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BEFORE THE STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS
The Paul R. Bonderson Building
901 P Street
Sacramento, California 95814

PUBLIC HEARING
ON FISHERY AND WATER RIGHT ISSUES
ON THE LOWER YUBA RIVER

February 10, 11, and 13, 1992

Written Testimony of
STEVEN P. CRAMER

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TESTIMONY OF STEVEN P. CRAMER

I, STEVEN P. CRAMER, hereby testify as follows:

1.0 INTRODUCTION

If called to testify in this matter, I would testify as to each of the following matters of my own personal information and belief, and could competently do so.

1.1 My educational background, work history and professional qualifications are described in Exhibit "A" attached hereto and included herein as if set forth in full.

1.2 I have been a fisheries consultant to private firms, state and federal agencies, and Indian tribes for the past four years after serving 13 years with the Research Section of the Oregon Department of Fish and Wildlife ("ODFW"). The focus of my work over the years has been the population dynamics of salmon and steelhead in the Columbia, Rogue, Klamath, and Sacramento Rivers. For most of my career with ODFW, I directed a major research program to determine the downstream effects on salmon and steelhead of the flows and temperatures released from two new reservoirs in the Rogue River Basin. Many of the circumstances were quite similar to those in the Yuba River. I have thoroughly analyzed abundance and harvest data on fall chinook in the Sacramento Basin, including the Yuba River, for a study in which I was commissioned by the California Department of Water Resources (Cramer 1989). In studies for the Department of Water Resources ("DWR") and others, I have analyzed environmental and diversion impacts on the survival of chinook salmon in the Sacramento River, Feather River, American River, and the Sacramento/San Joaquin Delta. I have directed extensive field studies of the survival of juvenile chinook salmon passing the Glenn-Colusa Irrigation District's diversion on the Sacramento River during the past two years. I have personally inspected the South Yuba/Brophy Diversion and the Hallwood/Cordua Diversion facilities and I have toured the entire lower Yuba River up to New Bullards Bar Dam.

2.0 THE LOWER YUBA RIVER FISHERIES MANAGEMENT PLAN LACKS INTEGRATION OF TECHNICAL ANALYSES AND MANAGEMENT RECOMMENDATIONS. ANALYSES AND RECOMMENDATIONS OFTEN CONTRADICT ONE ANOTHER.

2.1 I have reviewed the Lower Yuba Fisheries Management Plan (hereafter "Management Plan") and was immediately struck by the contradictions between the analyses presented and the flow regime that was recommended. This report appears to have been written by two sets of authors that never talked to each other. One set did the data gathering and technical analyses, and the other set developed flow recommendations that ignore the findings of the technical studies. After arriving at this conclusion, I reread the INTRODUCTION and found the following in the last paragraph:

> "Beak Consultants, Incorporated, Sacramento, California collected the data for this investigation, and DFG prepared the fishery management plan."

My conclusion was confirmed.

2.2 The unfortunate outcome of divided responsibility for "this investigation" is that the management plan is not supported by the data and technical analyses. In some instances, it appears from the analyses presented that CDFG has recommended management actions that will be harmful to the fish resources of the Yuba River. For example, the flows recommended during April-June would reduce Weighted Usable Area (WUA) for rearing of juvenile chinook and steelhead substantially below optimum, but the report makes no attempt to reconcile the discrepancy. A simulation of WUA for each life stage at the recommended flows should have been completed and would have demonstrated the magnitude of negative impact from this recommendation.

2.3 The report presents almost no information on the dynamic forces that determine the population productivity. The report presents estimates of WUA, but does not present data on the number of fish a unit of WUA can support. Thus, the report presents no analysis of the river's carrying capacity for any fish life stage and so never provides a basis for determining at what life stage and at what flows the WUA might be a limiting factor.

