents found handouts provided somewhat less useful, with an average score of 3.8. Twenty two said they had talked to their neighbors about ERRP visit and what they had learned, and half said neighbors were receptive to a similar training.

Table 3 Assessment of quality of ERRP contractor services and utility of advice and materials provided.

ERRP	Basin	Service	Explain BMP	Handouts Useful	Actions Taken(Y/N)	Profes'l Services	Access Grants	Talk w/ Neighbors	Neighbors Receptive	More TA
DM	Middle Eel	5	Y	4	N	N		Y	DK	Y
DM	Middle Eel	4.5	Y	5	Y	Y	Y	N		Y
DM	Middle Eel	5	Y	3	Y	N	Y	Y	Y	Y
DM	Middle Eel	5	Y	5	Y	Y	Y	Y	Y/N	Y
DM	South Fork	5	Y	2	Y	Y	Y	N		Y
DM	South Fork	4	Y	4	Y	N	Y/N	Y	Y	Y
DM	South Fork	5	Y	5	Y	Y	Y	Y	~	Y
NC, AB	South Fork	5	Y	5	Y	Y		Y	N	Y
AB, LD, NC	Outlet	4	Y	3	N	Y		N		Y
AB, NC	Middle Eel	5	Y	3.5	Y	Y	Y	Y	Y	Y
LD, NC	Outlet	4.5	Y	3	Y	Y	N	N		Y
LD, NC	Ten Mile	5	Y	5	Y	N		Y	N	
AB, LD, NC	Middle Frk	5	Y	4	Y	Y	N	Y	Y	Y
AB, LD, NC	Middle Frk	2.5	Y		Y	Y	N	Y	Y	Y
NC	Outlet	5	Y	4	Y	Y	Y	Y	Y/N	Y
AB, NC	Middle Frk	4	Y	5	Y	Y	Y	Y/N	Y/N	Y
NC	Mainstem	3	Y	2	Y	Y				N
AB, NC	Middle Frk	5	Y	4.5	Y	Y	Y	Y	Y	Y
AB, LD, NC	Middle Frk	4.5	Y	Y	Y	Y	?	Y	Y	Y
AB, LD, NC	Middle Frk	4.5	Y/N	2	N	Y	Y	Y	Y	Y
NC, AB	Middle Eel	5	Y	4	Y	Y	Y	Y	Y	Y

ERRP	Basin	Service	Explain BMP	Handouts Useful	Actions Taken(Y/N)	Profes'l Services	Access Grants	Talk w/ Neighbors	Neighbors Receptive	More TA
NC, AB	Middle Eel	5	Y	4.5	Y	Y	Y	Y	Y	Y
AB, NC, LD	Middle Frk	3	N/Y	4	Y	Y	Y	Y		Y
AB, NC, LD	Middle Frk	5	Y	Y	N	N	Y	Y	N	Y
NC, AB	Tenmile	4	?	N	N	N	N	Y	Y	?
NC	Middle Eel	5	Y		Y	Y	Y	Y	Y	Y
NC	Mainstem	4.5	Y	2.5	Y	N	N	Y	DK	Y

(Service: How was your level of service from the ERRP contractor?

Explain BMP: Did the contractor explain your options for implementing Best Management Practices (*pollution prevention/water conservation*)?

Handout Useful: Were the handouts and internet links useful to you? (*eelriverrecovery.org*) (*best practices books/videos, etc.*)

Actions Taken: Have you taken any of the recommended actions? If so, which ones?

Professional Services: Are you planning on seeking professional services for implementing the more challenging recommendations?

Access Grants: Would access to grant resources allow you to accomplish your goals?

Talk w/ Neighbors: Have you talked to your neighbors about the project? If so, which elements?

Neighbors Receptive: If so, do your neighbors seem receptive to improving their practices?

More TA: Is there more need for technical assistance? 0 = No Benefit 5 = Great Benefit

Additional Services Needed: Clients were also surveyed on what additional resources they thought could be supplied to speed implementation of best practices by their neighbors and cannabis growers throughout the Eel River watershed. Many expressed a desire for more information on composting techniques, improving soil health, conservation burn techniques, road and driveway maintenance, and farm site design and planning. Several said that group consultations that helped people organize and devise water plans for both individual and neighborhood use were much needed. Twelve were receptive to grant assistance for helping meet costs of water storage and coping with road problems. Technical assistance for road associations and other groups to help them plan and to possibly acquire grant resources for improvements was also highlighted as a need.

Embedding in Cannabis Group Events: Since direct outreach to cannabis growers did not adequately elicit requests for best practices technical assistance, ERRP sub-contractors began to attend events sponsored by pro-cannabis groups and businesses, where there were large numbers of growers in attendance (Table 4). This provided an opportunity to reach hundreds more small cannabis farmers and was successful in helping secure additional appointments. For example, at a CGA meeting in Laytonville in mid-September attended by 100 growers, 53 requested technical services visits. An SFA co-sponsored group tour of cannabis farms in the Covelo area described above (Attachment 9) not only provided assistance to three small farmers that day, but to 36 other SFA members who learned about best practices they could implement on their farms.

Small Water District Cyanotoxin Monitoring Assistance (Task 1.5)

Task 1.5 of this grant calls for “outreach and technical assistance to small water districts and community services districts in small unincorporated towns along the Eel River which use river water as a source for drinking water. The technical assistance shall be related to discussing desirability of monitoring cyanotoxins near in-takes; placement, maintenance and retrieval of water quality samplers; interpretation of monitoring results; and steps or measures to avoid exposure and algal contamination of domestic water supplies.”

