Final Report

Fiock Dam Removal

June 2001

Great Northern Corp.
PO Box 20
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96-JITW-06, #14-48-0001-96673
96-JITW-03, #14-48-0001-96673
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Submitted to:

US Fish and Wildlife Service
1829 So. Oregon St.
Yreka, CA 96097

Abstract:

This report describes efforts paid for in part by USFWS/Klamath River Basin Fisheries Task Force grant 14-48-11333-99-J029 to make all necessary changes to an irrigation system on the Shasta River to allow the permanent removal of a flashboard dam. The Shasta River is a tributary to the Klamath River in Northern California. Summer flashboard dams and their impoundments on the Shasta River are degrading water quality, reducing salmon and steelhead survival, and presenting passage problems for salmon and steelhead. This report describes a 6+ year process of "trials and tribulations" to remove one of those dams while continuing to meet the irrigation needs of the dam owner.

Introduction:

The Fiock family has been ranching in the Shasta Valley since the 1850's. Among the many improvements they have built was a flashboard dam in the Shasta River about 4 miles east of Yreka. That dam allowed then to raise the summer level of the river approximately six feet, high enough to cause a portion of the river to flow into a ditch for irrigation use in fields near the river.

The Shasta River widens considerably upstream of the Fiock dam, summer 1993.

That dam has been identified in Calif. Department of Fish and Game reports since at least the 1950's as being a fish passage problem for salmon. More recently it and several similar impoundments were recognized as significant sources of increased temperature and lowered dissolved oxygen, both of which are identified water quality impairments in the Shasta River.

In 1991, farmers and ranchers in the Shasta Valley formed a Coordinated Resources Management and Planning committee (CRMP) focused on finding and implementing measures to increase the productivity of the Shasta River for salmon and steelhead. Among their recommendations was the goal of removing the flashboard dams found in the Shasta in order to partially address the above mentioned problems. The Fiock Dam removal project was their first opportunity to attempt to do that.

Description of Study Area:

The Shasta River located in Siskiyou County, California flows out of the Eddy moutains and Mount Shasta northward into the Klamath River approximately twenty miles south of the Oregon border

The Shasta Basin area is approximately 800 square miles with a mean annual unimpaired runoff of approximately 162,300 acre-feet. The mainstem Shasta River is approximately 60 miles long, with a permanent winter storage reservoir at river mile 40. That reservoir limits the upstream range of salmon.

Key features of the Shasta River include significant spring flow in the upper reaches, increased water development in the middle reaches, river inflows and outflows of variable quantity and temperature, and various states of riparian vegetation throughout the system.

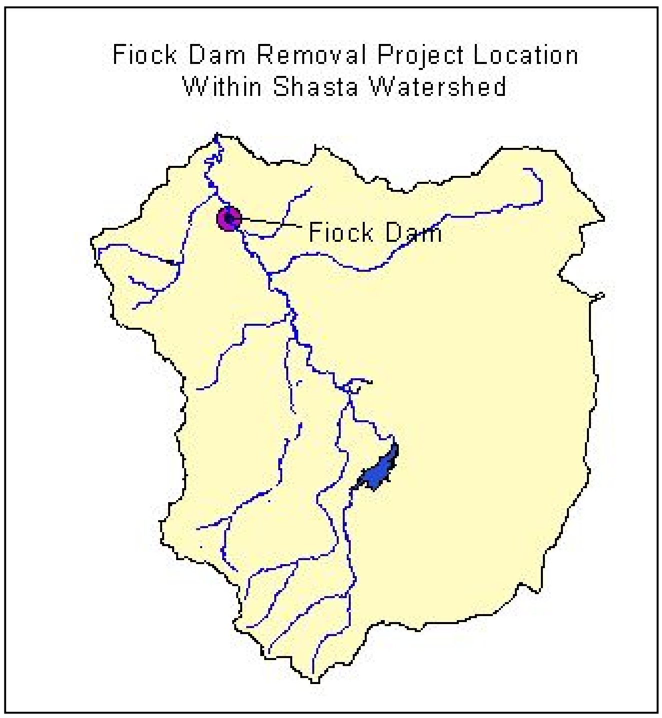
Elevated water temperature and reduced dissolved oxygen levels have placed Shasta River on the California 303 (d) list of impaired waterbodies.