2.4 A common shortcoming of IFIM studies is that they often ignore the dynamic links between one life stage and the next; they only consider the availability of usable habitat. The Management Plan is a classic example of this shortcoming. The Management Plan never discusses density dependent survival or growth, even though these are elementary concepts discussed in every textbook on fish population dynamics. In order to properly manage a fish population, one must know the weakest link in the life history sequence and how density dependent factors affect each linkage. Without consideration of carrying capacities, density dependent factors, and species interactions, there is a high probability of drawing erroneous conclusions regarding the effects of flow recommendations.

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3.0 **THE NEED FOR THE HIGHER FLOWS RECOMMENDED DURING APRIL-JUNE IS UNSUPPORTED AND IS CONTRADICTORY TO THE DISCUSSION OF FINDINGS FROM PHABSIM ANALYSES OF WEIGHTED USABLE AREA (WUA). THE RECOMMENDED FLOWS DURING APRIL-JUNE ARE LIKELY TO BE HARMFUL TO CHINOOK AND STEELHEAD IN LOW FLOW YEARS.**

3.1 The most glaring example of the lack of integration between data analysis and recommendations comes on page 108 of the Management Plan when the recommendation is made:

> "Results of the PHABSIM analyses of the physical habitat WUA/river discharge relationships indicate that the preferred physical living space requirement for fall- and spring-run chinook salmon, steelhead trout, and American shad are optimized by the following flow regime:

Time period	River discharge at the Marysville gage (cfs)
October 15 - March 31	700
April 1 - 30	1,000
May 1 - 31	2,000
June 1 - 30	1,500
July 1 - October 14	250-450"

This statement is grossly in error. In fact, the PHABSIM analyses discredit the flows listed for April to June in the table. WUA for shad was never estimated, and the fish present in April to June for which WUA was estimated would be juvenile chinook, juvenile steelhead, and steelhead fry. WUA was reported to be highest for juvenile chinook at 200 cfs. (p. 71), for juvenile steelhead at 200 to 450 cfs. (p. 76), and for steelhead fry at 100 to 200 cfs. (p. 76). The analyses presented show that WUA drops to only one-third to one-fourth of optimum if flows are increased to 1,000 to 2,000 cfs. as recommended during April to June.

3.2 Based on the data presented, the flows recommended for April to June appear to be based on misguided logic. The graph of recommended minimum flows compared to average flows (Figure 34 on p. 111) dramatizes that only in April to June did the authors choose to recommend higher flows than at other times of the year. The snorkeling surveys presented in Table 7 (p. 26) of the Management Plan indicate juvenile chinook and juvenile steelhead were highly abundant in May, but no shad were seen. The report indicates that juvenile chinook are present only into June (Table 3, p. 10, and discussion on p. 49), and I have confirmed this by reviewing CDFG's trapping data for the Hallwood-Cordua screen from 1975 to 1988. Thus, the Management Plan is recommending that habitat be limited to at least 60 percent to 75 percent below optimum for juvenile chinook and

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steelhead specifically during the period they are most abundant.

3.3 Mean lengths of juveniles seined each year by CDFG in the Yuba River indicate their growth was density dependent. That is, juveniles grew slower and were smaller in years when they were highly abundant. I could not find all of the necessary data in CDFG files to put together an analysis of density dependent growth in time for this declaration, but I did find several references to density dependent growth in file memos by Fred Meyer, Associate Fishery Biologist, such as the following, dated July 29, 1981: "Growth, as indicated by the change in modal length, was poor this year. The slow growth is attributed to density-dependent factors." This indicates juvenile rearing space is limiting and loss of WUA would be a detriment to the population. I showed in my report to DWR on Sacramento fall chinook (Cramer 1989) that survival of juvenile chinook released in the river at Knights Landing or upstream was positively related to fish size, i.e. larger juveniles survived at a higher rate to adulthood. Thus, a reduction in WUA area for juvenile chinook in the Yuba River would likely reduce the size of smolts, and thereby reduce the number of fish that survive to return as adults.