Summary of UCB/ERRP Cyanotoxin Monitoring Project: Cyanotoxins have been monitored at locations throughout the Eel River basin since 2013 (Bouma-Gregson and Higgins 2015) as a result of the initiative of UC Berkeley doctoral candidate Keith Bouma-Gregson. Support for his work comes from a U.S. EPA Fellowship grant and a National Science Foundation grant to UCB for Critical Zone Observatory monitoring. UCB uses solid phase adsorption toxin tracking (SPATT) samplers to measure cyanotoxins and successfully monitored 8 locations in 2013, 10 in 2014 and 14 in 2015. ERRP has provided access and volunteer support, including placement of SPATT samplers and retrieval at several locations in 2015. SPATT analysis is performed through a cooperative arrangement by UC Santa Cruz.

The 2015 results for presence/absence of cyanotoxins at 14 stations is below in Table 5. SPATTs were left at most locations for a month (and sometimes 6 weeks) versus weekly sampling in 2013 and 2014. Of 47 samples total, 77 % tested positive for Anatoxin-A, but ambient levels do not pose a high health risk. The danger is when pets and people, especially small children, coming in direct contact with blooms. The highest levels of toxins were Myers Flat, below Sproul Creek, and above Scotia.

Table 4 Events sponsored by other groups or agencies attended by ERRP sub-contractors for the purpose of outreach and support.

Date	Location	Partner	ERRP Sub	Benefit
7-May	Covelo	Women's Cannabis Collective	Bruce Hilbach-Barger	Outreach about meetings/program
7-May	Eureka	NCRWQCB	Dan Mar, Pat Higgins	Participate in Waivers discussion. Outreach to groups and clients.
8-May	Laytonville	NCRWQCB	Bruce Hilbach-Barger	Outreach at the request on NCRWQCB. Client contacts.
23-May	Garberville	Wonderland Supply	Dan Mar	Outreach about meetings/program
26-May	Willits	SWRCB, NCRWQCB, MCRCB, ERRP	Mar, Birkas, Desmond, Cornell, Hilbach	Kickoff & Coordination
3-Jun	Laytonville	Women's Cannabis Collective	Anna Birkas	Outreach about meetings/program. Build trust. Get client leads.
20-Jun	Miranda	ERRP Fools Farm Tour	Dan Mar, Bruce Hilbach-Barger, Higgins	Try to recruit clients from attendees, technology transfer, video record
27-Jun	Carlotta	Outpost Garden Center	Dan Mar	Outreach to Van Duzen grower community, support of NCRWQCB staff
15-Jul	Willits	Emerald Growers Association	Noah Cornell	Outreach about meetings/program. Build trust. Get client leads.
20-Jul	Garberville	SWRCB/NCRWQCB	Dan Mar, Pat Higgins	Gain trust, get Sproul Creek clients
2-Aug	Laytonville	Emerald Growers Association	Bruce Hilbach-Barger	Outreach about meetings/program. Build trust. Get client leads.
6-Aug	Round Valley	Small Farmers Association	Birkas, Cornell, Desmond, Hilbach-Barger	Three technical assistance visits with 40 growers - 8 Tribal members attending
16-Aug	Harris	Heartwood Institute	Dan Mar	Outreach to cannabis farmers enrolled in best practices class and other locals
12-Sep	Redway	Golden Tarp Award - Multiple Sponsors	Dan Mar	Outreach about meetings/program. Build trust. Get client leads.
16-Sep	Laytonville	Emerald Growers Association	Noah Cornell	Outreach about meetings/program. Build trust. Get client leads.

Outreach to and Monitoring Cooperation with Small Water Districts (Task 1.5.1) ERRP initiated contact with the Redway Community Services District (RCSD), the Garberville Services District (GCSD) and the Alderpoint Water District (AWD) to explore cooperative monitoring at the beginning of the project. Although there was some interest from RCSD Board Chair Michael McKaskle, their staff thought it premature for their participation in 2015 monitoring, and GSD Executive Director Ralph Emerson also declined participation. Despite numerous attempts, ERRP was never able to establish contact with the AWD. To fulfill the requirements of this grant, ERRP took initiative and deployed SPATTs upstream of the GSD and RCSD intakes on the South Fork Eel River and on the main Eel River proximate to the AWD intake at Alderpoint. ERRP volunteer Larry Bruckenstein helped cleaned and replace the SPATT below Sproul Creek from July through September 2015 and volunteer Willie Grover assisted with the Alderpoint SPATT . ERRP placed SPATTs above the intake for the AWD.



After failure to contact the AWD, ERRP mailed the district Secretary a letter (Attachment #23) with the 2014 UCB/ERRP cyanotoxin report and shared the same report with GSD staff. The report requested updating as more data becomes available. The RCSD invited ERRP to present information to their Board on January 20 (Attachment #24) and is open to the possibility of collaborating on future cyanotoxin monitoring of the South Fork Eel River. The RCSD Board expressed appreciation for ERRP’s efforts to promote water conservation and pollution prevention, as it helps increase their water supply and protect their water quality.

Figure 9 Alderpoint SPATT at top and encased I-Button temperature gauge below.

Table 5 Presence and Absence of Anatoxin-A (ATX) at 15 Eel River sampling sites from June through October 2015.

Location	Yes ATX	No ATX
Alderpoint	2	1
South Fork downstream of Sproul Creek	2	1
South Fork at Angelo Preserve	4	3
South Fork at Big Bend Lodge (South Leggett)	1	2
South Fork at Phillipsville*	2	1
South Fork at Myers Flat	4	0
Lower Eel at Holmes	0	1
Lower Eel Above Scotia	2	0
Middle Eel upstream of Woodman Creek	3	0
Upper Eel upstream of Dos Rios	4	0
Van Duzen near Carlotta	4	0
Van Duzen downstream of Swimmers Delight	4	0
Middle Fork upstream of Dos Rios*	2	1
Middle Fork downstream of Williams Creek	2	1

*Vandalized with loss of one month's data.

