Summary of Expenditures, JITW Fish Screens

Salary:	$1,833
Travel	180
Materials	5,285
Operating Expenses	4,380
General Administration	1,332
Additional monies	4,967
Total	$17,977

Cost Share and Matching Funds:

Freeman Ranch: DFG match screen design, fabrication and installation--$10,000; Landowner power costs, 10 years est.--$300.

Jim Whelan/DFG Meamber Ranch Prototype Screen materials from DFG--$500; labor $2000.

UC Davis, American Rivers Hatchery and Iron Gate Hatchery site use--$8500

Mike Deas initial study design and implementation--$1600

Kerry Mauro flow in manifold calculations and evaluation of alternatives $800.

Dave Webb, travel, testing, fabrication, literature search, etc.--$2000

Don Meamber, assistance at river site and IGH--$800.

Rick Wontock, NMFS assistance in design and testing—$2000

NRCS cost share at Lemos Fish Screen--$2700

DFG Screen Shop equipment and site use $2000

Total match above: $33,200

Other match—see Fiock Dam Removal Report for cost sharing .

Final Report

Shasta River Fish Screens on Three Ranches

Submitted by:
Great Northern Corp.
PO Box 20
Weed, Ca 96094

June, 2001

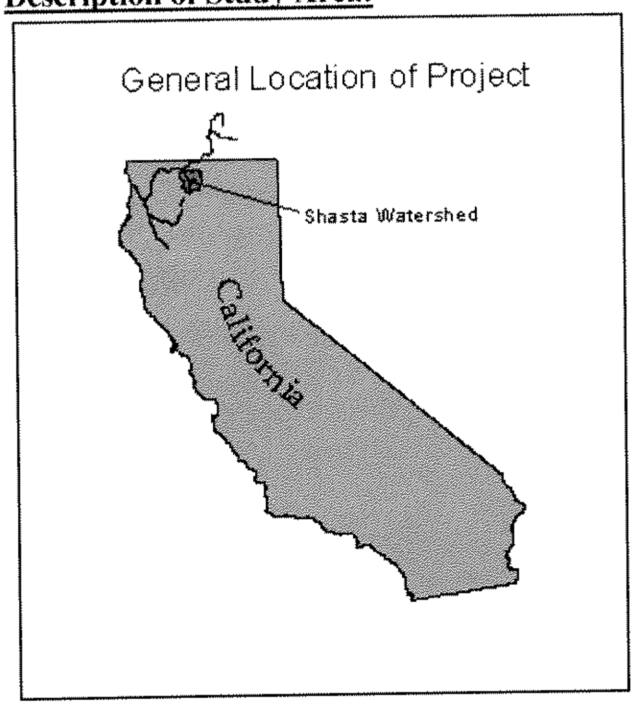
Cooperative Agreement #14-48-0001-96673
Project Number #96-JITW-03

Abstract: Grant funds from the Jobs in the Woods program, distributed by the Ecosystem Restoration Office in Klamath Falls and administered by the USFWS office in Yreka were used to provide one tube screen and two flat plate fish screens on three ranches along the mainstem Shasta River. Later additional funds were added to provide a fourth screen. With those additional funds a flat plate screen was partially funded on a fourth ranch, to be completed by in-kind matching labor provided by the California Department of Fish and Game, Yreka Screen shop

Introduction:

In 1996 the Jobs in the Woods program granted funds to buy and install three Plum Creek style screens from Lakos Corp. at three sites in the Shasta Valley. Costs, materials and designs were anticipated to be similar at each of the three sites, simplifying the overall process. As time went on, all of these assumptions proved to be false, and entirely new directions had to be pioneered.

Description of Study Area:



The Shasta Valley is located in Northern California, and is part of the larger Klamath Basin.

Because of its geology, vegetation and climate, the Shasta Watershed should be thought of as part of the Great Basin, with conditions similar to those typical of Eastern Washington, Eastern Oregon, Northern Nevada, and those parts of California east of the Sierras. It totals just under 800 square miles, and is part of the larger Klamath Basin.

