HISTORIC CHINOOK and COHO SALMON COUNTS FOR VAN ARSDALE FISHERIES STATION and RESERVOIR and RECOMMENDATIONS FOR REMOVAL OF SCOTT and/or IRON GATE DAMS

Daniel Brenner
GIS Consultant
Fall 2011

Executive Summary

By Patrick Higgins, Fisheries Biologist

SOURCE: Final Eel River Fall Chinook Monitoring 2010 Report
March, 2011

The 2010 fall Chinook monitoring project sponsored by Friends of Eel River was set up to document impediments to migration during low fall flows from the Potter Valley Project (PVP) that had been common in recent years. Only a small run was anticipated. Instead there were very high fall flows and one of the largest fall Chinook salmon runssince 1985-87 or possibly 1955-58. Prior to the salmon disbursing, a dive count on the lower Eel River was organized and over 400 fall Chinook were counted. Before the onset of rains on October 23, more than 2,000 fall Chinook salmon were estimated to be holding from just above the Van Duzen River to Fernbridge.

It is impossible to accurately estimate the escapement for the Eel River for 2010, but field observations, Van Arsdale Fish Station (VAFS) counts and professional judgment are used to bracket the size of the run, which was likely between 10,000 and 30,000 adults basin-wide. The California Department of Fish and Game (CDFG) survey of tributary spawning that is conducted annually can help further define the magnitude of this years run, but results were not available at the time of publication of this report.

The Chinook salmon rebound may have been going on for the last two or three years, with record counts at VAFS this year resulting from higher natural flows. The major reasons for the population rebound include 1) mainstem Eel River spawning habitat recovery, 2) high spring flows for recent brood years, 3) good ocean conditions, 4) reduced fishing pressure, and 5) a cycle of reduced pikeminnow abundance.

Favorable spring flows and mostly good ocean productivity are part of the Pacific decadal oscillation cycle (PDO), which has been favorable since 1995 and is likely to switch to dry on-land conditions and poor ocean conditions sometime between 2015- 2020 (Collison et al. 2003). Some restoration efforts like those in the upper South Fork Eel in Hollow Tree Creek may be assisting with salmon recovery, but mostly the rebound is resulting from natural forces.

The Chinook salmon is not necessarily the best indicator of Eel River ecological conditions because they only require a brief period of freshwater residence. In fact the Eel River is showing signs of extremely perturbed watershed hydrology and its water quality has so deteriorated that the South Fork, Van Duzen and lower Eel River are plagued with toxic algae. Habitat conditions in the lower Eel River are extremely poor and suitable deep water pools for Chinook salmon are limited. Algae blooms within these pools are a sign of acute nutrient pollution and pose a threat to fish health. Speedy action is needed to increase the pool holding capacity of the lower Eel River and some steps like deflection of flow into holding pools should be considered on an emergency basis. If the number of fish holding in the lower Eel were to double and the fall rains failed to materialize, a major fish kill is possible similar to the Klamath (CDFG 2003). Chinook salmon gene resources for the Van Duzen River are still present, despite the river losing surface flow for most of late summer and fall in most years since 1997. Aggressive restoration action is needed there, using bioengineering, to bring the river back onto the surface and to create a refugia from Yager Creek to the mouth of the Eel River befitting these magnificent fish.

While mainstem Eel River spawning habitat appears to be recovering from past sediment impacts, and is driving the current population increase, tributaries are drying up and their productivity decreasing (Higgins 2010). A basin-wide effort is needed to implement water conservation and to reduce nutrient pollution, if the Eel River is to be recovered.

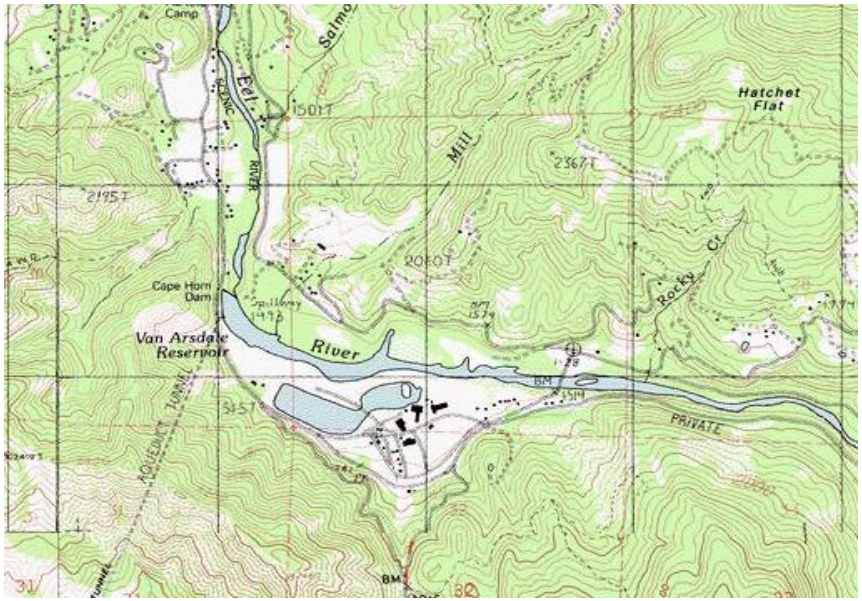
Potter Valley Project (PVP) spring flows have increased since the implementation of the National Marine Fisheries (NMFS 2000) Biological Opinion (B.O.). Summer flows have improved in some years like 2006 when 40 cfs was released, but baseflows in 2009 were only 10 cfs. PVP fall releases have remained very low, however, and there are strong indications that adult migration and spawning has been delayed. For example, the high flows in 2010 allowed free migration to VAFS and the peak of the run was in the second week of November, while the 2009 run struggled in low flow conditions and peaked a month later in mid-December at VAFS. The worst case fall flow scenario caused a fish kill in the lower Eel River below Fernbridge on November 2, 2002 that is documented herein, when the mainstem Eel at

Scotia was flowing just 87 cfs and releases at Cape Horn Dam and the PVP were just 28 cfs. It is recommended that “block water” reserved for salmon protection should be increased to 7,500 acre feet (AF) from its current 2,500 AF under the NMFS B.O. so that 100 cfs could be released from the PVP for up to 30 days when needed to prevent future fish kills. This increase would still only represent less than 5% of the water currently exported.

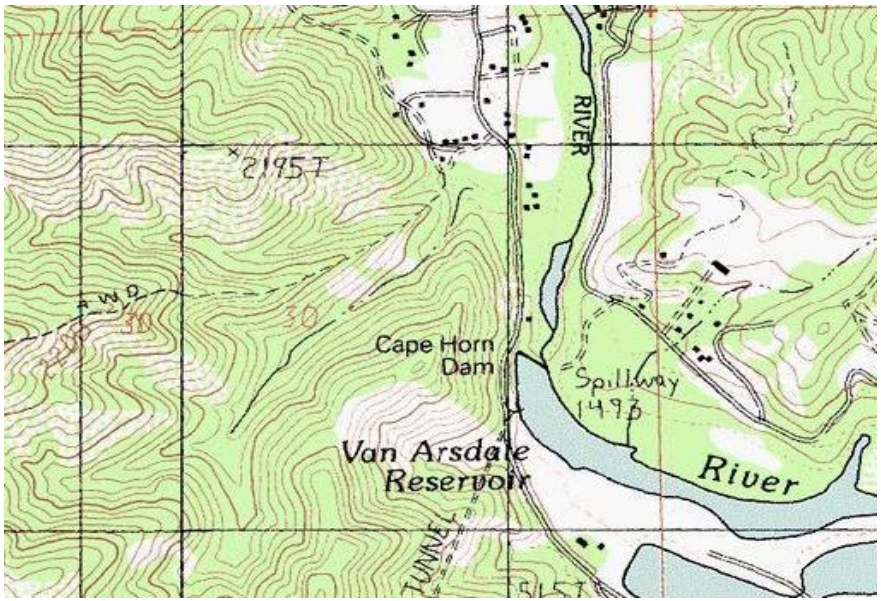
The Sacramento pikeminnow population exploded during drought cycles after its introduction in 1980, but the population of adults that predate on salmonids is currently in a down cycle in response to several factors. Pillsbury Reservoir is a pikeminnow factory of sorts and the upper river will remain dominated by them for as long as that PVP impoundment remains. There are ample opportunities for pikeminnow control downstream of Cape Horn Reservoir and several actions are recommended below.