3.4 At first glance, I thought perhaps the flows recommended for April to June really would not harm juvenile chinook and steelhead, because these recommended flows were slightly lower than the mean of actual flows at Marysville during 1969 to 1988. However, upon examining the monthly values presented in Appendix 1 of the Management Plan (p. 127-128), I found it would have been necessary during 1969 to 1988 to augment flows to reach the recommended flows in 11 years during April, 17 years during May, and 14 years during June. I determined the need for flow augmentation by counting those months in which the minimum flow observed was below the recommended minimum. I can speak from personal experience that it is possible for a river to produce a greater number of chinook smolts under low flow conditions than under normal or high flow conditions. On the Rogue River, we found the highest abundance of chinook smolts during 1976 to 1983 was produced during 1977, which was by far the lowest flow year we sampled (Cramer, et al. 1985). Thus, in those years where flow in the Yuba would be augmented, this new management action would likely be detrimental to chinook and steelhead juveniles, just as the WUA analyses indicate.

4.0 **THE MAIN MOTIVE FOR THE RECOMMENDATION OF HIGH MINIMUM FLOWS IN APRIL TO JUNE APPEARS TO BE ENHANCEMENT OF AMERICAN SHAD. THUS, SHAD ENHANCEMENT IS FAVORED AT THE EXPENSE OF CHINOOK AND STEELHEAD.**

4.1 The discrepancy between the PHABSIM analyses and the flows recommended in April to June seem quite obvious, so I wondered what the real motive was behind the authors' recommendation of higher minimum flows in April to June. On page 82, they say these flows would be "suitable" for emigration of chinook and steelhead, they would prevent redd dewatering and stranding, they would provide "acceptable" attraction flows for adult spring chinook, and they would provide American shad attraction, migration and spawning flows. I take exception to all these justifications, except those for shad. First, there is no evidence in the Management Plan or elsewhere (that I have discovered) that special flows are needed for smolt emigration in the Yuba River. Most smolts in the Yuba River have less than 20 miles to migrate to reach the Feather River and there are no obstacles in their way. Second, dewatering and stranding should be insignificant issues because emergence of chinook fry is complete by April and steelhead typically spawn in tributaries. Specification of flow ramping rates can prevent stranding. Third, there is no evidence that spring chinook respond to "attraction" flows. Homing of spring chinook is highly accurate (Quinn and Fresh 1984), and they do not need to be attracted into the Yuba River. I also find no evidence that a self-sustaining population of spring chinook even exists in the Yuba River (I will discuss this further).

4.2 Because the Management Plan provides no evidence or discussion to support the three points that I have just discounted, I strongly suspect that enhancement of shad is the key motive for the authors' recommendation of higher flows in May to June. In fact, the Management Plan section on AQUATIC HABITAT AND STREAM DISCHARGE RELATIONSHIPS discusses flows for optimum WUA for chinook and steelhead and then, we see on page 80, "Based upon the present understanding of American shad, flows of 1,000, 2,000, and 1,500 cfs. during April, May, and June, respectively, should be adequate . . .". It appears obvious that this is what the flows are really designed for. The Management Plan cites the study of Painter, et al. (1979) which concluded that to maintain a historic distribution of adult virgin shad to the Yuba River, the May to June flow of the Yuba should not be less than 33 percent of the Feather River discharge and the Feather River should not be less than 34 percent of the Sacramento River discharge. Thus, it appears strongly to me that the authors' desire is to enhance adult shad attraction without regard to the detriment of juvenile chinook and steelhead.

4.3 In my opinion, designing flows for shad instead of chinook and steelhead is an irresponsible strategy for two reasons. First, chinook and steelhead are indigenous to the basin and the economic value of chinook to ocean and river fisheries is vastly greater than that of shad. The Management Plan states at the outset that chinook salmon are considered the primary species of importance (p. 1 and several other places). Second, the key factors affecting survival of shad operate outside the Yuba River (Meinz 1979), so managing the Yuba for shad is a big gamble. Returns of shad to the Sacramento River basin in recent years have been poor (personal communication with Fred Meyer, CDFG, Rancho Cordova) and demonstrate the downside of this gamble.