ATX Presence and Absence by Month and Reach 2015

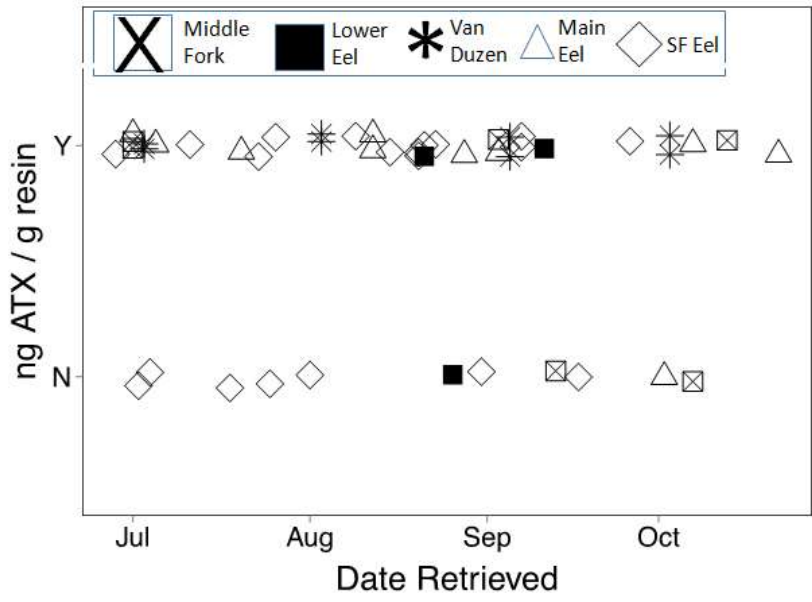


Figure 10 Chart showing presence and absence by month retrieved. Data from UC Berkeley with lab work by UC Santa Cruz.

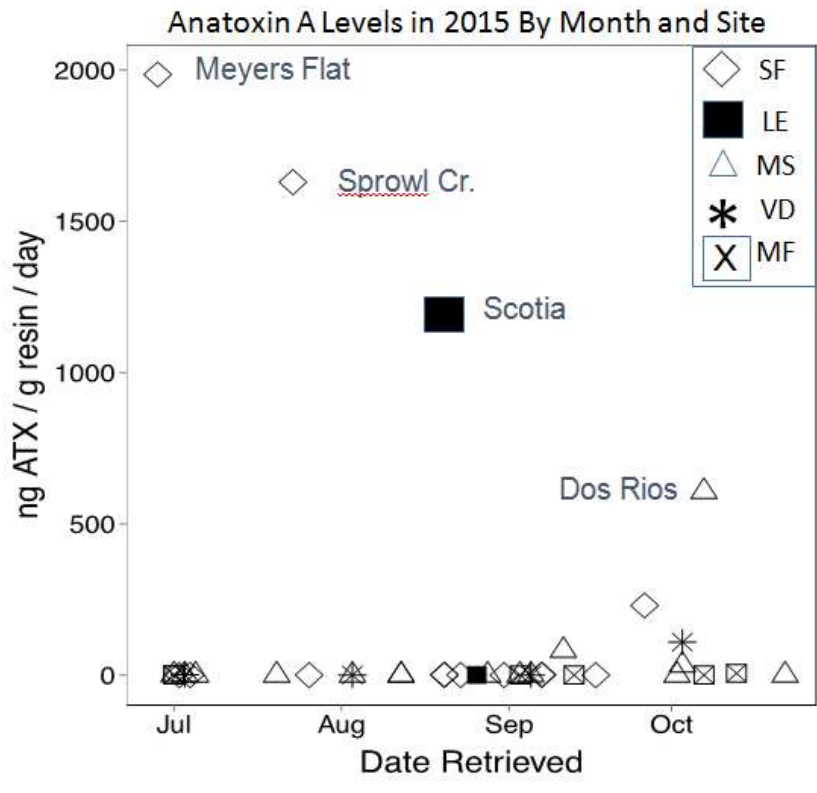


Figure 11 Chart indicating the highest levels of ATX in July and August on South Fork and lower Eel in September.

Media Outreach/Website/Educational Materials (Task 1.6)

Because of the limited number of cannabis farmers that could be directly involved, our grant also required that diverse public outreach and educational materials be developed and disseminated via the media and the internet, including social media. These products are described below, and will have lasting value in terms of supplying information to cannabis growers of sufficient detail that they could employ themselves without further assistance. This report section follows sub-tasks in the grant document by turn.

Press Releases (1.6.1) There was a total of eight press releases related to best practices outreach and citizen monitoring of water temperature and cyanobacteria. The press list used by ERRP included all targeted media as specified in grant (Attachment #25). For all releases see Table 6..

Table 6 . Press releases by date, theme and attachment number

Date	Theme	Attachment No.
May 25, 2015	Emandal Kick Off Meeting	Attachment #26
June 12, 2015	Best Practices Meetings	Attachment #27
July 22, 2015	Cyanotoxins Increasing as Flow Drops	Attachment #28
August 8, 2015	Cyanobacteria and Water Temperature Monitoring	Attachment #29
September 13, 2015	Eel River Flows Near Historic Lows	Attachment #30
October 19, 2015	Salmon Awareness Festival Creates Excitement and Raises Consciousness	Attachment #15
February 10, 2016	Advisory Against Driving in Streams in Winter	Attachment #16
March 5, 2016	Swain's Flat Outreach	Attachment #43
April 20, 2016	Release of the Eel River Monitoring and Water Quality Awareness Pilot Project Final Report	Attachment #44

Forest and News Articles (1.6.2) ERRP staff has published the four required articles in the Trees Foundation Forest and News quarterly magazine. Articles appeared in the Summer 2015 (Attachment 31), Fall 2015 (Attachment 32) and Spring 2016 (Attachment 48) editions.