It is an area of frequent winds, high evaporation rates, limited rainfall and sunny days. Because of its elevation (2300-3500 feet or higher) the growing seasons are short, limiting the crops which can be grown. Distance to markets and lack of infrastructure further limit agricultural activities that can be profitably pursued.

Much of the perimeter Shasta Watershed is steep, dry, and frequently volcanic ground. Because the terrain is so dry and rugged, it has been relatively little impacted by human activities over the last 150 years.

The flat, central portions of the Shasta Valley present a very different picture. Here despite the fact that it contains areas of as little as 5 inches of precipitation per year, agricultural activities predominate. Most ground is dedicated to cow-calf beef production including dryland grain and grazing, irrigated and sub-irrigated pastures, and grass and to a lesser extent alfalfa hay. Additionally, there are limited areas of small orchards, truck gardens, strawberry bedding plants, potatoes, garlic and lavender.

Wherever possible, irrigation is used, either from surface water from the Shasta River or its tributaries, or from ground water. Irrigation with surface water is generally accomplished via wild or controlled flooding. Irrigation using ground water is almost invariably done with sprinklers.

Other land use activities include limited timber harvest, and a history of gold mining, now largely abandoned.

Urbanization is limited. Incorporated areas include Yreka (pop. 7100), Montague (pop. 1300), and Weed (pop. 3000), along with smaller unincorporated urban and sub-urban areas. Total population in the Shasta watershed is approximately 16,500.

Socially, high levels of unemployment (generally 10-20%), loss of timber related jobs, and ongoing marginal profitability in the agricultural sector all are worrisome, and contribute to community distress. Conversely, low crime rates, good climate, minimal traffic congestion, abundant public land for recreation and good major transportation routes make the area attractive.

Road travel into and out of the area is accomplished primarily on Interstate 5 which runs north-south through the center of the Shasta Valley, and to a lesser extent by Highways 3, 89, 96 and 97.

The Shasta River has been identified by a variety of studies or documents as having a very high priority for watershed improvement work. These include:

1. California Unified Watershed Assessment: Category I (Impaired) Priority Watershed, needing to improve water temperatures and levels of dissolved oxygen.
2. California Regional Water Quality Control Board (North Coast District): Identified as impaired for beneficial uses in the areas of Temperature and Dissolved Oxygen.
3. Viewed as critically important to salmon restoration in the *Long-Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program* Klamath River Basin Fisheries Task Force, January 1991. Finds improvements needed in land uses including irrigation, livestock, and timber harvest in order to improve water quality.
4. Lower portions of Shasta identified as "Area of Critical Environmental Concern" in *Redding Resources Management Plan*, US Department of the Interior, Bureau of Land Management, Redding Resource Area, California, June 1993. Calls for management for benefit of anadromous fish.
5. Described by the Pacific Fishery Management Council as: "The Shasta River is the most important chinook salmon spawning stream in the upper Klamath

River." Annual *Review of Ocean Salmon Fisheries*, all years, 1978 to present. Pacific Fisheries Management Council, Portland Oregon. 1978-2000.

6. The *Shasta Watershed Restoration Plan*, Shasta CRMP 1997 identifies high water temperatures, low dissolved oxygen, excessive fine sediment, low water levels, reduced spawning and rearing habitat, lack of fish screens and a need to address ground water usage before it becomes critical. For upland areas recommends implementation of RMAC process. Overall describes need to develop improvement measures for above problems consistent with ongoing economic survival of private landowners.

A variety of other reports exist describing specific conditions in the Shasta Valley. Collectively all investigations into resource needs of the Shasta Valley tend to call for: 1. Improvements in all phases of irrigation to reduce water withdrawals and subsequent tailwater return, and minimize other irrigation related impacts on fish, 2. Erosion reduction to minimize fine sediment impacts on spawning gravel, 3. Measures to reduce livestock impacts on riparian zones of streams.

Methods and Materials:

Originally 3 screens were planned at the Meamber, Lemos and Peters Ranches. Each was intended to be a Lakos brand Plum Creek screen. During this same time period, we were operating a Plum Creek Screen at the Fiock Ranch in partnership with the DFG fisheries biologist (Jim Whelan, Yreka DFG) as part of an ongoing effort to substitute a pumped diversion for the irrigation impoundment that had been in place there since 1889.