Ultimately, Scott Dam needs to be removed and Chinook salmon and steelhead allowed to re-inhabit the hundreds of miles of headwater streams above the PVP. Gravelly Valley underneath Pillsbury reservoir was one of the most productive salmonid habitats in the basin (Williams et al. 2008) and could be a refugia, if restored. Although the fall Chinook salmon return to VAFS was a record dating back to 1946, the likelihood of spawning success of these fish is low because spawning habitat between Scott Dam and Cape Horn Dam is extremely degraded. Similar steps to the Trinity River Restoration Program (McBain and Trush 1997) are needed to augment spawning gravels and to alter confining riparian vegetation. The 9 MW of power generated by the PVP is miniscule compared to the benefits of restoring the Eel River salmon and steelhead. A phased decommissioning should be planned with the removal of Scott Dam no later than 2020. Users of Eel River water in Mendocino, Sonoma and Marin counties need to start paying for it, which could fund needed restoration measures. Prompt action to restore the Eel River has the potential to rebuild the fall Chinook salmon population to 100,000 fish annually, and State and federal government agencies need to do more to actively manage Eel River fisheries resources and to restore the river’s ecosystem function. The Native American tribes of the basin have a strong interest in becoming co-managers of the Eel River basin and they may have access to additional resources necessary to monitor fisheries and water quality and to restore the river and its fish before it is too late.

VAN ARSDALE FISHERIES STATION/RESERVOIR



VICINITY MAP OF VAN ARSDALE FISHERIES STATION/RESERVOIR and PHOTO OF CAPE HORN DAM



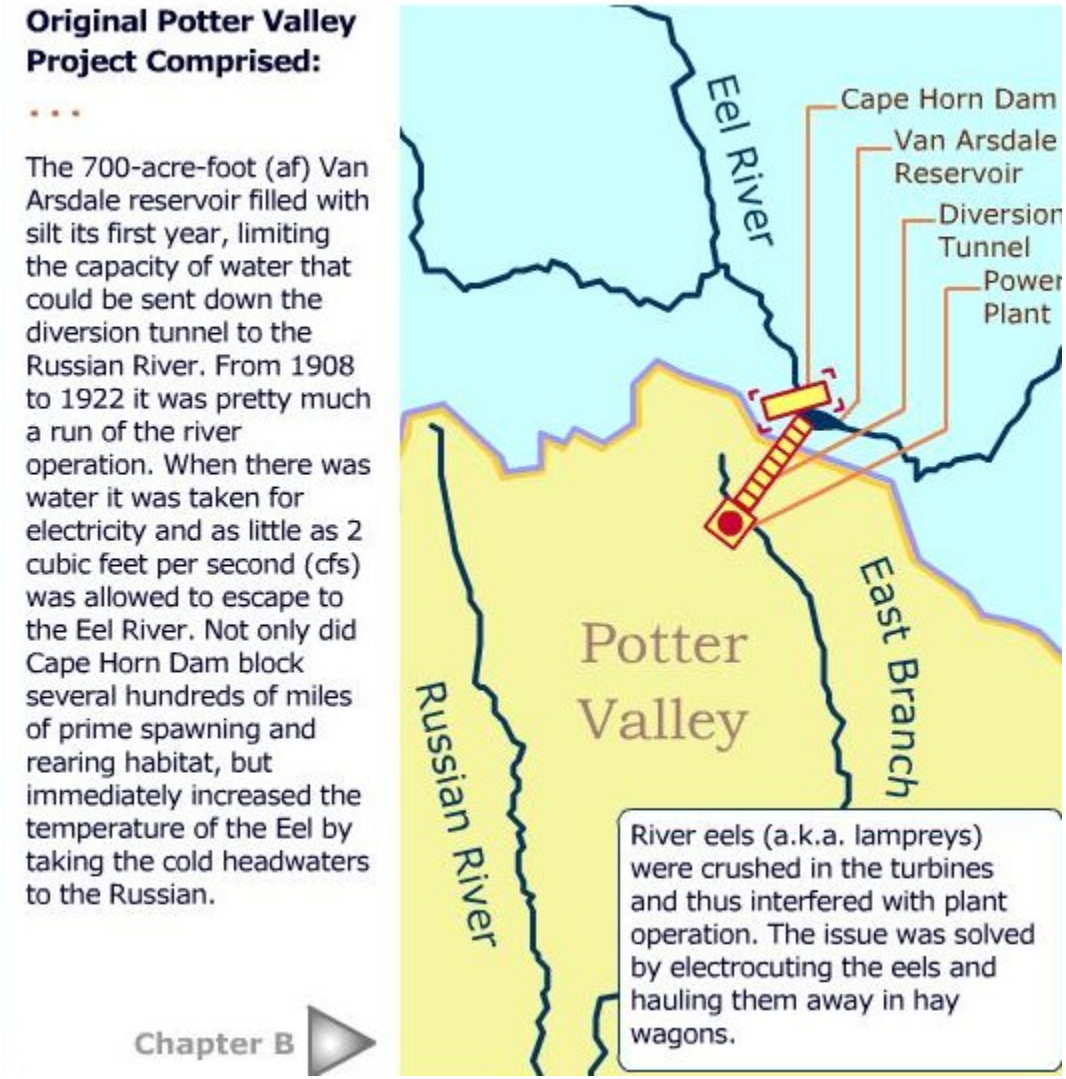
Van Arsdale is the bay for the water diversion tunnel at Cape Horn dam, the PG&E Potter Valley Hydropower Project, and the site of the oldest fish counting station in California. Built in 1922 as part of the licensing for the second dam to be built on this system, Scott Dam. By this time three generations of fish were lost because Cape Horn Dam did not have a fish ladder, between 1907 and 1922. It is said that only 40% to 45% of the fish that arrive at this site actually are able to make it up this fish ladder, demonstrating that fish ladders really do not solve the problem of getting salmon to where there is adequate and safe spawning and rearing habitat.

The next generation is then severely interfered with by dams. These dams block at least 125 miles of prime spawning and rearing habitat, but recent GIS maps indicate that there could be more than 1,000 miles available for this purpose. Loss of this fishery has impacted the north coast from Eureka to Bodega Bay fishing industry with the loss in the billions of dollars.

http://eelriver.org/fish-monitor/fish-count/

Map and Imagery of Scott Dam and Lake Pillsbury

Map of Potter Valley Project (Source: www.pottervalleywater.org)



Friends of Eel River Potter Valley Project documentation slide

Scott Harris of CDFG at VAFS.

Scott Harris (personal communication) of CDFG provided 2010 data for VAFS Chinook salmon returns through December 31. The count was a high for the entire VAFS period of record and a total of 2,315 fish were counted (814 males, 755 females and 746 jack salmon). Chinook salmon weekly counts for 2010 are captured in Figure 4 and those for 2009 are displayed in Figure 5. The total return to VAFS in 2009 was 519 (Harris 2010). The 2010 run began arriving on October 29, peaked by mid-November and few fish returned in December. This contrasted with run timing in 2009 when flows were lower and the run peak occurred in December. Male Chinook arrive earlier than females and jack salmon are not present later in the run (Harris 2010).