4.4 The report states on page 63:

> "Results of temperature simulations indicate that flows of 1,000, 2,000, 1,500, 1,000 and 700 cfs. at Marysville during a warm April, May, June, October, and November, respectively, will meet the above temperature criteria."

This statement is presented in such a way as to be misleading. Indeed, the simulations indicate these flows will "meet" the temperature criteria, but they are far from necessary to meet the temperature criteria. The graphs presented on pages 57 to 59 indicate that April to June temperature criteria would be met even in a warm year with 245, 1,000 and 1,000 cfs. in April, May, and June. However, I place low confidence in the accuracy of the temperature model used and agree with the report that additional temperature studies are needed. Temperature should be modeled on a daily time step rather than on the monthly time step used in the Management Plan.

5.0 IT IS DOUBTFUL THAT A SELF-SUSTAINING RUN OF SPRING CHINOOK EXISTS IN THE YUBA RIVER. THE OCCASIONAL SPRING CHINOOK FOUND IN RECENT YEARS ARE PROBABLY STRAYS FROM THE FEATHER RIVER HATCHERY.

5.1 I found no evidence to support the existence of a self-sustaining run of spring chinook in the Yuba River. Evidence does substantiate that the indigenous run was extinct by about 1930. The indigenous run held over summer in the river above the site of Englebright Dam and spawned above that point. Fish ladders at Daguerre Point Dam were washed out in 1927-1928, and new fish ladders were not installed until 1938. New Bullards Bar was not constructed until 1969, so flow and

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temperature below Daguerre Point would have enabled over-summer survival of spring chinook. Because the maximum life cycle of spring chinook is six years and passage at Daguerre Point Dam was blocked 10 years, the run must have been extinct before new ladders were completed in 1938. The Management Plan cites Fry (1961) as saying the run virtually disappeared by 1959. The occasional sightings of spring chinook were probably strays. Hatchery spring chinook were planted in 1980, but at no other time, so there has been no attempt to reestablish a spring run.

5.2 It is highly likely that any spring chinook entering the Yuba River are strays from Feather River Hatchery. Feather River Hatchery has reared and released three to six million spring chinook smolts annually since 1967 (personal communication, Don Schlicting, Manager of Feather River Hatchery, California Department of Fish and Game, Oroville). Since 1984, most of the spring chinook reared at Feather River Hatchery have been released near Vallejo in the estuary, which is likely to impair their imprinting and cause a high degree of straying on return. Cramer (1989) estimated from recoveries of coded wire tags (CWTs) from fall chinook at spawning areas in the Sacramento Basin that an average of 69 percent of all Feather River Hatchery fall chinook that had been released in the estuary strayed to locations outside the Feather River upon return. Based on this experience with fall chinook, it seems highly likely that some spring chinook from Feather River Hatchery which are trucked to the estuary also stray into the Yuba River. Spawning of chinook is surveyed annually in the Feather River by California Department of Fish and Game, and a number of marked fish with CWTs were recovered in 1979 and 1980. Among these CWTs recovered, four of six in 1979 and 13 of 16 in 1980 were spring chinook from Feather River Hatchery. This level of straying from Feather River Hatchery should account for the occasional sightings of spring chinook in the Yuba River.

5.3 Temperatures during spawning and egg incubation are now poorly suited to production of spring chinook (p. 50). The Management Plan identifies that in three of six years during 1973 to 1978, temperatures below Englebright Dam regularly exceeded 55°F during September and October (traditional spawning time) which would result in high egg mortality. The temperature regime has been altered as a result of thermal energy storage in the impoundments upstream, such that temperatures at spawning and incubation are higher than historically. Not only are these higher

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temperatures often lethal to eggs in October, but they also speed up egg development rates and cause spring chinook to emerge early in the winter when fry survival is poor. This is similar to the problem we identified in the Rogue River below Lost Creek Dam, where increases in river temperature during fall and winter following completion of the dam caused early emergence of fry and greatly reduced their survival (Cramer, et al. 1985). The new temperature regime is well suited for fall chinook which spawn through November and into early December, because temperatures have dropped some by then and emergence of fry is delayed until February and March.