Back-up self-cleaning mechanism at work. This was required all too often.

All the above ranch owners were watching the effectiveness of the Plum Creek screen at the Fiock Ranch, and over a period of 5 years its performance proved to be increasingly unsatisfactory. That field experience convinced Lemos and Peters that they did not want to be obligated to use and maintain that style of screen. The Meambers meanwhile, became reluctant early in the process to take on the added costs and complexity of the backwash system, and expressed a desire to use a non-self cleaning screen if possible.

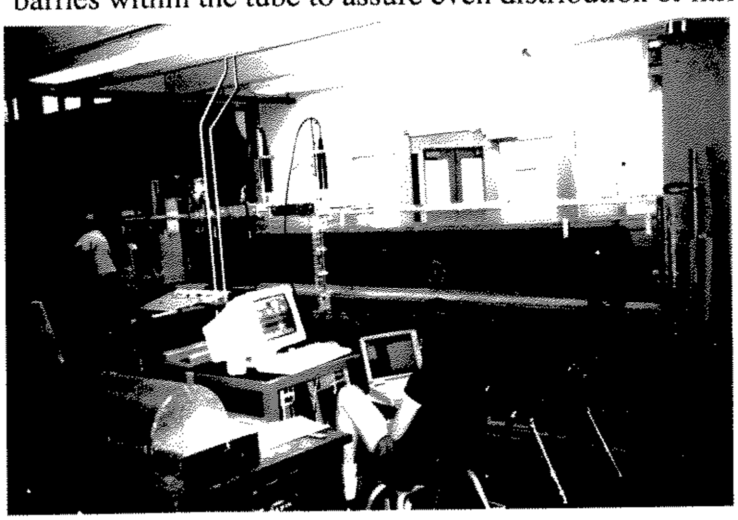
The experience at the Fiock Ranch, coupled with changes in desire at the Meamber Ranch led to new alternatives being developed for each of the screens eventually installed. In order to complete the project, individual screens were developed to meet the needs of the Meamber and Lemos Ranches. The Peters ranch was dropped from the project, and a new screen at the Fiock Ranch was substituted. Funds were also utilized to fabricate a temporary passive screen on the Freeman Ranch. A partnership was then forged with the DFG to have this grant provide materials, with DFG providing labor, to fabricate a permanent self-cleaning screen on the Freeman Ranch, allowing the temporary screen to be salvaged for future use elsewhere.

Details on each of these projects will follow:

Meamber Ranch

The Meamber diversion (see map, attachment 1) appeared to be the easiest to screen, so this was where custom screen design process was begun. Jim Whelan and Dave Webb decided to try a prototype non-self-cleaning tube screen at this site. To save costs and allow experimentation, we initially utilized salvaged screen materials from the DFG scrap yard to build a test model from. Of particular concern was the ability of the screen to function in a river known for large volumes of filamentous algae which tended to stick to screen surfaces.