Radio Shows/Podcasts (1.6.3) Project technical experts were required under our proposal to do at least five radio interviews on talk shows or news programs to discuss the project’s status, and to cover highlights and significant milestones. ERRP’s Managing Director Patrick Higgins has hosted eight two-hour Monday Morning Magazine programs on KMUD radio and has interviewed all the best management sub-contractors on air at least once. KMUD is located in Redway, CA is highly supported by the local community in southern Humboldt and northern Mendocino Counties and is a good way to communicate with many people in the cannabis culture. Table 2 includes the dates of the programs and the names of the people who were interviewed. Best practices topics were also included in KYBU weekly Eel River Update segments reported for Task 1.2. For access to all Sound Cloud segments see <https://soundcloud.com/eelriver-recovery-project>.

Table 7 Monday Morning Magazine segments hosted by Patrick Higgins with other ERRP experts listed by date.

Date	Person(s) Interviewed
May 4, 2015	Kyle Keegan – Fools Farm – Restoration Specialist
June 1, 2015	Bruce Hilbach-Barger (re: RVIT), Anna Birkas – Village Ecosystems
July 6, 2015	Dr. Paul Domanchuk (re: Cyanotoxins), Mickey Bailey (Cannabis farmer)
August 3, 2015	John Evans – Big Bend Lodge (ERRP Partner on Cyanotoxin Study), Joe Scriven – Mendocino RCD (re: Grants for Pollution Prevention/Restoration), Tom Leroy – Pacific Watershed Associates (re: Farm Planning)
September 7, 2015	Sunshine Johnston (re: Sustainable Cannabis Farming)
December 7, 2015	Dan Mar – Hightide Permaculture (Best Practices Free Services), Hollie Hall (Water Rights and Water Permitting)
February 1, 2016	Amy Conway – ERRP Volunteer – Temperature Monitoring
February 8, 2016	Kyle Keegan – Fools Farm (re: Feb 27 Winter Workshop), Phil Geogakakos – UC Berkeley Doctoral Student (re: Water Temperature Monitoring).
March 7, 2016	Greg Blomstrom (BBW Forestry) – Forest Health, Fire Risk & Water Yield

Website and Facebook Development (1.6.4) The ERRP website www.eelriverrecovery.org is an excellent source of information on best practices for Eel River cannabis farmers with a suite of related pages including soil building, water security, erosion control, pollution prevention, forest health, and regulatory compliance. Water temperature monitoring and Eel River algae studies also have very informative pages developed, including links to reports and reference documents in the new on-line Eel River Library (<https://eelriverlibrary.omeka.net/>). The ERRP website also contains the scientific reports, charts and photos that capture the findings of the 2015 temperature flow study and results of cyanobacteria monitoring. Google Fusion tools were used to make photos linked to make locations accessible on the ERRP website (See Task 2.3). The ERRP Facebook page was updated numerous times beginning in June 2015 with the Emandal event, through summer best practices outreach, to the fall Salmon Awareness Festival, and the final public meetings on Van Duzen River and in Laytonville in March 2016 (<https://www.facebook.com/Eel-River-Recovery-Project-523002807756231/timeline/>).

Cell Phone Application (1.6.5) When the ERRP website was completely rebuilt; it was designed to be viewed on mobile phones, I-Books and other mobile devices. This makes it easy for any mobile device user to make the ERRP website or Face Book page an icon on their screen and instant access to the ERRP Home Page. (<https://www.youtube.com/watch?v=pG9dY4xZKzc&feature=youtu.be>). This capacity is equivalent to an APP and, therefore, satisfies the requirement of Task 1.6.5.

Public Domain Publications (1.6.6) Due to resources expended on document and historic photo capture at agencies and at Humboldt State University Library, and to establishment of the Eel River Library, ERRP did not have sufficient resources to also capture 24 out of print public domain articles. In lieu, ERRP is posting an equivalent number of scientific reports and watershed management studies pertaining to the Eel River to the Eel River Library system, which augments the many documents scanned under Task 2.5.

Videos on Best Practices and Monitoring (1.6.7, 1.6.8, 1.6.11) ERRP was able to work with Access Humboldt, a non-profit organization that provides affordable video production services, airs content on Humboldt County Cable TV channels, and streams the same content on the Internet. There were several tasks that included video deliverables: four 30 minute videos were required under Task 1.6.7, 20 YouTube segments were called for in Task 1.6.8, and video content from Water Day 2015 was to be edited as part of Task 1.6.11 (Table 3). All segments were run on Access Humboldt cable channels at least 10 times in rotation and also posted to the Internet by both Access Humboldt and by ERRP using Vimeo (<http://www.eelriverrecovery.org/video.html>). Water Day videos include a presentation by UCB doctoral candidate Keith Bouma-Gregson entitled: Is It Swimmable? Cyanobacteria of the Eel River (see <https://vimeo.com/155460969>). Dr Sara Kupeferberg's illuminating presentation on yellow-legged frog monitoring is also available: <https://vimeo.com/155457650>, and more citizen monitors are being trained in Covelo (4/30/16) and at Benbow on May 1, 2016. ERRP is encouraging citizens to help test the hypothesis that yellow-legged frog egg masses per kilometer upstream and downstream of Eel River tributaries are an index of adjacent stream health.

Table 8 Best Practices and Monitoring Videos: Titles, lengths and web addresses.