Shasta River watershed in Northern California

Anadromous fish using the system include fall chinook salmon (Onchorynchus tshawytscha), coho salmon (Onchorynchus kisutch), and steelhead trout (Onchorynchus mykiss).

The climate of the Shasta Valley is extremely dry, with total precipitation ranging between 5 and 35 inches per year, depending on location. Temperatures on the valley floor range from below zero to over 100 degrees F.

Historically the Shasta River was the most productive salmon-bearing stream in the entire Klamath--Trinity Basin. Counts of Fall Chinook spawner returns begun in 1930 (after runs were described as insignificant in comparisons to their previous numbers) were as high as 81,000. The Shasta produced similar high numbers of steelhead, and unknown numbers of Spring Chinook and Coho. Spring Chinook are no longer found in the system.



Fiock dam at approximately river mile 12

Since the 1930's, Fall Chinook salmon numbers have dropped as low as 530 (in 1992), leading to concerns of extinction of the run, and precipitating the formation of the Shasta CRMP. By 1995, numbers had rebounded to as high as 13,000 demonstrating the continued resiliency of the Shasta system.

Factors limiting salmonid production of the Shasta range from over-harvest to loss of habitat. Within the Shasta Valley, substantial efforts have been underway since 1991 to improve habitat conditions for cold water fish. The removal of summer flashboard dams is one of the goals of the Shasta CRMP, part of an ongoing effort to improve water quality.

Fiock dam, summer, 1992

There were six flashboard dams in the Shasta, ranging from four to six feet tall. All except the Fiock dam are shared by several water users and/or irrigation districts, making their removal particularly difficult. As the oldest dam (built in 1889), the lowest dam in the system (RM 12), the highest dam (6 feet), the site of the worst water quality (DO well below 4 mg/l at times in bad years), the Fiock Dam was selected as the highest priority for removal. It was hoped that it would serve as a demonstration project for the future removal of other dams in the system.

Methods and Materials:

The Fiocks wished to continue ranching in the Shasta Valley, and to do that needed to continue to be reliably supplied with the water they needed for irrigation. Possible removal of their dam was contingent on successfully supplying their water needs at an affordable price via some other mechanism. In addition, as part of a fisheries restoration effort, any change in delivery systems would need to include appropriate screening to exclude fish.

Investigations were initiated by the Shasta CRMP utilizing volunteer assistance from the Bureau of Reclamation in Klamath Falls (BOR), the California Department of Fish and Game (DFG), the Natural Resources Conservation Service (NRCS), and the Fiocks. Options considered included low head/no head diversions from possible locations upstream, increasing the capacity of an existing ditch from the next diversion dam upstream, pumping from French drains, and the construction of a more fish friendly structure at the existing site. Over many months, it became apparent that most of the above possibilities could not meet the targeted goals of supplying reliable and economic irrigation water, and improving conditions for fish.

Recognizing that no quick solutions were at hand, the DFG volunteered to loan a self-cleaning screen, lift pump, installation costs, and provide first year operating costs to allow a pump to be used for lifting the water, rather than utilizing the existing dam. That system was assembled on an expedited basis, and installed for the 1994 summer irrigation season.

Meanwhile, the NRCS offered to develop a design and possible cost share for a new dam to replace the existing structure that clearly was in need of major repair. That would provide the Fiocks with a long-term irrigation diversion system that would be both reliable and cost effective in terms of water delivered, but wouldn't do much for fish or water quality.

The Fiocks said they would be happy to have their irrigation needs met by a pumped system, as long as someone else paid the substantial power costs. If those power costs could not be met, they wanted to be able to revert to a gravity diversion system, and the dam and impoundment that was implicit in doing that.

Operating on the assumption that the Lakos Plum Creek Screen loaned by DFG for this project would perform satisfactorily, the Shasta CRMP prepared a funding request early in 1994 to the Klamath River Basin Fisheries Task Force (TF) for funds sufficient to purchase a replacement Plum Creek screen, and also cover anticipated power costs for four years. That funding request was granted, and the funds made available for the 1995 summer season.