5.4 In my opinion, the costs of reestablishing a self-sustaining run of spring chinook in the Yuba River would far outweigh the benefits. To begin with, there is a low probability that such a reestablishment can succeed at all, for the reasons just discussed. If it did succeed, substantial releases of water would be required during summer to provide holding water for adults and extra cold water releases would be required during fall to enable successful spawning. The cold water releases in the fall would leave extra heat energy in the reservoir, which would increase the temperature of water released in the late fall and winter. That warmer water in fall and winter would accelerate emergence of fall chinook into an environmentally more hostile time of hear and likely reduce their survival. If earlier emergence was of any benefit, then genetic selection would have already occurred so that spawning times and incubation rates would have produced that earlier emergence. All of this discussion is theoretical, and the temperature aspects need to be tested by accurate modeling of the temperature inputs and outputs from New Bullards Bar and Englebright Reservoirs. This should be completed before hit-and-miss test releases of water are made, with the fish being forced to live with the associated costly side effects. If such temperature modeling indicates desirable release temperatures can be achieved to meet the needs of spring and fall chinook, then test releases should be negotiated.

6.0 ORIGINAL DATA FROM THE CDFG STUDY BY KONOFF (1988) OF FISH LOSSES AT THE SOUTH YUBA/BROPHY DIVERSION INDICATE SURVIVAL OF FISH PASSING THROUGH THE INTAKE AND BYPASS CANALS IS PROBABLY GREATER THAN 95 PERCENT.

6.1 I thoroughly reviewed the CDFG study reported by Konoff (1988) on the estimated losses of juvenile chinook at the South Yuba/Brophy diversion levee and found that it contained substantial omissions of pertinent data. The diversion of water by the South Yuba/Brophy Irrigation

Districts actually takes place at a large pool off channel from the Yuba River, so water flows to this point of diversion through an intake canal and the undiverted portion of this water flows back to the Yuba River through a bypass canal (Figure 1). In the study reported by Konoff (1988), juvenile chinook were marked and released at the intake of the diversion canal and then recovered during the following four (4) days in two fyke traps in the bypass canal (Figure 1). A fyke trap was also placed across the mouth of the intake canal, reportedly so that all fish entering the canal could be monitored. Konoff (1988) reports the numbers of marked fish released and recaptured during two separate experiments in May 1988, but does not report if any marked fish were recaptured in the second fyke net. The report implies that the fyke traps captured all chinook passing down the bypass canal, and thus, that the proportion of fish recaptured equals the proportion that survived. Upon reading the Konoff report, I immediately wondered why they used two fyke traps back-to-back in the bypass canal if the fyke traps were 100 percent efficient.

6.2 The report does not address the rate at which juvenile chinook escaped around the fyke nets installed at the inlet and the outlet. Even if the wings of the fyke nets were perfectly sealed to the bottom and edges of the stream, fry could escape through the meshes of the fyke-wing panels. They used 1/4" mesh hardware cloth for these panels, and Fisher (1978) showed that 1/4" mesh screen would only retain about 50 percent of juvenile chinook up to 49 millimeters long. The Konoff study included some fish of this size. Snorkelers inspected the fykes and concluded their seams were fish tight, but "fish could possibly escape through the upper and lower mesh on the fyke nets," (appendix to Konoff (1988)). They also observed that fish were capable of avoiding the fyke nets when they saw a group of "15 juvenile chinook salmon holding 2 to 3 feet upstream of the fyke net opening in the intake trap right at the point of maximum velocity." I have found from personal experience with a similar fyke trap in Lobster Creek of the Rogue River basin that even if underwater inspection indicates the fyke trap is fish tight, large proportions of the outmigrating juvenile chinook find ways to escape around the trap through pores in the cobble substrate, or through meshes of the fyke panels.