Title	Length	Web Address
Transitioning from a Grower to a Farmer	32:54	https://vimeo.com/147791060
Water Conservation and Pollution Prevention – An Expert Panel Discussion	31:04	https://vimeo.com/147790268
Taking the Pulse of the Eel River	28:58	https://vimeo.com/147791430
Living Soils with Jesse Dodd	29:52	https://vimeo.com/147795035
Watershed Conscious Property Management	24:38	https://vimeo.com/147788689
Making Biochar for Fuels Reduction	24:39	https://vimeo.com/147792921
Water Conservation Tips with Larry Desmond	19:30	https://vimeo.com/147795723
Clean and Abundant Water with Anna Birkas	16:09	https://vimeo.com/149454151
Making Compost with Kyle Keegan	14:03	https://vimeo.com/147791785
Making Compost Tea with Noah Cornell	10:43	https://vimeo.com/149451904
Water Rights and Permitting with Holly Hall	10:15	https://vimeo.com/147789371
Biodynamic Composting in the Basque Country with Jesse Dodd	7:40	https://vimeo.com/147780192
Water Day 1: Yellow-Legged Frogs of the Eel River – Dr Sarah Kupferberg	16:40	https://vimeo.com/155457650
Water Day 2: Is It Swimmable? Cyanobacteria of the Eel River	24:21	https://vimeo.com/155460969

Brochures on Best Practices (1.6.9) This task calls for production of five brochures that convey key points on best practices or information about citizen assisted water quality monitoring. The first handouts developed on short notice for the NCRWQCB May 7 meeting focused on regulation of cannabis cultivation where the Waivers of Waste Discharge for cannabis farmers were unveiled, one that gives a project overview (Attachment #33) and the second that explains the best practices portion of the ERRP grant (Attachment #34). The latter was used to orient growers in attendance and resulted in the projects first appointments for technical services. The five brochures that meet the criteria of 100 or more copies being disseminated are as follows: 1) general promotion of best practices technical services (Attachment #35), 2) citizen assisted monitoring (Attachment #36), 3) watershed conscious property management (Attachment #37), 4) water security (Attachment #38), and 5) building living soils (Attachment #39).

Additional brochures produced included one done in support of the RVIT EPA (Attachment 18) explaining their programs, and a final best practices brochure on *Achieving Water Security with a Water Budget* (Attachment #47). Hundreds of brochures were printed and circulated during the project. Four hundred brochures have been printed at the close of this grant that will continue to be disseminated at grow stores, at high traffic businesses in the Eel River watershed, and in cooperation with cannabis outreach groups like CGA, SFA and the Humboldt Sun Growers Guild.

Outreach Posters (1.6.10) This task calls for the production of ten 3’ X 4’ posters for display at conferences, at schools or in public buildings. Four such posters have been created and disseminated, including use at pro-cannabis group sponsored events tabled by ERRP best practices sub-contractors. The four posters are 1) general best practices promotion (Attachment #40), 2) building living soils (Attachment #41), 3) water security (Attachment #42), and 4) creating a watershed conscious property. Other posters developed include those for the RVIT EPA (see Task 1.2.3) and for promotion of best practices meetings (Attachments #42, #44-46).

Table 9 Best Practices Poster Titles and web addresses.

Title	Print Version (ppt)	Web Version (pdf)
Building Living Soils	Download	View / Download
Water Conservation / Security	Download	View / Download
Watershed Conscious Property	Download	View / Download
Best Practices Summary	Download	View / Download

Assist Citizen Monitors, Temperature Sensors, Photopoints, & Time Lapse Cameras (Task 2.1)

ERRP has collected water temperature data since 2012 (Higgins 2013; 2014). Under this grant 50 water temperature probes, more than 100 deployed, photopoints documented with the help of volunteers. Placement of ten time lapse cameras on strategic reaches of the Eel River or in key tributary basins was also required.

Water Temperature Monitoring: ERRP purchased 50 Onset Instrument Optic Pro automated water, the NCRWQCB loaned 50 more and UCB made several dozen available in conjunction with the on-going cyanotoxin research and other research projects. Data were collected by ERRP and other parties at 175 locations in 2015 with cooperation from 50 volunteers (see ERRP Volunteers above). See Task 2.3 and Table 11 for a list of cooperators. See Task 2.4 for map tools and projects involving temperature data. Data are collected by ERRP following protocols of Lewis et al. (2000) and as often as possible at locations where baseline data were previously collected (Friedrichsen 1998, 2000, 2001, 2003).

Photo points: Grant requirements specified that photopoints be established at all ERRP temperature probe locations, with photos taken in an upstream and downstream direction. In addition to photos at the time of probe placement and retrieval, the proposal specifies that photos also be taken during a mid-season probe check. These requirements were based on a grant opening date of April 2015, but the grant did not open until May. Probe placement was as late as July at some locations and time did not allow for a mid-season check or taking associated photos. However, photopoint locations have been augmented to include sites where no probes were placed in order to provide records of channel changes over time and to document low flow conditions throughout the Eel River basin. Also, ERRP personnel visited a number of locations where probes were to be placed, only to find the stream reach dry. Photopoints were established at these sites although probes were not in use there. Observations and photo documentation of stream desiccations provided the basis for the development of the map of dry stream segments that are part of the final report and are posted to the Internet as well. Photos have been acquired for 114 locations throughout the Eel River basin and are posted to the Internet and linked in Google Earth maps ([See Map](#)).



Figure 12 South Fork Eel River tributary Redwood Creek just above the convergence with Seeley Creek. May 22, 2015.



Figure 13 Redwood Creek lacking surface flow on October 3, 2015.

Time Lapse Cameras (2.1.4, 2.2.2, 2.2.3) Ten time-lapse cameras were purchased and placed in cooperation with the assistance of volunteers at strategic locations throughout the Eel River basin (Table 4). This was a new activity for ERRP and results from time lapse camera placement were less than optimal at some locations, but very useful at others. Camera imagery illustrates drought stress at some mainstem Eel River locations as well as in tributaries where baseline conditions can be established for flow monitoring. See the location of time-lapse cameras (Figure)

Table 10 ERRP volunteers, sub-basins, and GPS locations where time lapse cameras were placed.