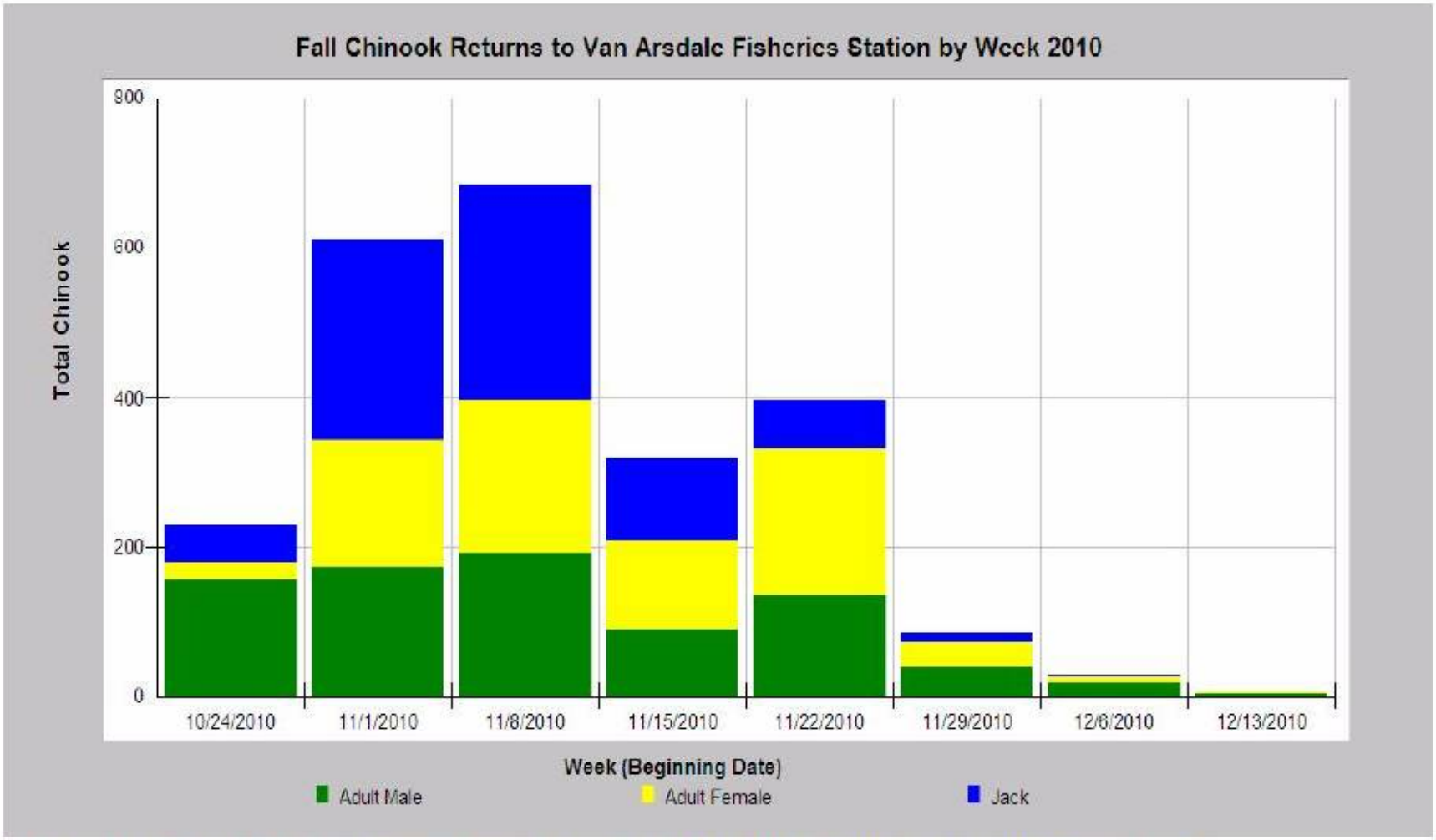


Figure 4. VAFS Chinook salmon returns by week in fall 2010 show the peak of the run in early November due to excellent flows for passage . Preliminary data Scott Harris, CDFG via email.

Figure 4
Patrick Higgins, Fisheries Biologist
Final Eel River Fall Chinook Monitoring 2010 Report

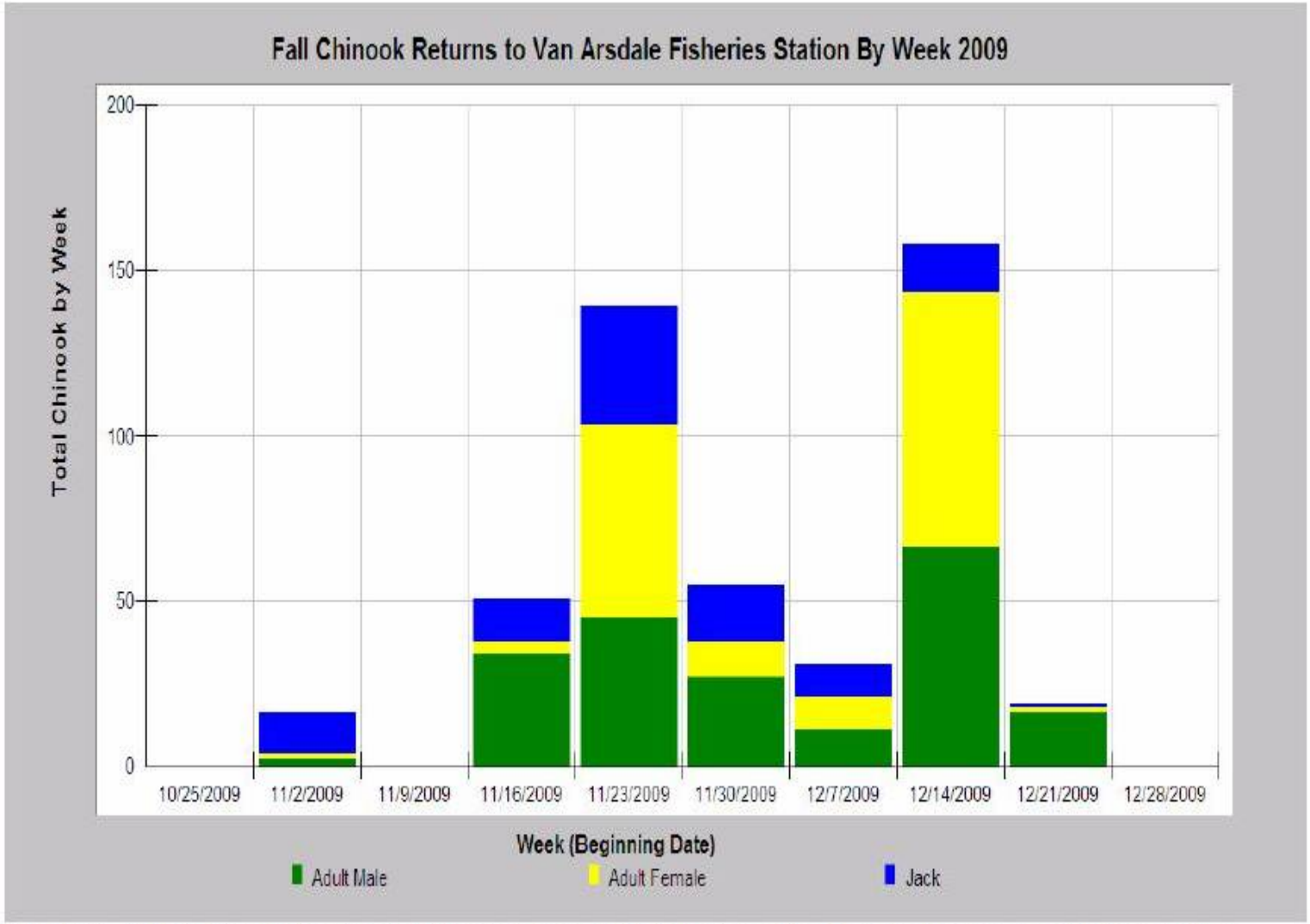
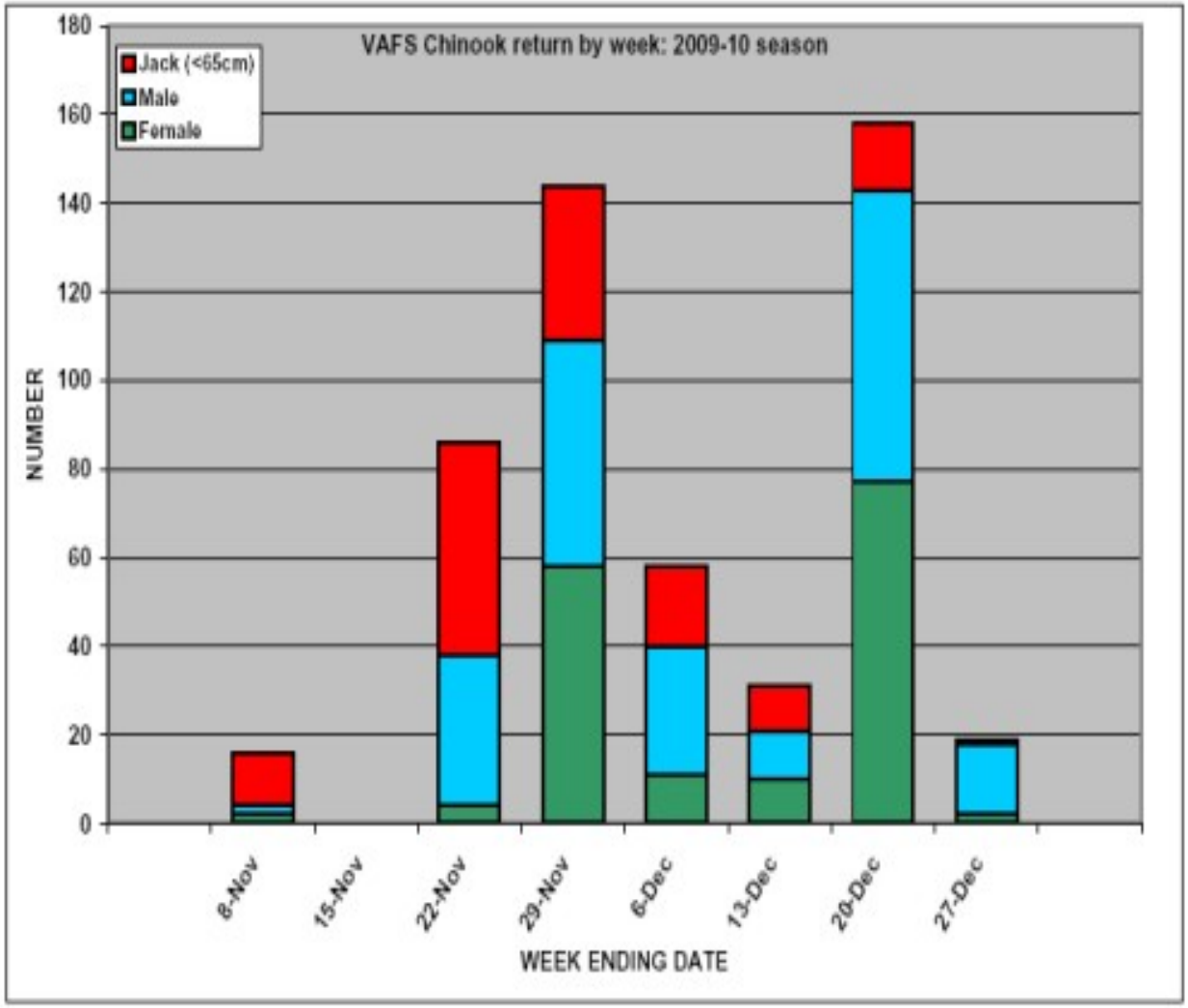