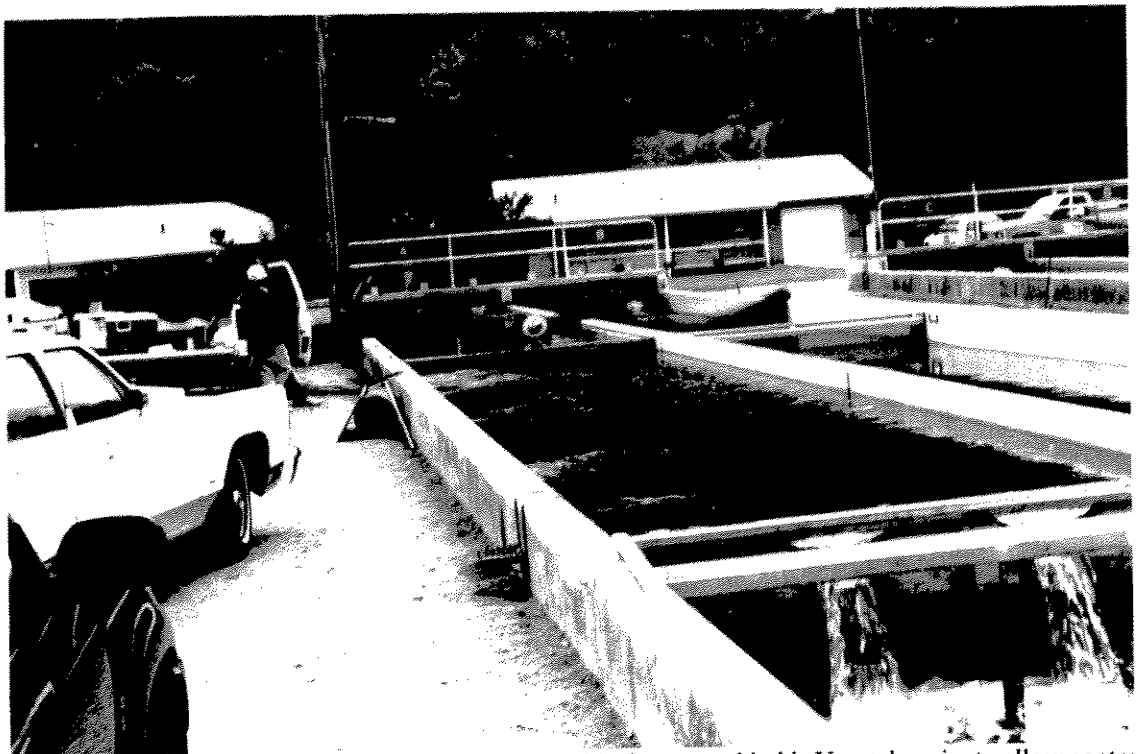
We bought and installed a 15"culvert to lead from the river into the existing pump sump, then fabricated a 15.4" by 10 foot long tube screen using 5/32 inch hole size[1], mild steel, perforated plate which we inserted into the culvert. We then began experimenting with baffles within the tube to assure even distribution of inflow.



Initial testing of Meamber Screen at U.C. Davis Hydraulics Lab.

Over what proved to be a three year testing period we removed and transported the screen for testing of its various baffle designs to UC Davis the Hydraulics lab, to American Rivers hatchery for further testing by DFG utilizing a hatchery raceway, and finally to Iron Gate Hatchery for testing with NMFS personnel to assure that its final version would fully conformed to

[1] At the time this work was being started, steelhead were not being considered for ESA listing, and 5/32" was the standard opening on fish screens in anadromous fish-bearing waters.



Final testing at Irongate Hatchery. Plywood bulkhead in foreground holds V-notch weirs to allow control and measurement of flow. Bulkhead in background blocks flows except those going through screen.

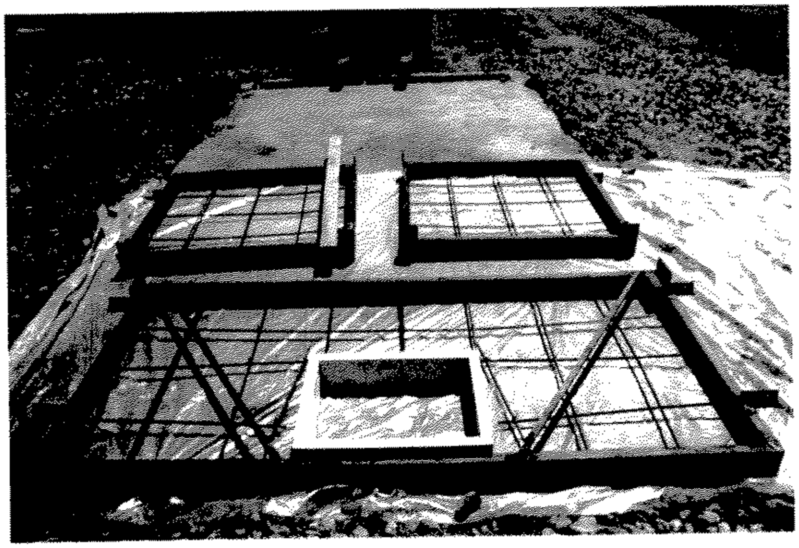
now-current DFG and NMFS criteria. We also performed a protracted search to seek mathematical description of our empirical findings to allow eventual extrapolation to future tube screen designs for varying volumes of water diverted.