ERRP Volunteer	Where	SubBasin	Lat	Lon
Paul Domanchuk	VD near Swimmers	VD	39°44'32.56"	123°38'17.11"
Jeff Hedin	McCoy	SF	39.928616	-123.762493
Phil Georgakakos	Angelo	SF	39°44'32.56"	123°38'17.11"
Phil Georgakakos	Elder Creek	SF	39°43'43.24"	123°38'52.92"
Gordon Crawford	MF/Main @ Dos Rios	MF/ME	39°42'40.25"	123°20'41.49"
Bret Lovelace	North Fork	NF	39°58'49.05"	123°20'42.78"
Proud Savage	Chamise Creek	ME	40° 2'33.37"	123°33'12.62"
Larry Bruckenstein	Sprowel Creek	SF	40° 3'53.79"	123°49'31.88"
Mickey Bailey	Woodman	ME	39.775823	-123.392535
Mickey Bailey	Main Eel at Woodman	ME	39°46'34.73"	123°23'28.18"

Van Duzen River at Swimmers Delight: This time-lapse camera was placed by long time volunteers Paul Domanchuk and his wife Barbara just below Swimmers Delight County Park near Carlotta on the Van Duzen River. The camera was placed on private property on July 12, 2015 and recorded fluctuations from very low flows at the peak of summer to very high flows associated with December rains before the camera was download on December 24. A professional video recording was made of the series and subsequently posted to You Tube (<https://youtu.be/-3VSDogtH0M>). This camera remains in place and will be operated by ERRP in the future years.

McCoy Creek: This stream flows from a sub-basin that is in recovery from past logging and maintains cold water temperatures year-round. The time-lapse camera was operated in cooperation with volunteer Jeff Hedin on his property on lower McCoy Creek about a mile upstream of its convergence with the South Fork Eel River. The camera was installed on July 1 and retrieved on November 15, 2015. Imagery showed that McCoy Creek maintained flow through the Fall despite experiencing a fourth year of a severe drought. The camera was removed at the end of the Fall season because a secure winter location safe from high flows could not be identified.

South Fork Eel River Angelo Preserve: UCB doctoral candidate Phil Georgakakos placed a time-lapse camera on the Angelo Coast Range Preserve, located on the west bank of the South Fork Eel River below Elder Creek. The camera was deployed on July 16 and images downloaded on September 17, 2015. The camera is pointed sideways at the stream and at a short distance. The most noticeable difference during the low summer flows is that foam forms in areas of turbulence around the boulders in the image. During a visit to the Angelo Preserve in January 2016, this camera was inaccessible because of high flows. It will be relocated to the more accessible east bank and the new focal point will show a broader upstream view that better shows stream flux.



Figure 14 Map of time-lapse camera locations.

Elder Creek: Phil Georgakako also placed a time-lapse camera on Elder Creek, which flows from a well-studied intact watershed in the heart of the Angelo Coast Range Reserve. Images caught by this camera show that base flows in Elder Creek from July 16 to September 17 fluctuated very little. The time-lapse movie has good color and is posted at <https://vimeo.com/152286422>. Unfortunately, the Elder Creek camera was secured to a log suspended over the creek that was dislodged during high December flows and the camera was lost. Another camera was attached to the bridge over Elder Creek well above high water, providing another sequence of photos and a winter movie will soon be available.

Main Eel River and Middle Fork at Dos Rios: Volunteer Gordon Crawford placed one time-lapse camera on his property at Dos Rios where the upper main Eel River and the Middle Fork Eel River converge. When the camera was placed on July 3, 2015, both the main Eel and Middle Fork flow could be captured with a single camera. In October, ERRP supplied a second camera so that one would catch the Middle Fork looking upstream while the other could focus on the upper main Eel above the convergence. The camera in July was attached to a cable and the mount slipped, resulting in no usable footage from July through October. However, winter time-lapse photos and movies from these two cameras will soon be available.

North Fork Eel River: New ERRP volunteer Bret Lovelace deployed a time-lapse camera on his property on the North Fork Eel River above Mina Bridge, beginning in October 2015. Time-lapse photos and a movie from this location will soon be available.

Sproul Creek: This tributary of the South Fork Eel River was once an important producer of coho salmon but has been experiencing disconnected flow during the prolonged recent drought. Larry Bruckenstein volunteered to assist with time-lapse camera placement on his property lower Sproul Creek. The camera was placed on July 15 and imagery downloaded on October 22, which shows that flows became disconnected again in 2015. Some flow resumed after mid-September when tree evapotranspiration decreases, but lack of rain in October kept flows very low. The angle at which this camera is placed has direct sun exposure which makes the imagery harsh and much of it difficult to see, so it is not posted. The camera remains in place and winter lighting may be better. This location will be occupied in the future with the camera angle adjusted as needed.

Main Eel at Woodman: A second camera placed in cooperation with volunteer Mickey Bailey was on the mainstem Eel River above Woodman Creek. Placement on June 22 was too far from subject and the camera was moved on July 6 to a better location and imagery was downloaded on October 22. The camera angle changed somewhat during the period likely as a result of wind. The time lapse photos and video are informative, but of low quality and, therefore, are not posted to the Internet.



Figure 15 Volunteer Proud Savage tightens clamps holding Chamise Creek time lapse camera. 8/28/15.