Meanwhile, the local NRCS office, due to a combination of personnel transfers and shortages, lack of local engineers, and revised agency goals was unable to dedicate sufficient time to prepare designs for a permanent concrete structure. Since constructing a permanent pump intake would need to be coordinated with the less flexible siting requirements of a permanent flashboard dam structure, little could be done except continue to operate the loaned DFG pump and screen utilizing the TF funds until the NRCS design was complete.

The DFG-supplied screen and pump performed reasonably well the first season, although it did require significant hands-on efforts by the DFG fisheries biologist assigned to the Shasta who assumed primary responsibility for its successful operation. In subsequent years, changes in the river channel and aquatic vegetation in the vicinity of the screen resulted in rapidly escalating requirements for hand cleaning of the screen to remove filamentous algae, re-starting of the pump following loss of prime due to screen clogging, and a generally unsatisfactory service record. Ultimately its unreliability resulted in visible losses in hay production for the Fiocks, a situation well noted by other ranchers throughout the Shasta Valley.

As time went by, the NRCS continued to be unable to devote the resources necessary to produce the dam designs. With the listing of Coho Salmon as a candidate endangered species, the newly arrived

NRCS District Conservationist was faced with the realization that even if the NRCS did finish the design work, construction of a structure that would impact coho survival was unlikely to successfully traverse the permitting process. In addition, with an endangered species present and the known impacts of a dam on water quality NRCS cost-share funds were no longer an option. Reluctantly, in the Fall of 1997 he informed the Fiocks that NRCS would have to withdraw from that effort.

1998 was the final full year of availability of funds from the original TF grant for a pump and screen at the Fiock Dam. Any funds not expended would have to be returned. Additional funding had been secured for ongoing power costs, but no additional funds were expected to be available for a fish screen and pump. If the existing unsatisfactory system was going to be replaced, it would apparently have to occur in 1998.

Meanwhile, the Fiocks were faced with tough choices. Their hoped for fallback system--a new dam--was not going to be. Their old dam structure had continued to deteriorate, and was clearly unsuitable for further service without a substantial investment of time and money. With the ESA, permits for the necessary repair work looked problematic, and in any case they were short handed, and could hardly afford the time it would take during their busiest season.

The Fiocks, Shasta CRMP and DFG sat down to once again look at all the options. By this point the Fiocks were certain they did not want a Plum Creek type screen.

Jim Whelan, CDFG helping the self cleaning screen get clean (again).

In anticipation of this, the CRMP and DFG had been looking for alternatives in the Sacramento River drainage where substantial funds had been made available for fish screening as part of the Cal-Fed process. It was hoped that something might have been developed in that arena that would work. This did not prove to be the case, as essentially all fish screen work seemed to be concentrated on massive diversions. In the meantime, additional discussion with the Fiocks was focused on the difficulties of successfully securing ongoing funding for power costs. Advice was sought from a local pump contractor, who suggested a multi-step approach, involving:

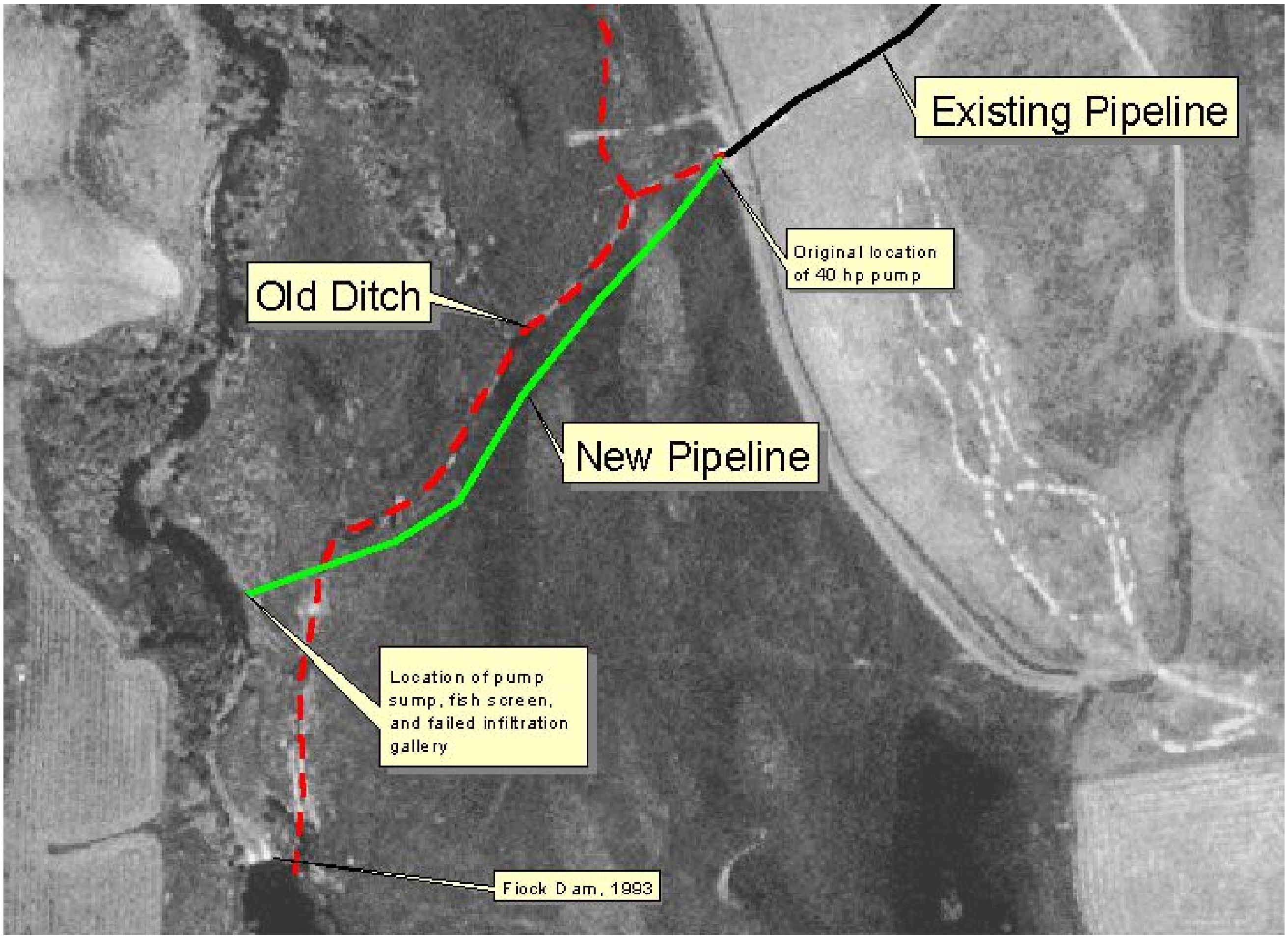
1. Create a gravel infiltration gallery from which to pump the irrigation water. The infiltration gallery would filter out the algae and fish. The gallery could be constructed by excavating an opening into the bank of the river, and then filling it with rocks beginning with large boulders, then followed with progressively smaller rocks to fill in the spaces.

2. Install a pump sump in the middle of the infiltration gallery. The pump sump could be constructed from perforated corrugated metal pipe 6 feet in diameter and 12 feet high, standing on end. It would be surrounded by the above rock-filled infiltration gallery, allowing water from the river to enter the sump from all sides, while filtering out fish and debris.

3. Re-locate a 40 hp lift pump which was part of the existing irrigation system to the pump sump at the edge of the river, where it would pump directly from the sump, rather than supplying the 40 hp pump with water from the gravity ditch which was then being filled by the DFG-supplied 10 hp pump.

4. Install 850 feet of 12 inch pipeline to connect the 40 hp lift pump from near the edge of the river to the existing pipeline it had been previously been connected to.

5. Use the DFG pump in the future only to provide low-head water for the lesser flood irrigation needs also being met by the existing gravity ditch.



Locations of irrigation improvements on Fiock Ranch

He reported successfully utilized similar infiltration galleries elsewhere, and believed that the overall electrical costs would not be substantially more than what the Fiocks were already paying. It looked like an option that would accomplish several things:

It would:

1. Allow us to create a permanent pumped system that would reliable and economically meet the Fiock's needs.

2. It would exclude fish.

3. It would permanently eliminate the impoundment and its associated fish and water quality problems.

4. It appeared we could begin with the funds available to us to build the infiltration gallery, then pump from it with the DFG pump and continue to put the water into the existing gravity ditch. We could then secure additional funding to finish up with moving the 40 hp pump and installing the 850 foot pipeline.