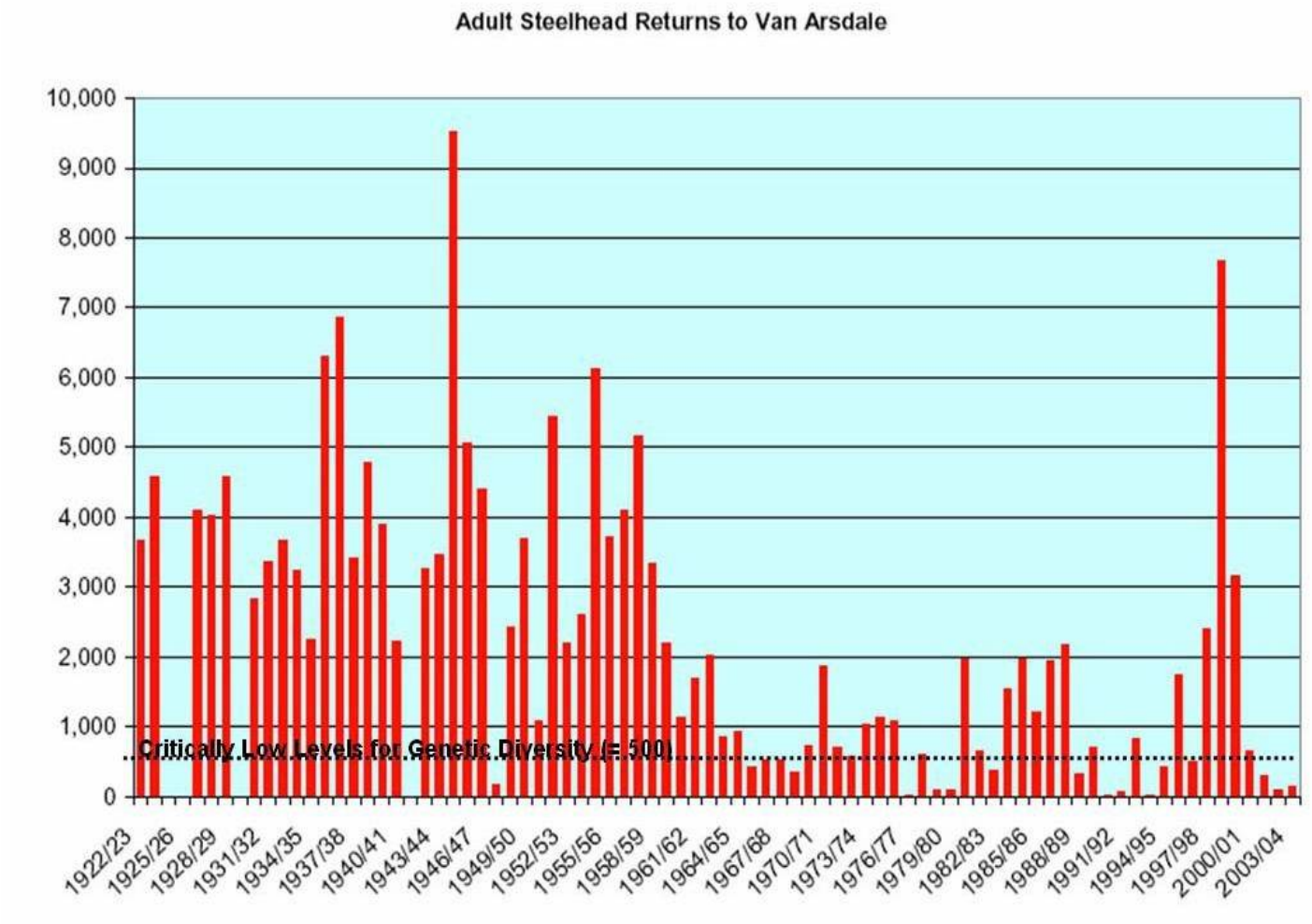
Figure 5. VAFS Chinook salmon returns by week in fall 2009. Flows were poor for migration and as a result the peak of the run is in December. Data from Harris (2009).

Figure 5
Patrick Higgins, Fisheries Biologist
Final Eel River Fall Chinook Monitoring 2010 Report



Van Arsdale Fisheries Station Chinook Salmon Counts, Fall-Winter, 2009

Source: Friends of the Eel River



Prudent Alternative (RPA): Implications for the survival and recovery of Eel River Chinook Salmon, Coho Salmon, and Steelhead Trout,