The Meamber Ranch used this screen for all of its irrigation for 3 years with consistently good results. At the end of that period we had sufficient confidence to fabricate a final version with the exterior screen made from 18 gauge 304 stainless steel with 3/32" openings and 41% open area, and the baffle made from 24 Ga. 304 stainless steel formed into a tube that fit within the screen.

Meamber tube screen in place in Shasta River. Large quantities of filamentous algae cling to rocks and wrap upstream screen support, but are washed clear of screen itself. Don Meamber reports cleaning the screen manually every month or two.

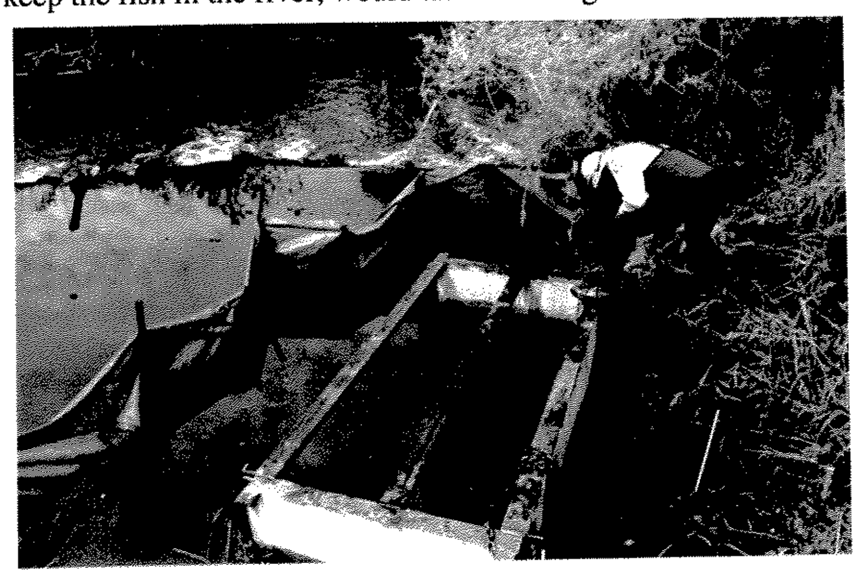
The Lemos Ranch

Once the Lemos's had rejected the rotary drum self-cleaning design, we were left with no off-the-shelf screens to choose from. We needed to develop a design that could be made from the funds available, and also perform satisfactorily under difficult conditions for their 3 cfs diversion. Any design would also have to instill sufficient confidence to assure acceptance by the Lemos family before money was spent. Working with the Lemos's, we collectively arrived at a design consisting of a concrete box body that could e-fabricated off-site, then brought in and inset into the bank of the river.