5. Once everything was successfully installed, the Fiocks were willing to take responsibility for future power costs.

Given the potential benefits, and lack of alternatives, we decided to proceed. It was mid-summer, 1998.

We were faced with a mad scramble to secure permits and approvals from the Corps of Engineers, Department of Fish and Game, Regional Water Quality, National Marine Fisheries Service and US Fish and Wildlife Service. Coordinating with overlapping jurisdictions and an endangered species was not an easy process. With help from all sides we were able to secure the needed permits.

We decided to proceed in steps. In the first year (late summer, 1998) we would construct the infiltration gallery, extend the electrical wiring, mount the existing DFG 10 hp pump to the pump sump, and continuing to use it to fill the gravity ditch. That would allow us to construct the infiltration system and test it at the end of 1998, and for the summer of 1999 while still retaining the rest of the original system should things not work out.

Meanwhile we would attempt to secure the additional funding needed to install the pipeline and move the 40-hp lift pump to the pump sump in the infiltration gallery at the end of the summer of 1999. Once all of that was done, and all details taken care of, any remaining funds would be used to offset electrical costs until they were expended, at which point the Fiocks would take over. If we were unable to find the needed additional funding, we still had funds for several years' power costs, which would allow us to develop other options.

As excavation work on the infiltration gallery began, things began to go wrong. In this area of he Shasta Valley, there is a silica cemented hard pan layer down about 10 feet below the surface, which cannot be dug through. It forms the bottom of the river, and the maximum depth of our infiltration gallery. On top of this hard pan is a three-foot layer of sand and gravel which at the time was entirely below the water level of the river. Above that was about six feet of sandy silt soil. The soil could be readily removed, but once excavation began in the sand and gravel layer, it would liquefy and flow as a slurry from the edges to the center of the hole. As it flowed inwards, it undermined the edges of the excavation, and causing the overlying six feet of soil to break off in large chunks and fall into the hole.

We enlarged the hole, hoping that an angle of repose could be established that would allow the banks to be stabilized, yet still allow us to remove all the sand and gravel resting on the hard pan layer. It soon became apparent that the sand and gravel slurry was so liquid that it would never stabilize until long after the hole was so big that the excavator would no longer be able to reach the center of the hole.

We stopped to consider our options. Ordinarily in material such as this sheet piling is used to cordon off the edges of the hole. Here the presence of the hard pan would have prevented sheet piling from working, and in any case it wasn't available. Our best alternative seemed to be to buy large boulders with which to line the hole with and hold back the sand-gravel slurry. That would allow us to dig out the center. Excavator time and boulder costs were rapidly consuming available funds, but we had passed the point of no return, and had to proceed.

Our first disaster

As work proceeded, we hauled in loads of rock, excavated, and lined the hole with the rocks, working our way around the perimeter.

Side-dump dump truck bringing in one of many loads of rock.

The pile of sand grew to the point that in got in the way and we decided to load it into the side-

Pile of excavated material grows as infiltration gallery is constructed dump truck that was hauling boulders to us, and stockpile it out of the floodplain about 1/8 mile away. We loaded the material into the truck with the excavator, taking a mixture of sand, gravel and water directly from the excavation.

Once full, the truck left for the stockpile area, with pinkish water and sand sloshing over its sides. Work continued until about 10 minutes later, when the son of the excavator operator (who had been riding in the dump truck to open gates) came running up yelling that the dump truck had tipped over! We all thought it was a joke, but he was insistent, so we stopped everything, and drove over to see what had happened. The sand had managed to re-consolidate and solidify on the short drive, and settled into the bottom of the truck. When the driver tried to dump it, the water all came out, but the sand was sharp enough to stick to the bed of the truck. As the load of sand sticking to the bed of the truck passed the center of gravity, rather than slide out as it should have done, it tipped the whole truck over. We went back for the excavator, and gingerly tipped the truck back onto its wheels. While the damage was minor, before it tipped over the truck had been like new. It wasn't any more. All we could do was go back to work. (sorry, no pictures). We didn't haul any more slurry that way.

Eventually we managed to install the pump sump, boulders, smaller rocks, and fine gravel. We placed geotextile fabric over the gallery, and covered it with dirt (see photo, next page). We installed the pump, hooked up the electricals and turned it on. Everything seemed ok.