Patrick Higgins, February 2010

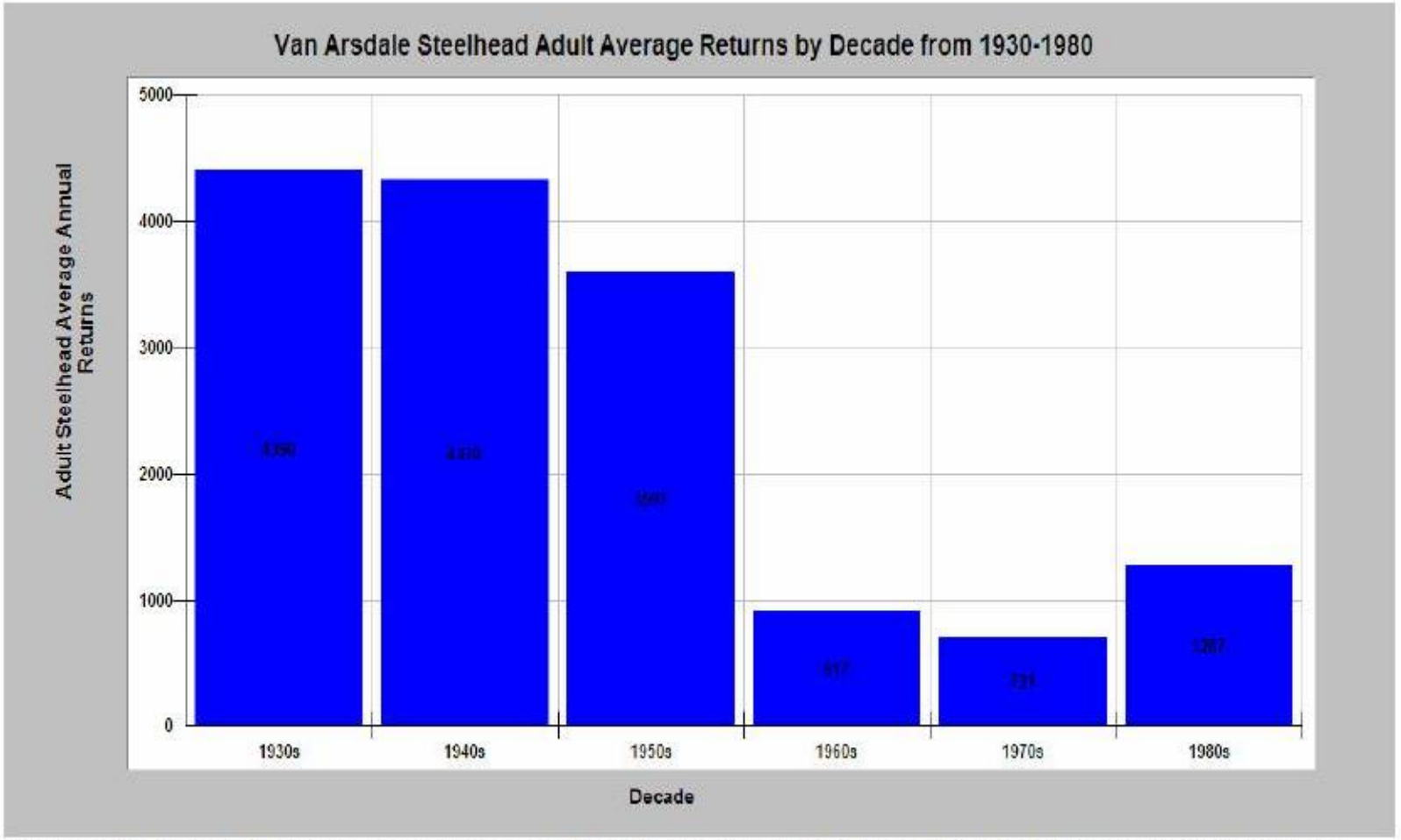


Figure 12. Decadal average of annual steelhead returns to the Van Arsdale Fisheries Station from NMFS (2002).

Evaluation for the Effectiveness of Potter Valley Project National Marine Fisheries Service Reasonable and Prudent Alternative (RPA): Implications for the survival and recovery of Eel River Chinook Salmon, Coho Salmon, and Steelhead Trout,

Patrick Higgins, February 2010

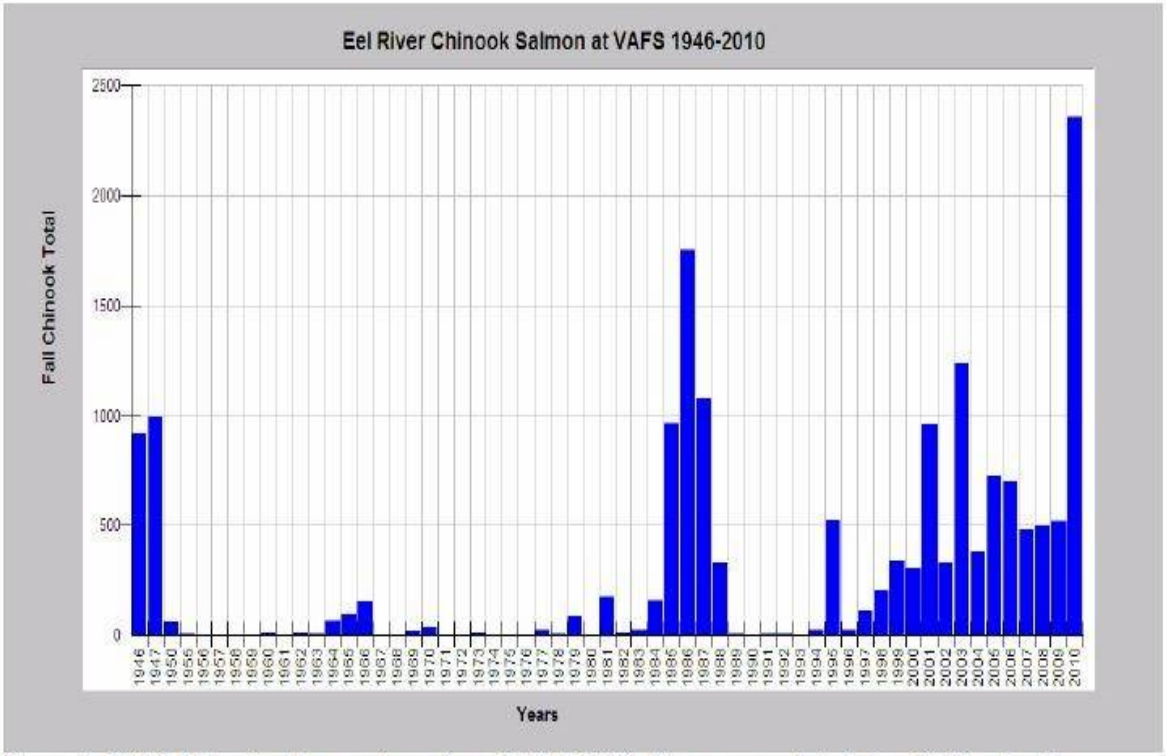


Figure 3. VAFS Chinook salmon returns from 1946 to 2010. There are no data before 1946 and only 1946, 1947 and 1950 returns were reported before 1955. Lack of returns in many years could be as a result of insufficient flow releases at Cape Horn Dam for Chinook to migrate that far. Data from Harris (2010).

Patrick Higgins, Fisheries Biologist,
Final Eel River Fall Chinook Monitoring 2010 Final Report

Source: Potter Valley Project (www.pottervalleywater.org)

ANNUAL CHINOOK AND STEELHEAD COUNTS
VAN ARSDALE FISHERIES STATION
1933-34 THRU 2009-10

SEASON	CHINOOK	STEELHEAD
1933-34	ND	3,247
1934-35	ND	2,255
1935-36	ND	6,310
1936-37	ND	6,861
1937-38	ND	3,413
1938-39	ND	4,786
1939-40	ND	3,889
1940-41	ND	2,225
1941-42	ND	ND
1942-43	ND	ND
1943-44	ND	ND
1944-45	ND	9,528
1945-46	ND	5,054
1946-47 *	917	4,409
1947-48	994	178
1948-49	ND	2,433
1949-50	ND	ND
1950-51	55	1,091
1951-52	ND	5,444
1952-53	ND	2,197
1953-54	ND	2,590
1954-55	ND	6,131
1955-56	5	4,745
1956-57	0	4,109
1957-58	2	5,151
1958-59	0	3,335
1959-60	0	2,206
1960-61	9	1,130
1961-62	0	1,693
1962-63	9	2,030
1963-64	3	846
1964-65	63	921
1965-66	93	423
1966-67	148	525
1967-68	0	531
1968-69	0	354
1969-70	15	719
1970-71	34	1,863
1971-72	0	696
1972-73	0	586
1973-74	12	1,040
1974-75	1	1,123
1975-76	2	1,078
1976-77	0	39
1977-78	23	590
1978-79	5	106
1979-80	84	87
1980-81	0	1,966
1981-82	175	647
1982-83	9	369
1983-84	26	1,534
1984-85	153	1,980
1985-86	961	1,194
1986-87	1,754	1,952
1987-88	1,080	2,208
1988-89	328	331
1989-90	6	691
1990-91	0	31
1991-92	5	60
1992-93	4	823
1993-94	2	34
1994-95	21	434
1995-96	525	1,743
1996-97	26	511
1997-98	107	2,393
1998-99	200	7,679
1999-00	343	3,150
2000-01 **	303	641
2001-02 ***	955	308
2002-03	329	102
2003-04	1,235	149
2004-05	379	234
2005-06	725	253
2006-07	700	1,625
2007-08	478	625
2008-09	496	320
2009-2010	516	308

* Forty-seven coho salmon were trapped this season
** One coho was trapped this season
*** Four coho were trapped this season