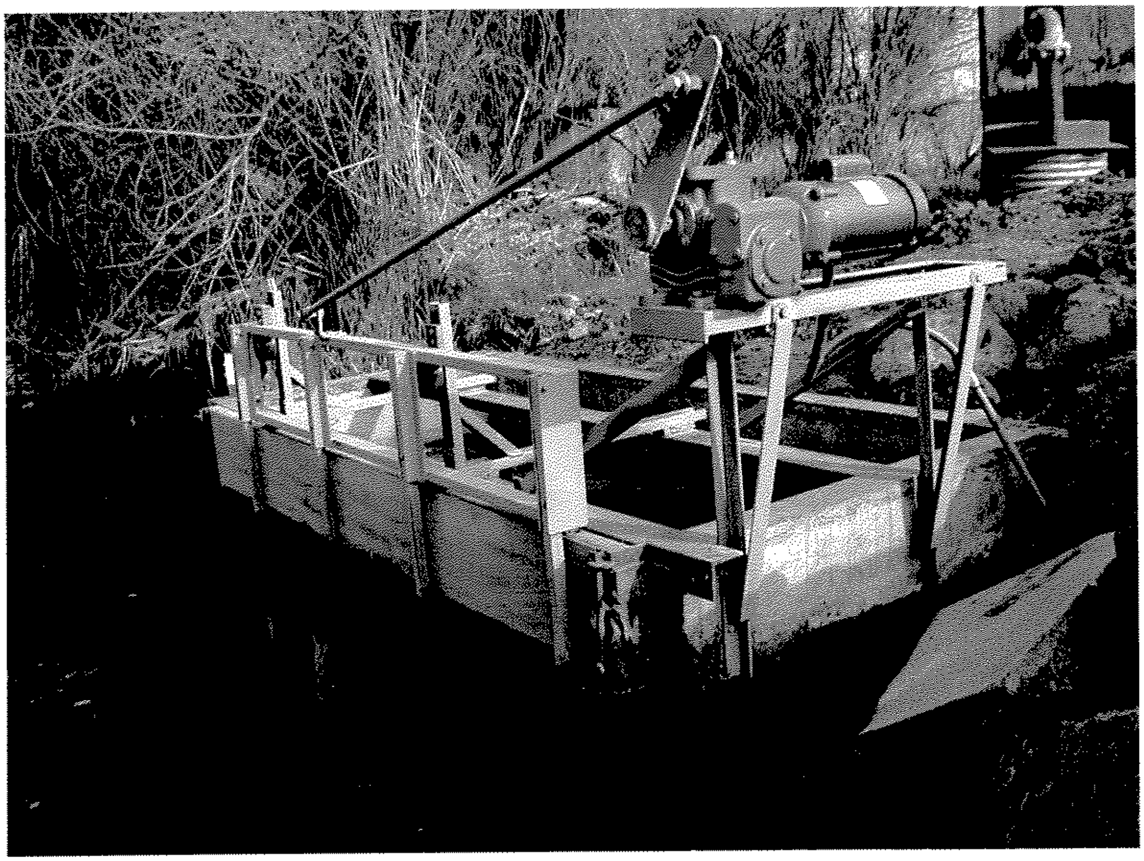
Steel forms for walls of Lemos screen bay await pouring of concrete. Once cured they were stood up and their corners welded together forming the three walls of the screen bay. Floor for the screen bay was poured separately, then all were transported to screen site for installation.

That concrete box would hold a conventional flat plate screen and wiper assembly, and could be connected to their existing pump sump with a short culvert. That design would keep the fish in the river, would take advantage of the natural sweeping forces of the river flowing past to remove debris, and could be fabricated and installed during the low water period of the summer irrigation season without necessitating a prolonged shutdown of irrigation. Costs were uncertain, but appeared to be close to affordable with available funds.



Jim Whelan removes lifting chains from screen bay walls after being set into place. Tarp prevents interchange of muddy water in construction area with water in river.

We proceeded with this approach, fabricated and installed the concrete box body in the fall of 1999, then fabricated the screen and wiper mechanism during the winter of 1999-2000. The system was installed and working for the irrigation season of 2000, and continues to serve in that capacity for 2001.



Lemos fish screen, operational in spring of 2000, but still needing its steel top to be installed

As built, the concrete box is nominally four feet wide, four feet tall, and eight feet long. The stainless steel 3/32" 41% open area screen is attached to steel tubing frame which slides into a slot in the face of the concrete box. The wiper mechanism and drive motor are attached to the exterior of the concrete box. During winter the screen and wiper assembly is removed, and a steel plate is substituted for the screen to exclude debris.

<u>Peters Ranch</u>

Because of site difficulties and insufficient funds, this site was deleted from the screening project, and the Fiock Dam removal site substituted. Funding will be sought in the future to screen this site.