Chamise Creek: This stream has an important steelhead population and joins the middle fork mainstem Eel River from the west side just downstream of Island Mountain. Volunteer Proud Savage has deployed water temperature gauges in the creek on his property since 2012 and allowed placement of the time lapse camera in 2015. The camera was placed on August 28 and imagery was downloaded on January 10, 2016. While Chamise Creek maintained surface flow at the location of the camera, flow was disconnected in a reach just upstream. The flow fluctuation shown in the composite film of the time-lapse imagery is dramatic with videos for both July-Dec 2015 <https://vimeo.com/152285876> and early 2016 <https://vimeo.com/162623242>.

Woodman Creek: This stream has a steelhead population but salmon have been blocked from entering since the construction of a dike across its mouth built by the Northwestern Pacific Railroad. The fish passage impediment is planned for removal as part of a restoration project, but Woodman Creek also suffers from flow depletion and has become disconnected in summer during the recent drought. Mickey Bailey owns the parcel at the mouth of Woodman Creek and assisted with placement of two time-lapse cameras, including one on the creek itself and one on the main Eel River not far upstream. The Woodman Creek camera was placed on June 21 and imagery was downloaded on October 22, 2015. It is apparent that the stream became disconnected in July and the pool it flowed into receded until it appeared dry. The pool refilled and slight surface flow connections occurred in early October. See the complete video at <https://vimeo.com/152294890>.

Data Organization, Quality Assurance and Quality Control, and Analysis (Task 2.2)

Although this task only required performing quality assurance and quality control (QA/QC) on ERRP collected data, 2015 raw temperature data were acquired from other entities including California State Parks and UCB. Subsequent editing was performed as needed. QA/QC involved downloading data from automated temperature loggers that have been retrieved from streams. An Onset Instrument device known as the Optic Shuttle and their HOBOWare software are used to transfer data from the probes to the computer. Once downloaded, continuous temperature probe data are edited to remove any outliers that do not reflect ambient stream temperature, such as air temperatures prior to placement and after probe removal. Another step in QA/QC is to analyze the patterns of fluctuation to detect anomalies, such as the stream being de-watered in mid-season. This can be detected by excessively high or low temperatures that reflect air and not water temperatures. Probe malfunction can also cause corrupted data. It is critical that data anomalies are recognized and removed prior to analysis. The Native Fish Society and PG&E shared 2015 data but they trimmed sets and performed QA/QC prior to sharing.

In order to perform the water temperature trend analysis that is part of this project (see Task 2.3), all available historic electronic water temperature data were also assimilated. Active outreach and collaboration efforts with agencies, universities, watershed groups, consultants, and private companies helped acquire 2766 separate Eel River water temperature data sets from different sites collected between the years of 1993 and 2015 (Table 5). This represents a total of more than 10 million stream temperature measurements, far more than has ever been available in any previous compilation. Building on the foundation of previous compilations from Humboldt County Resource Conservation District (Friedrichsen et al. 1998) and the Humboldt State University Forest Science Project (Lewis et al. 2001), ERRP has obtained and compiled significant additional datasets from entities including California State Parks and Pacific Gas & Electric Company (PG&E). To our knowledge, this is the first time that PG&E has shared its entire Potter Valley Project stream temperature data in electronic form.

The vast majority of our data were acquired at the original temporal resolution (ranged from 15 to 120 minutes), which maximizes flexibility utility for future analyses. In addition to the hourly data shown in Table 1, we acquired several datasets that are only available as daily summaries (PG&E 1980-1994, California Data Exchange Center 2007-2015, U.S. Geological Survey 1960-2005) and one (Humboldt Redwood Company 2002-2014) which is only available only as annual summaries. The condition of the datasets from prior years we received varied among data sources and years, so a fairly intensive screening and trimming process was conducted following established protocols. This was a time-consuming process due to the extremely large size dataset, but it significantly improved the quality of the data. QA/QC has been closely coordinated with the NCRWQCB and they will receive all processed data.

Table 11 Inventory of hourly water temperature data we have acquired and compiled for streams in the Eel River Basin.

Source Entity	First Year	Last Year	Number of Site-Years
Eel River Recovery Project/UC Berkeley	2012	2015	261
Friends of the Van Duzen	2007	2008	23
Humboldt County Resource Conservation District (various contributors)	1999	2003	798
Humboldt State University Forest Science Project (various contributors)	1993	1998	645
NorWeST California Department of Fish and Wildlife	2009	2010	2
NorWeST North Coast Region Water Quality Control Board	1996	2009	155
NorWeST USFS Aquatic and Riparian Effectiveness Monitoring Plan	2002	2013	6
NorWeST USFS Mendocino NF	1996	2013	100
NorWeST USFS Six Rivers NF	1996	2010	65
Pacific Gas & Electric Company	2005	2014	458
California State Parks	2003	2015	208
U.S. BLM Arcata	2012	2014	5
US Forest Service Redwood Sciences Lab	2004	2015	25
US Geological Survey	2007	2015	15
Grand Total	1993	2015	2766

Analysis of Water Temperature Trends 1980-2015 (Task 2.3)

The final deliverable under this task is *Stream Temperatures in the Eel River Basin 1980-2015, Phase 1: Compilation and Preliminary Analysis* (Asarian et al. 2016). The unexpectedly large breadth of data incorporated took more time than anticipated in quality assurance and quality control activities, which decrease the time available for statistical analysis. However, what has been produced will be of extremely high value to the NCRWCB, other agencies and Tribes, academic institutions and the curious general public. These include a comprehensive database including all water temperature from 1980-2015, electronic Appendices, GIS elements, and even Google Maps the public can explore.