ND= No recorded data

ANNUAL CHINOOK AND STEELHEAD SALMON COUNTS, VAN ARSDALE FISHERIES STATION
1989-90 TO 2009-10

1989-90	6	691
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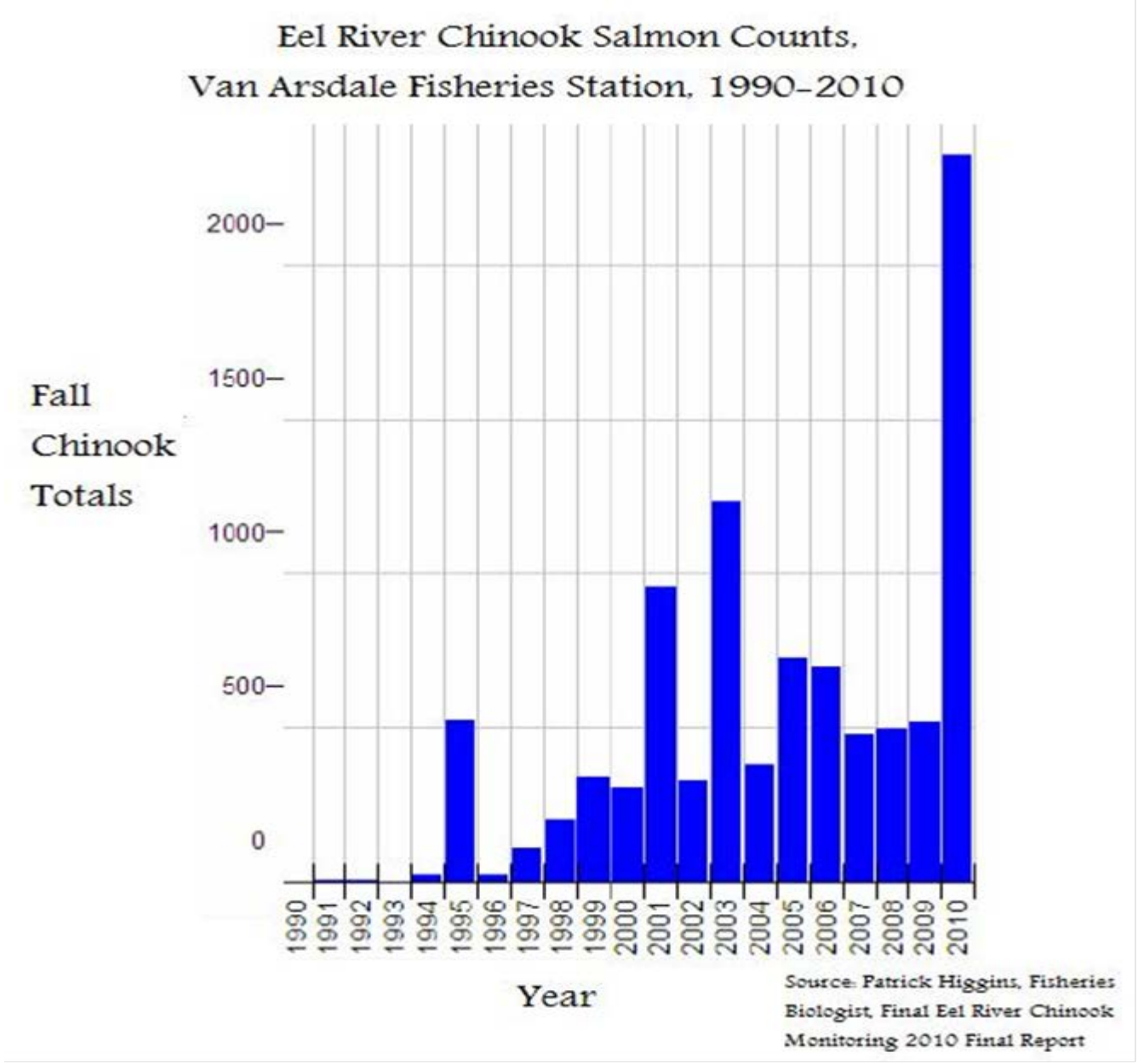
Souce: www.pottervalley.org,
Pacific Gas and Electric Company

Source: (www.pottervalleywater.org)



Patrick Higgins, Fisheries Biologist

Final Eel River Chinook Monitoring 2010 Final Report

Bioengineering needs to be applied at the mouth of Soda Creek just downstream of Scott Dam. Massive aggradation at the mouth of this stream has caused elimination of riparian vegetation and created a channel that is very poor fish habitat and that loses surface flow in summer and fall. This project should be given priority, since re-establishment of connectivity here would increase available spawning and rearing areas for steelhead and Chinook salmon spawning within the PVP affected reach of the upper Eel. At the end of December 2010, the Eel River at Cape Horn Dam was flowing at 7960 cfs and associated scour and fill of the stream bed likely reduced spawning success for the 2,315 Chinook within the PVP. **Action is needed now.**

Patrick Higgins, Fisheries Biologist,

Final Eel River Fall Chinook Monitoring 2010
Final Report

Ultimately, Scott Dam needs to be removed and Chinook salmon and steelhead allowed to re-inhabit the hundreds of miles of headwater streams above the PVP. Gravelly valley underneath the Pillsbury reservoir was one of the most productive salmonid habitats in the basin (Williams et al. 2008) and could be a refugia, if restored. Although the fall Chinook salmon return to VAFS was a record dating back to 1946, the likelihood of these fish spawning success is low because salmon habitat between the Scott Dam and Cape Horn Dam is extremely degraded. Similar steps for the Trinity River Restoration Program (McBain and Trush, 1997) are needed to augment spawning gravels and to alter confining riparian vegetation. The 9 MW of power generated by the PVP is miniscule compared to the benefits of restoring the Eel River salmon and steelhead. A phased decommissioning should be planned with the removal of Scott Dam no later than 2020. Users of Eel River water in Humboldt, Mendocino, Sonoma and Marin Counties need to start paying for it, which could fund needed restoration measures. Prompt action to restore the Eel River has the potential to rebuild the fall Chinook salmon population to 100,000 fish annually, and State and federal government agencies need to do more to actively manage Eel River fisheries resources and restore the river's ecosystem function. The Native American tribes of the basin have a strong interest in being co-managers of the Eel River basin and they may have access to additional resources necessary to monitor fisheries and water quality and to restore the river and its fish before it is too late.

Recommendation for removal and decommissioning of Scott Dam

Patrick Higgins, Fisheries Biologist,

Final Eel River Fall Chinook Monitoring 2010 Final Report

Friends of the Eel River

by Nadananda
November 18, 2002

FOER has taken on the effort to remove two antiquated PG&E dams that are part of their Potter Valley Hydroelectric Project. This project produces a very small amount of electricity, and it is well known that this is really a water-delivery system in the guise of a power plant.

The first dam, 50-foot high Cape Horn that forms the Van Arsdale Reservoir, was completed in 1908 and quickly filled with silt. With the help of extenders, misnamed ? floodgates,? the dam creates a bay for the tunnel that removes up to half of the water produced in the headwaters of the main stem of the Eel River. The power plant is at the foot of the mile-long tunnel in Potter Valley, where the water is released into the east branch of the Russian River. The second dam, 130-foot high Scott Dam that forms Lake Pillsbury, was completed in 1925 and captures winter runoff that is released during the spring, summer, and fall months.

For most of its 94 years of life, this project has held the Eel River in a continuous drought condition. While 340 cubic feet per second of water (cfs) is released to the Russian River, only 5 cfs is allowed to escape to the Eel River. Before 1983, only 2 cfs were allowed into the Eel River. These amounts are extremely small and are not enough water for the once-prolific and famous salmonid fishery to survive and thrive. During the past two winters, just over 1,000 salmonid arrived at the Cape Horn fish-counting station where more than 500,000 used to run. As with the Klamath, the Eel is in the grips of farmers and developers to the south.

Documentation of previous effort towards decommissioning and/or removal of

Scott and Cape Horn Dams,

Friends of the Eel River Newsletter, Fall 2002

After spending a concentrated six months and more as a study group, we decided to take on the effort to remove the two antiquated PG&E dams. Careful consideration led us to believe that the only way we could fight Goliath was through the legal process, using the Public Trust Doctrine, the Clean Water Act, the Endangered Species Act, and other legislation. Over the past eight years FOER has been taking the appropriate steps necessary to use legal action to restore natural water flows to the Eel River, to remove the two antiquated dams, and to close the tunnel. To that end, we hired well-known attorney Stephan Volker to guide us through the legal process. As of this writing, we are waiting for the final Biological Opinion of the National Marine Fisheries Service on a plan submitted to and approved by the Federal Energy Regulatory Commission from PG&E and the Potter Valley Irrigation District. It is due on November 27, 2002, the Wednesday before Thanksgiving. Since the NMFS has already said they would give a ?jeopardy? ruling on the plan (in other words, there is not enough water for fish to survive and they will die under this plan) PG&E asked for a 30-day extension to give- them time to try to work out a deal since a jeopardy ruling could cause the plant to be shut down. We are about to see many of the same situations found in the Klamath situation repeated on the Eel. We feel confident with our many supporters backing us that we will be able to persevere and win this effort.