Disaster #2.

Twelve hours later the water level within the sump dropped so low that the pump sucked air and lost its prime. We restarted it, and the same thing happened within a few minutes. Apparently fines from the sand and gravel layer had migrated into the infiltration gallery and plugged it sufficiently to prevent its working.

Replacing soil over infiltration gallery. Geotextile fabric in place to minimize movement of fines downwards into gravel.

At that point we had essentially no money left from the original Task Force pump grant. We had a system that was not working, and the Fiocks would need to irrigate within a few days. We were trapped. We initiated discussions with the USFWS to search for a way to access additional funds on an emergency basis. With their help we were able to convert funds that had originally been slated for use in constructing livestock exclusion fencing to instead be used to re-excavate and re-install the infiltration gallery. We hoped that we would be able to do a better job the second time, and stay well within the original foot print, minimizing the further migration of sand and gravel from the edges.

We bought more excavator time, we bought more rocks, we re-opened the hole, removed nearly all the rocks, then re-installed everything. More geotextile fabric, more dirt over the top, then start the pump again. This time things worked fine. We rented a larger gasoline powered pump to do a simulated full capacity test (equal to both the 10 hp and 40 hp pumps running simultaneously)

Drawdown test in progress, Sept., 1998

The water level dropped substantially, but we were able to keep pumping. We hoped that perhaps over time we would move fines through the gravel into the pump, then out onto the ground, slowly increasing inflow rates. That happens in wells, after all. The irrigation season of 1998 ended, and we staggered to a halt, glad to have gotten through, but without a feeling of certainty of how long the system would function.

We began working on the steps for the next year. With help from the local NMFS office, we were able to secure a $5000 Fish America grant to help to finish up the processes of removing the dam. We were able to have the Fiocks sign up with NRCS for cost share money for installing the pipeline that would be necessary for us to move their lift pump to the edge of the river. We received a second grant of funds from DFG for energy costs, duplicating the Task Force grant we already had for the same purpose. We were able to get permission to use the TF electrical costs grant for other tasks related to finishing the job on the promise that future operations costs would be transferred to the Fiocks. As funds fell into line, we went into the spring of 1999 feeling like things might work out ok.

In April of 1999 we resumed operations with the DFG pump lifting water into the old gravity ditch. Things were going well--the river was high, the pump was working, and the Fiocks had the water they needed.

Disaster #3

Then summer arrived. The river dropped several feet as snowmelt ended. Naturally, the water in the sump dropped also. Time went on, the river dropped more. The level in the sump dropped. By mid-summer the inflow rate was inadequate to keep up with pump—hottest days of the year, and no irrigation water, another disaster.

Again DFG rose to the occasion, re-assembled the original Plum Creek system, and resumed pumping directly from the river into the old gravity ditch. As before, they resumed spending countless hours babying the fish screen, trying to keep up with the Fiocks irrigation needs. Despite our best efforts, the Fiocks again were loosing critical hay production.

The Shasta CRMP and DFG again re-grouped, searching for a way out. The above grants were still in place, but were not enough. One other option remained that might help. We had a grant from the USFWS, matched by another from the NRCS dedicated to the delivery of three fish screens in the Shasta River. Those grants had become problematic too—they had originally specified purchasing three Plum Creek screens, but the experience accrued at the Fiock Ranch left everyone convinced that those screens were not a good choice. We decided to substitute a flat plate fish screen at the Fiocks for one of the ones originally planned for these grants. Since flat plate screens cost substantially more than Plum Creek Screens, we realized that we would probably have to personally donate a substantial amount of labor and materials to the effort. There seemed to be no other option.

Our plan at that point was to remove some of the infiltration gallery rock before the end of the summer of 1999, and in its place set a concrete vault designed to hold a flat plate fish screen and wiper assembly. Over the winter we would make the wiper and screen, and install it prior to the irrigation season of 2000. We would also proceed with the pipeline and pump re-location during the winter of 1999-2000.

During the last half of the summer of 1999, we designed, formed and pre-cast a concrete base for the vault. Once cured, we built forms on it to allow us to set it in place in the river, and pour its walls once it was in place. We included slots for inserting the screen frame, and a short length of 24" culvert in the back to connect it to the existing pump sump.