All data are available in Excel and Access and are being provided to the SWRCB and NCRWQCB and are compatible with the internet data sharing website SWAMP. The report uses summary statistics to characterize water temperatures by year type, 1) hot, 2) moderate and 3) cool, which are characterized by comparison of the maximum floating weekly averages (MWAT), maximum floating weekly averages (MWMT) and absolute maximum temperatures are generated for each location. The MWAT and MWMT are recognized as being more representative of ambient conditions than daily average or maximum data (Lewis et al. 2001). In addition, we have grouped nearby and comparable sites together to maximize the number of years of data for time series analysis. At some locations, there are over 20 years of data. Data were shared by the NorWeST U.S Geological Survey, National Water Information System (<http://qwweservices.usgs.gov/>), which is studying climate change scenarios for Western North America streams and will use updated ERRP data to re-run models in the fall of 2016.

Create Electronic Maps of Project Results (Task 2.4)

This task required that our GIS analyst develop to develop several map projects and to assimilate all useful themes for understanding the health of the Eel River watershed. Data assimilated and integrated into the final mapping project for this grant include: the National Marine Fisheries Service (NMFS), the U.S. Geologic Survey (USGS), California Department of Fish and Wildlife (CDFW), USGS NWIS, PG&E and other sources. Maps made during the project enhanced the quality of reports and provide powerful summaries on the ERRP website. All data are being submitted as part of final grant performance in their native format complete with metadata. The latter is used to convey the quality of information, the purpose it was derived, and the bounds of fair use as well as contact information for all sources. Projects employ ESRI software, including ArcGIS and ArcMap.

Water Temperature: This theme represents the heart of the current ERRP project, and will graphically represent current and historic temperature of streams and reaches throughout the Eel River Watershed. Types of data include locations of historic (1980-2014) monitoring sites with associated summary statistics (i.e. MWMT) and locations of 2015 temperature monitoring sites. The temperature map used scientifically sound break points based on suitability for salmonids (Table 12). The map of 175 locations that is color coded based on this rating is available as Figure 12.

Table 12 Thresholds for water temperature suitability for steelhead rearing and associated color codes for required Arc GIS temperature theme.

Temperature Range	Steelhead Suitability	Color Code
< 16 C	Optimal	Dark Blue
16 C – 20 C	Suitable	Light Blue
20 C – 25 C	Stressful	Yellow
25 C – 28 C	Acutely Stressful	Orange
> 28 C	Lethal	Red

Eel River Tributary Dry Reaches 2015: As ERRP conducted field work related to temperature data collection and photopoint establishment, where streams were becoming disconnected or dry became apparent. Figure 13 shows maps of dry stream reaches where ERRP observed such conditions and was able to photo-document them. This map should be viewed as an extremely conservative look at the problem Eel River Basin-wide and underestimates where streams went dry, but it is useful as a start and for future trend monitoring. Extensive dry reaches are apparent in Outlet, Ten Mile, Tomki, Redwood (near Redway), and Salmon Creek near Miranda. Factors that are causing desiccation include young over-stocked forest evapotranspiration, extensive road networks that alter hydrology, changes in wetland and grassland complexes, de-watering for agricultural uses, and aggradation. The latter problem may be the dominant problem for loss of surface flow in erodible lower Eel River, Van Duzen and lower South Fork Eel River watersheds.



Figure 16 Location of water temperature probes deployed as part of the 2015 ERRP cooperative water temperature project.



Figure 17 Locations and extent of dry stream segments throughout the Eel River Watershed during the summer of 2015.

Identify, Scan and Electronically Post Eel River Reports and Photographs (Task 2.5)

In fulfillment of this task, documents were acquired from several sources by scanning the original paper versions, or in electronic form. Documents are captured as image files and then translated into optical character recognition documents that are being made available on line in a form that has key word search capability. Many of the historic documents captured would otherwise be unavailable to researchers and the interested public. The larger benefit for this project is the establishment of the ERRP Eel River Library (<https://eelriverlibrary.omeka.net/>). All documents captured are posted in the Eel River Library and thousands more documents were acquired that can be added during future projects.

Humboldt State University – The Humboldt Room at HSU was visited and Eel River documents identified and captured. A total of fifteen Masters Theses, one doctoral dissertation, and proceeds from a lecture pertaining to the Eel River and its fishes were acquired by scanning.

California Department of Fish and Wildlife – The Eureka Office of CDFW has a very large library of historic documents and photographs, many of which are not available in electronic form, and some documents may be rare. Our organization worked closely with Michelle Gilroy at CDFW Eureka to gain access to the approximately 120 documents and photographs that were scanned. Documents include stream surveys, fish inventories, snorkel surveys, descriptions of water quality conditions, watershed conditions, logging inspections, and fish passage reports. A coho document database created by CDFW (Garwood 2012) was recently discovered and permission for sharing was allowed, including 1,844 documents from the Eel River basin related to coho salmon provides documents that will be incorporated when there are more resources.

Six Rivers National Forest – ERRP personnel visited with Karen Kenfield, Forest Fisheries Biologist at the SRNF Supervisor's Office in Eureka. Karen informed us of important USFS Eel River related documents already available on line and then directed us to other documents not in electronic form. Approximately 47 documents from the USFS collection were scanned, including stream surveys, spawning surveys, field notes, reports about land use impacts, historical overviews, status of fish runs, fish distribution, and migration barriers.

CEMAR Collection- The Center for Ecosystem Management and Restoration (CEMAR) assimilated all documents of all sorts related to Eel River steelhead, which they shared with ERRP. Types of information include: reports, stream surveys, stocking records, journal articles, maps, memos correspondence, news articles, and photos. Adding the 1900 files acquired from CEMAR to the Eel River Library proved beyond the capacity of this project, but ERRP intends to assimilate them in the future.

Next Steps: The Omeka library system on which the Eel River Library is based is easily expandable and additional resources will be sought to make the collection more robust and useful to users of all types.

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Attachments

<http://www.eelriverrecovery.org/Attachments.zip>