Documentation of previous effort toward decommissioning and/or removal of Scott and Cape Horn Dams, Friends of the Eel River Newsletter, Fall 2002

Thinking About Decommissioning

By Kathy Glass

No dam is forever. Concrete has a limited lifespan for structural integrity. Reservoirs invariably fill with silt and lose their water-storage capacity. The dams of the Potter Valley Project (PVP) in particular rest on soil of questionable seismic safety. Since Cape Horn Dam dates from 1908 and Scott Dam from 1922, we can reasonably expect to decommission these two dams within the near future (less than 50 years), either by systematically planning the decommissioning and restoration, or as a result of catastrophic failure.

A new study by the Arcata-based Center for Environmental Economic Development (headed up by Prof. Dan Ihara) takes a look at some of the benefits to Lake and Mendocino counties from decommissioning of the Potter Valley Hydroelectric Project. An earlier study documents economic benefits to Humboldt County. Both studies are available from Friends of the Eel River, either online or printed.

The Potter Valley hydroelectric license comes up for renewal in 2022, begging the question of "Do we really need this aging hydro operation?" It is not within the purview of a Federal Energy Regulatory Commission (FERC) license to simply allow diversion of water without a clear need for power generation.

Meanwhile, not content to wait until 2022 or the next major earthquake, Friends of the Eel River and other citizens' groups are legally challenging FERC to examine a "no project" alternative for the PVP sooner than later. This unrelenting citizen pressure to put an end to diversions of Eel River water means that the question of decommissioning will be forced upon the public and the corporate owners (PG&E) within the next few years.

Furthermore, important decisions are being made today and in the immediate future (next few years) by consumers of water in the southern counties (Marin, Sonoma and southern Mendocino), with development plans relying on future availability of water supplies. In a related planning debate, water allotments from Lake Mendocino (on the Russian River) are presently under discussion, and plans to raise the height of that dam are also afloat. Should Eel River diversions come to an end, the southern counties will have to face adjustments in their summer water supply. In fact, the Sonoma County Water Agency should adjust now in preparation for the end of Eel River diversions and not continue to factor this imported water into its long-term supply plans.

Because the Potter Valley hydroelectric project generates only 9 megawatts of power in the face of increasing costs to produce it, it has been generally acknowledged (in PG&E's own reports, as well as those of the Sonoma County Water Agency, to name a few) that this is an uneconomical power-generating operation.

In order to avoid the public having to absorb decommissioning and restoration costs related to the PVP, it is imperative that we begin discussing openly the responsibility of the license-holder, PG&E, in returning the upper Eel River basin to its natural state. In fact, this is PG&E's responsibility by law, not only as the owner of the hydro license and financial beneficiary for decades, but as its obligation to the public trust. Certainly the facility and its license cannot be sold without taking into account this liability on the part of the operator of the PVP.

We are pointing this out because FERC is not evidencing awareness of this great and looming responsibility of decommissioning, nor are any other public agencies or officials. *NO ONE* has ever focused on who is responsible for the cost of decommissioning in case of earthquake damage, for example, or the discontinuance of the hydro license. The PVP would likely have changed hands already if not for public vigilance on this issue and concern that accountability for dam safety and environmental health is clear. Part of the problem is a lack of forward-thinking leadership on water and sustainable-development issues, hence the need for reports such as this one, financed independently since the government isn't doing it.

Clear thinking also shows us that it is cheaper in the long run for PG&E and the public to quit operating the Potter Valley hydro project than to continue producing an insignificant amount of electricity at a financial loss, especially when the economic losses to downstream residents of the Eel are factored in.

CONTINUED ON PAGE 8

Photo by Wilana Anderson

DR. DAN IHARA PRESENTING THE ECONOMICS OF DECOMMISSIONING THE PVP TO MENDOCINO AND LAKE COUNTIES AT OUR FALL MEMBERSHIP MEETING.

Documentation of effort towards decommissioning and/or removal of Scott and Cape Horn Dams, Friends of the Eel River Newsletter, Fall 2004

The economic losses to Eel River residents as well as the deterioration of natural capital (fisheries, a healthy river) are presently externalized costs that the public at large (including future generations) must absorb. It is right to insist that the massive costs of restoring the upper Eel are met by PG&E or a future buyer of the project, and it is apparently necessary to force this discussion on the principals through legal means.

Certainly it is cheaper to end the travesty of a hydro operation that is really just a water-delivery system than to find fish elsewhere or give up on the economy in the Eel River watershed. This report proposes a scenario whereby we Save Money while Restoring Habitat and Providing Jobs—what more could we want?

Moving ahead with decommissioning and restoration would not only benefit the ecosystem of the Eel River, but this important work could bring in millions to local counties, as the latest report shows. Jobs include heavy-equipment operators, engineers, GIS techs, and riparian and revegetation workers. With a restoration program, the PVP dams become not a liability but an asset to local economies!

Documentation of previous effort toward decommissioning and/or removal of Scott and Cape Horn Dams, Friends of the Eel River Newsletter, Fall 2004

Endangered Species Act
Section 7 Consultation

BIOLOGICAL OPINION

for

The proposed license amendment for the Potter Valley Project
(Federal Energy Regulatory Commission Project Number 77-110)

Action Agency: Federal Energy Regulatory Commission

Consultation Conducted By: National Marine Fisheries Service, Southwest Region

Date Issued: NOV 26 2002

Source of information for recommendation for decommissioning and/or removal of Scott Dam

(http://www.swr.nmfs.noaa.gov/psd/Final_Potter_Valley_Project_BO.pdf)

FORUM

A River Might Run Through It Again: Criteria for Consideration of Dam Removal and Interim Lessons from California

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UC Santa Cruz, California 95064 USA

ABSTRACT / Resource managers are increasingly being challenged by stakeholder groups to consider dam removal as a policy option and as a tool for watershed management. As more dam owners face high maintenance costs, and rivers as spawning grounds for anadromous fish become increasingly valuable, dam removal may provide the greatest net benefit to society. This article reviews the impact of Endangered SpeciesAct listings for anadromous fish and recent shifts in the Federal Energy Regulatory Commission's hydropower benefit costs analysis and discusses their implications for dam removal in California. We propose evaluative criteria for consideration of dam removal and apply them to two case studies: the Daguerre and Englebright Dams on the Yuba River and the Scott and Van Horn Dams on the South Eel River, California.

Case study on impacts of Scott and Cape Horn Dams and possible decommissioning

Environmental Management, Vol. 28, No. 5, pp. 561-575,

http://www.scu.edu/cas/environmentalstudies/upload/river%20might%20run%20through%20it%20again.pdf

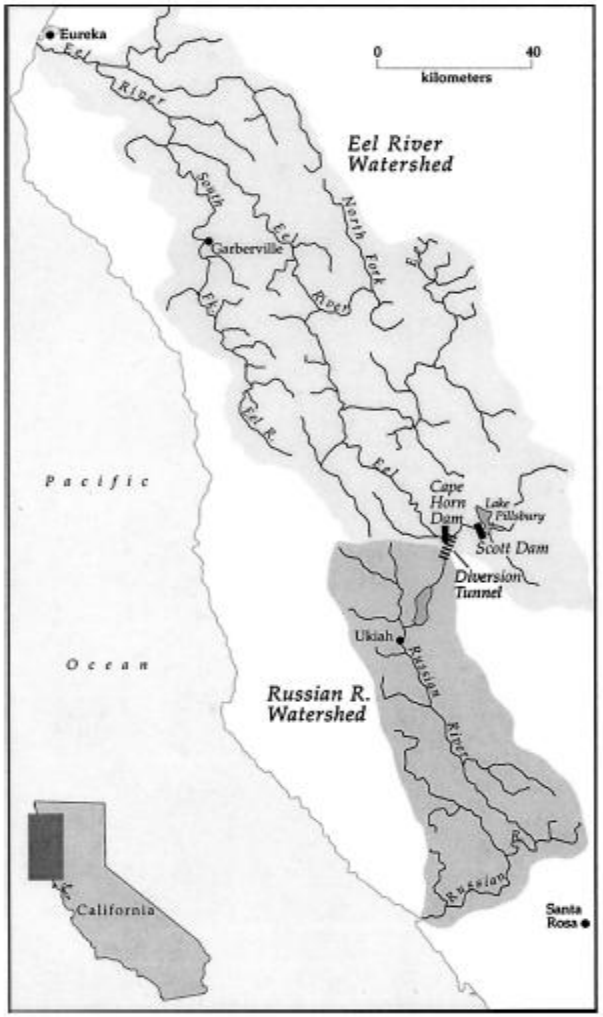

Figure 2. Russian River and Eel River watersheds. (Cartography by John E. Isom.)

cial fishermen and urban water districts are hoping that those within the watershed can resolve the issue successfully.