In late September, we went back to the river, new permits in hand, re-excavated the infiltration gallery, and installed the concrete base with attached forms. We then cut an opening in the side of the pump sump that we had installed the year before, inserted a culvert into the opening, and attached it to the stub of a culvert we had extending from the forms of the new screen vault. Next we replaced the fill material over that culvert and against the forms for the vault. Finally we poured the walls for the vault.

Once cured we loosened the form boards from the inside, and shut things down for the winter.

Concrete vault in place at end of irrigation season, 1999. Fish screen to be fabricated and installed over the winter.

In December, we began installing the pipeline. Again, conditions were difficult. We had planned to do this work in October, but securing permits delayed the process. By December, groundwater levels had risen, and we found ourselves working in a swamp, pumping continuously to dewater the 3-4 foot deep trench for the pipe. Work proceeded much more slowly than it should have. Pipe costs also jumped substantially. We continued. The pipe was installed, thrust blocks poured, and the 40 hp pump mounting hardware installed at its new site by the river. Finally, fieldwork ceased until spring.

Meanwhile, the fish screen and wiper mechanism had to be designed and fabricated. This work was done primarily on weekends by a DFG biologist and the CRMP coordinator. There was a lot to learn but by late March everything was ready to install.

The local power company was paid to install the transformers necessary for the newly moved 40 hp pump motor, which ran on 480 volts, rather than the 220 volts that had operated the 10 hp pump. New electrical hardware had to be purchased and installed for both pumps so they would both be able to be powered of the same 480-volt source. A step-down transformer was purchased to run the screen wiper motor at 120 volts. Some parts could not be upgraded from 220 volts to 480 volts and had to be replaced, again resulting in unanticipated costs.

Finally everything remaining was taken to the site, and installed. Misc. problems were resolved, and the pumps started. The irrigation season arrived again.

Everything is now working as intended, and we are through the summer irrigation season with no apparent problems. The job appears to be done. It’s a good thing that it is.

Mike Farmer and Ron Dotson (CDFG) inspect Fiock fish screen prior to installing covers and final backfilling.

Results and discussion of accomplishments:

Dams and impoundments substantially change the nature of any river. Yet at the same time, they have important functions. In the case of the Fiock Dam, it had been a critical element in supplying irrigation water, which in turn allowed the production of hay and late summer pasture. Without that production, much of ranch's feed base would have been lost, and the cattle would have had little to eat between late August and early March. To successfully remove the dam and its impoundment we had to provide an alternate method to meet the Fiock's ongoing need for irrigation water, without substantially increasing their costs of production.

Over the course of nearly seven years, we were first able to supply water on a temporary basis with a stand-alone 10 hp lift pump and fish screen. This met the Fiock's water needs (more or less), but added $300/month in electrical costs. We met those costs with grant funding, but granting agencies made it clear that was not going to go on forever. Eventually, by re-locating an existing pump nearer to the river, we were able to eliminate most of the costs and losses resulting from pumping the water twice, making it feasible to transfer the ongoing electrical costs to the Fiocks. Designing and building a fish screen suitable for the site was the other critical step.

With the dam removed, the river no longer reaches widths of 125 feet. Over time it will re-accumulate sediment and re-grow emergent plants, narrowing the river back to the 25-35 feet wide that it is above and below the site of the former impoundment. Transit time for the river will be increased, temperature gains reduced, and levels of dissolved oxygen increased.

Summary and Conclusions:

By now it should be clear that this was a long, hard pull. The whole process could have collapsed at any point if all of the participants had not been committed to somehow reaching a successful outcome.

Had the Fiocks not been extremely patient, not been able to absorb the costs of several years of reduced production, and not been willing to live with the uncertainty of whether or not they would even be able to irrigate with us messing with things, they would have had to withdraw from the process.

Had DFG not stepped forward more times than anyone can now remember, we would have had to quit long before we reached the end.

Had Fish America, NMFS, USFWS, DFG and NRCS been unable to be flexible and stay focused on the final goal, the money would not have been available when and how it was needed to deal with the problems as they arose.

We originally focused on removing this dam in part because it looked like the easiest one to tackle. Five others remain. The task ahead looks daunting, but we have learned a lot.

Summary of Expenditures

See attached.