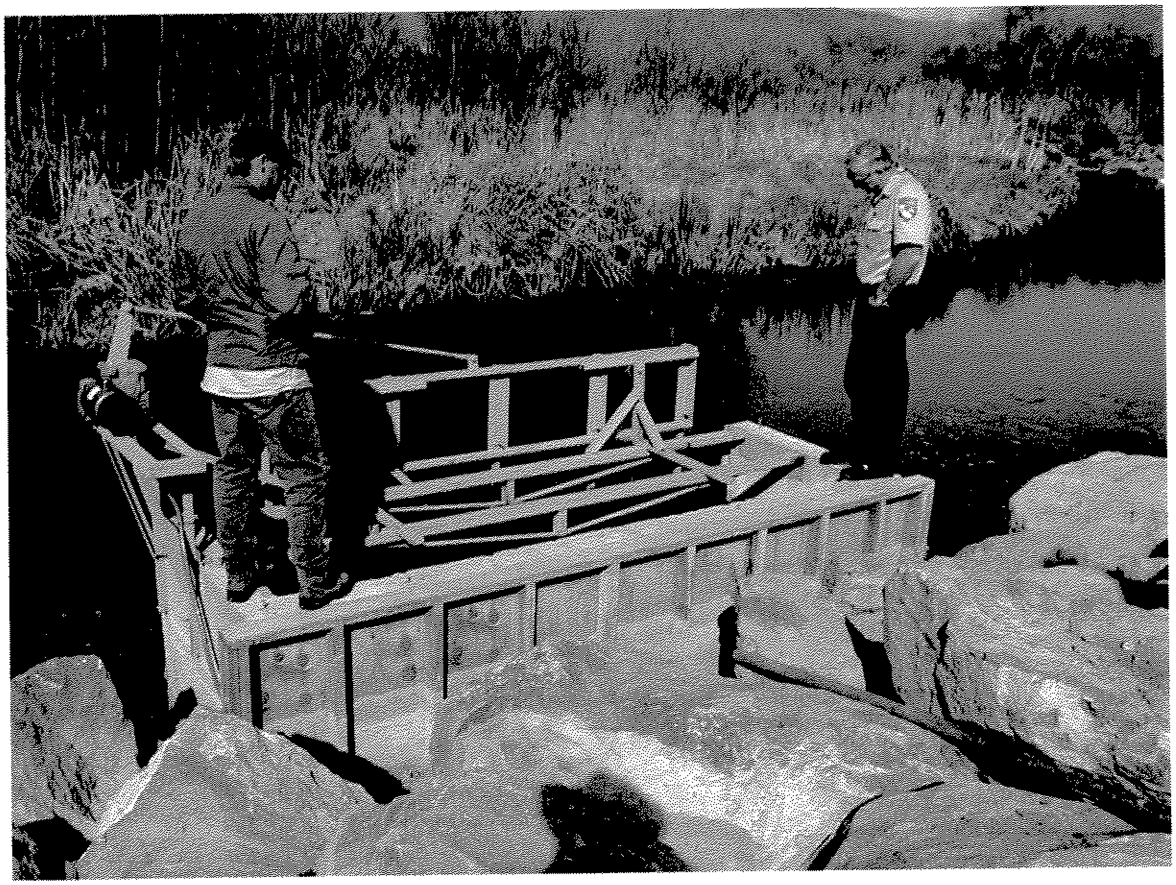
Fiock Ranch:

The above-mentioned experiences with the Plum Creek Screen convinced the Fiocks that they did not want to have to rely on that type of screen either. At the same time, we were faced with the overriding need to successfully complete the work in progress to eliminate the flashboard dam on the Fiock Ranch. Based on our efforts at the Lemos Ranch, we decided to take a similar approach with the Fiock Ranch for their 3-cfs diversion.

In the case of the Fiocks, site considerations resulted in a design for a concrete box that was ten feet long, four feet wide, and eight feet deep. The weight of the walls would have been too great to lift readily, so we chose to pour a concrete base, build the wall forms and attach then to the base, then move that assembled unit to the site, set it in place, and then pour the concrete walls.

Fiock screen bay, with poured-in place-walls visible, awaiting screen and wipers. Remains of old Fiock dam visible in background.

That process went relatively smoothly, and was able to be completed between irrigations during the fall of 1999. Again the wiper mechanism was fabricated over the winter, and installed in time for the 2000 irrigation season. Performance since then has been without problems. Other than size differences, design and materials are as described for the Lemos screen.



Mike Farmer and Ron Dotson of Calif. DFG inspect Fiock screen prior to completion. Backfilling and installation of steel cover remain to be done.