The Upper Eel River: Scott Dam and Cape Horn Dam

The damming and diversion of the upper Eel River illustrates California's history of inter-basin water transfer and contention over water rights, and how this contention drives contemporary discussions of dam removal in this watershed. The Potter Valley Project (PVP) includes Cape Horn Dam, Scott Dam, and a diversion tunnel that diverts 90% of the water from the headwaters of the Eel River into the Russian River and down to Sonoma County (Figure 2). Cape Horn Dam was built in 1908 and created Van Arsdale reservoir. This reservoir filled up with sediment almost immediately and Scott Dam was built 13 years later to create Lake Pillsbury and provide greater storage capacity for the PVP. PG&E bought the project in 1930 and still uses Scott Dam to produce hydropower. Seventy years later, this diversion is providing Sonoma County with $40 million in free water every year, and the facility continues to contribute to the dramatic decline of anadromous fish in the Eel watershed (Friends of the Eel River 2000a).

The Eel River once supported half a million chinook salmon, coho salmon, and steelhead, but today is host to less than 30,000. Scott Dam is 39 m high and does not, altered stream flows below the dam disrupt instream spawning habitat for the anadromous fish that do negotiate the Daguerre (Rose 2000).

In 1998 CalFed issued a multivolume Ecosystem Restoration Program Plan, identifying numerous opportunities for restoring ecosystem health to the region's rivers and including consideration of removal of Daguerre and Englebright Dams (CalFed 2000). Since then, CalFed has recommended the removal of the Daguerre, although formal studies and a work plan have not yet begun. CalFed chose the Yuba River Watershed for possible restoration activities because the spring- and fall-run salmon have been extirpated from most of the other tributaries to the Sacramento River, and the Yuba holds the most promise for restoring habitat and preventing or forestalling an ESA listing. Removal of these dams could conceivably triple or quadruple the entire amount of spawning habitat available in the Sacramento River watershed. The consequences of listing these fish would have huge implications for water supply in other parts of the Bay-Delta region because NMFS could require dam operators to follow a flow release schedule to favor salmon spawning, and this could put commercial fishermen and farmers out of business and curtail water delivery to Los Angeles (Reisner 1998). If these dams were removed, salmon could access their historic spawning habitat above the dam, and NMFS would not impose a flow release schedule. Consideration of dam removal makes more sense as a policy option because of the economic and social costs associated with a "no action" alternative (Rose 2000).

The South Yuba River Citizen's League (SYRCL) was founded in 1983 to educate and advocate on behalf of wild river and wilderness issues in the region, and its staff submitted to CalFed a proposal to study the benefits and costs of removing the Englebright Dam. Their

The quantity of the mercury in the Englebright reservoir's sediments is a wild card in this case. Mercury was used extensively in 19th century placer mining, and losses to the river were as high as 30% (Hunerlach and others 1999). Mercury in sediment progressively methylates or "dissolves" in the relatively warm and calm waters of a reservoir, making it available for bioaccumulation in fish as a potent neurotoxin (May and others 1999). Those favoring retaining the dam suggest that the Englebright dam protects the health of the downstream river by blocking mercury, but this argument does not address the escalating problem of mercury exposure. The threat of mercury exposure could trigger consideration of reservoir draw down to prevent further methylation. One of the three sediment management alternatives in Table 6 would then be much more appropriate than leaving the mercury in the reservoir to methylate. When the mercury studies are completed, the discussion of removing Englebright dam may be substantially reconfigured. This issue illustrates that the cost of "no action" may turn out to be greater than dam removal.

The regulatory action of NMFS will also play a critical role in shaping the decision to remove the Englebright dam. There does not appear to be any biological justification for excluding the above-dam habitat from designation as critical to salmon recovery. In this case, to apply the ESA, NMFS should designate habitat above the dam as critical and force the dam owners to resolve the issue of fish access. The dam's height of 81 m poses significant costs and engineering challenges to constructing a fish passage structure, however, and it may prove to be cheaper to remove the dam than to spend millions of dollars on a fish ladder, one that may prove to be inadequate. In any event, EPCA's reform of FERC's decision-making process will require the construction of fish ladders when the Englebright's hydro

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from maintaining the dams and weigh this with the costs and benefits of decommissioning the facility. Factors that should be considered include potential economic benefit of restored fisheries, ecological benefits, safety-related costs, recreational benefits and losses, and costs of physical deconstruction and restoration.

Like the Edwards Dam, the PVP will be a test case for the FERC. The commission's decision will demonstrate its seriousness in applying EPCA's "equal consideration" criteria to an application for license renewal. If FERC mandates fish habitat restoration, continued operation of the PVP may be too expensive for any owner. Returning the diverted water to the Eel River would also challenge the immutability of other interbasin water transfers and strengthen people's sovereignty over resource management in their own watershed.

Conclusions and Recommendations

Based on the above criteria and case studies, we make the following policy recommendations:

1. Public agencies that have adopted watershed-based ecosystem management should include analysis of the potential benefits of removing dams as a routine matter of policy. Virtually all U.S. dams were built prior to the passage of national environmental laws, but public resource managers now have sophisticated tools for evaluating their impacts. A small yet unknown number of the 75,000 dams in the United States could be removed with measurable economic and ecological benefits to society. Public agencies should develop objective and transparent criteria-based processes to make decisions about watershed management, including evaluation of dam and fish passage repair or removal.
2. The NMFS should elaborate its own criteria for designating historical habitat now blocked by dams as "critical" under the ESA. To address the significant impact dams continue to have on threatened anadromous fish, NMFS needs to reevaluate how they define critical habitat relative to dams and how they assign costs. Public interest groups should not allow NMFS to hide behind the ambiguity of its policy. NMFS should spell out what conditions should trigger studies of designating "critical" above-dam habitat for anadromous fish and should state clearly who is responsible for these studies. The ESA itself may not provide sufficient clarity to guide public agencies in considering the impact of dams, and this issue may have to be resolved in the courts.
3. Congress should resist private industry initiatives that would weaken the essential reforms of EPCA and serve to restrict social and environmental considerations in the FERC relicensing process. The current system is slow and somewhat cumbersome, but hydropower dams can have devastating and permanent environmental impacts on public resources.
4. We concur with the Hydropower Reform Coalition that Congress should establish a national dam decommissioning fund financed by dam owners. Those who have profited from public resource use should bear the financial cost of restoring any habitat they may have degraded.
5. States should pass laws like California's SB 1540 to inventory obsolete, abandoned, and malfunctioning dams. Watershed management policies depend on accurate and ecologically informed knowledge of their resources to make sound decisions. Some dams may be located at the lower end of a watershed on streams with major fish runs. These dams should be identified and targeted for fish passage improvement if not removal.
6. Local resource management agencies and watershed councils should investigate fully the opportunities for removing nonessential dams (i.e., abandoned dams, dams that exist only for reservoir-based recreation opportunities).

Dam removal, when it provides a net benefit to society, is a logical policy option for watershed councils. Individual dams may confer benefits that outweigh their costs, but if public agencies analyze an entire watershed, it may be possible to demonstrate that the removal of an individual dam will result in a net positive benefit to society. The health of a watershed could be improved if the services provided by a network of dams can be reconfigured to make one expendable. This kind of negotiation relies heavily on active and responsible stakeholder participation. The threat of ESA listing consequences to a watershed—and distant stakeholders—may be great enough to overcome the resistance of recalcitrant stakeholders.

Removing hazardous dams that degrade the environment clearly provides direct benefits for both human communities and natural ecosystems. But dam removal can also have a larger impact on environmental management as a symbol of ecological restoration. The high profile, high-energy work that goes into dismantling a dam and restoring a river can catalyze further efforts to improve the environment. Dam removal gives people the opportunity to become educated about the effect of logging practices and water diversion on their river and the potential rapid recovery of

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salmon populations provides hope as well as an immediate return on their investment. Successful dam removal also calls into question other environmentally damaging institutions in our society as people come to see that dams are not a permanent part of our landscape.

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