Freeman Ranch:

With the listing of coho, the Freeman family contacted us wishing to take whatever steps were necessary to comply with the ESA for both their 2-cfs diversion and their 1-cfs diversion. In order to help them do this and still be able to irrigate during 2000, we decided to fabricate a temporary non-self cleaning flat plate screen that would fit in their existing pump bay, and seek opportunities for a more permanent solution later. To this end, we attached 3/32" perforated stainless steel plate to wooden frames made to match the contours of their pump bay. One of the Freeman family periodically cleans the screen as conditions require. We subsequently made arrangements with the Yreka Screen shop of the DFG to have them fabricate a self-cleaning screen for this site using materials we would provide, and with long-term maintenance to be the responsibility of the Freeman Ranch.

In addition, we modified the old Plum Creek screen for their use on a second diversion, hoping that conditions at their site might be within its functional abilities to self-clean. While it allowed them to meet the legal requirements of the ESA, it did not prove to be sufficiently reliable for their continued use either, and a modified tube screen is now planned for them

Plum Creek screen awaiting transport to Freeman Ranch. It didn't work out there either.

Results and discussion of accomplishments:

Originally three Plum Creek self cleaning fish screens were planned to be purchased and installed for three irrigation diversions from the Shasta River, something that would have been a relatively simple process. Fortunately, experiences gained from the use of one of those screens made it clear that they would not be able to perform satisfactorily, and that some other alternative would have to be found. In the end custom designed and locally fabricated screens were provided at all of the sites screened. Three of these were substantially more expensive than the off the shelf screens originally planned, and the fourth (the tube screen) was nearly the same cost. The difference was made up by the donation of labor by a DFG fisheries biologist and the CRMP coordinator who felt it was important for these projects to be successfully completed. Additional donation of labor by the DFG screen shop provided the final assistance needed to successfully meet the terms of this contract.

While a tube screen is not a new concept, no information seemed to be available describing what if anything needed to be done to assume relatively uniform inflow. We worked with Dr. Mike Deas of UC Davis, Rick Wontock of the NMFS, and George Heise of the DFG to design, test, refine and retest baffles using the original temporary Meamber tube screen as a prototype. Once DFG and NMFS criteria were attained we proceeded to fabricate a final stainless steel version. Simultaneous field-testing assured us that the tube screen design could and would work under conditions present at the Meamber site.

At the Fiock and Lemos sites, a search of existing designs utilized by the Calif. DFG and the Oregon DFW turned up nothing that would readily serve conditions on those two sites. Ultimately in order to be able to hold costs down, work during the summer when the water was low, and allow irrigation to continue without interruption, we developed prefabricated design approaches that allowed us to proceed despite these constraints. Another advantage of the designs settled on was that they never diverted fish from the river, nor did they rely on bypass pipes or relatively small bypass flows to remove fish or debris as is the case with most flat plate screens.

On the Freeman Ranch, a conventional flat plate screen in a diversion ditch similar to over 50 already constructed by the Yreka DFG screen shop seemed to be the best design. Fortunately they were able to provide the largest part of the cost by donating the time required for design and construction, as long as we were able to provide materials. Construction is planned for the fall of 2001. All materials are purchased and ready.

Summary and Conclusions:

Fish screening in a small river like the Shasta apparently can never be done on a cookie cutter basis. Where standard designs cannot be used, each screen must be designed and priced individually, with a corresponding risk factor of cost over-runs, design inadequacies, and other problems. There seems to be no way around this. The approaches pioneered under this grant at the Lemos and Fiock ranches will serve to provide prototypes for use elsewhere in the Shasta River, and are being investigated by the engineer for the NRCS for use in the Scott River and elsewhere. The tube screen design has already being suggested for use in the Sacramento watershed by NMFS based on the baffle information we developed, and we are planning to utilize a tube screen design in the Little Shasta River later this year, confident that it can perform well under a variety of conditions.

Successfully meeting the commitments of this grant—to provide fish screens at ultimately four diversions would not have been possible without the considerable donation of time and thought by Jim Whelan of the DFG throughout the entire multi-year process, the use of the Yreka Screen shop facility on weekends for fabrication of the Meamber, Lemos and Fiock screens, and the offer of fabrication and installation labor by the Yreka Screen shop for one of the Freeman Ranch screens.

JITW-96 Fish Screen Sites in
Shasta River Watershed