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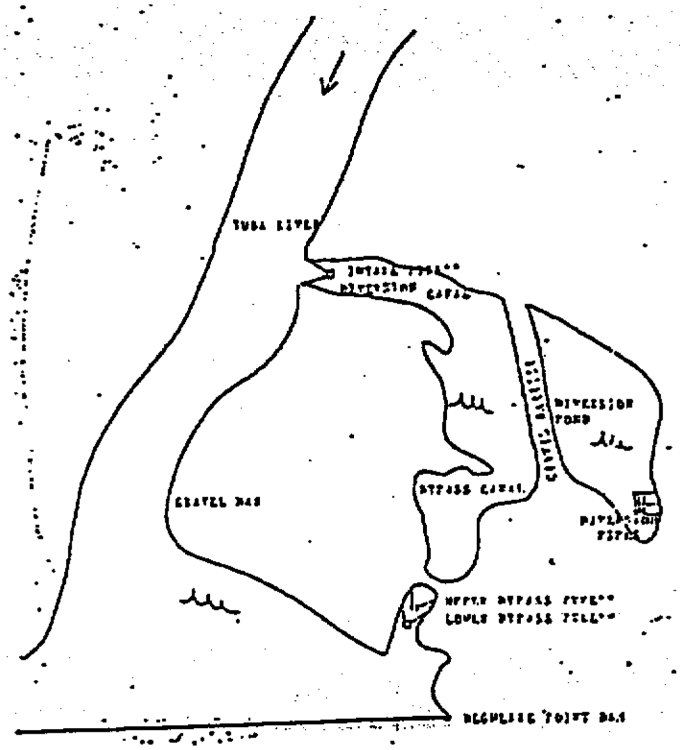

Figure 1. Map of South Yuba/Brophy Diversion study area (from Konoff (1966)).

I therefore requested, and was granted, access to the original data sheets recorded by CDFG for this study. The data were quite enlightening and demonstrated conclusively that the fyke traps did not capture all fish passing down the bypass canal. In both of the tests (May 11-15 and May 23-27), substantial numbers of chinook were captured in the lower fyke trap within the bypass canal. If the upper fyke trap was only partially effective, there is every reason to believe that the same was true of the lower fyke trap. I summarized the catches in the upper and lower fyke traps of the bypass canal in Tables 1 and 2. In the first test, 413 chinook marked with an upper caudal clip were released shortly after dark (May 11) and 492 chinook marked with a lower caudal clip were released early in the morning (May 12). In the second test, 506 chinook marked with an upper caudal clip were released in the afternoon of May 23 and 517 chinook marked with a lower caudal clip were released at night on May 23. All marked fish were released just downstream of the intake fyke trap. In the first test during May 11-15, catches in the upper fyke net averaged about one-third of the fish released and the lower fyke net captured another six to 10 percent of the marked fish released. In the second test during May 23-27, catches in the upper fyke ranged from 35 percent to 59 percent of the marked fish and catches in the lower trap averaged 2.6 percent to 3.9 percent of marked fish. In this second test, the data also indicate that the lower fyke was becoming less effective through time. After the second day of the four-day recovery period, few fish were captured in the lower fyke, although catches in the upper fyke remained about the same. Decreasing capture efficiency is a common problem with fyke traps, because the scouring effect of flowing water gradually widens the gaps between the substrate and the mesh panels.

Table 1. Summary of Marked and Unmarked Fish Released and Recovered by CDFG at the South Yuba/Brophy Diversion During May 11-15, 1988 (Original CDFG Data)

Chinook Type	Intake Chinook	Upper Fyke		Lower Fyke	
		Chinook	% of Intake	Chinook	% of Intake
No Mark	3541	930	26.3%	275	7.8%
Upper Caudal	413	141	34.1%	26	6.3%
Lower Caudal	492	179	36.4%	54	11.0%

Table 2. Summary of Marked and Unmarked Fish Released and Recovered by CDFG at the South Yuba/Brophy Diversion During May 23-27, 1988 (Original CDFG Data)

Mark Type	Intake Chinook	Upper Fyke		Lower Fyke	
		Chinook	% of Intake	Chinook	% of Intake
No Mark	1315	1290	98.1%	79	6.0%
U Caudal	506	220	43.5%	13	2.6%
L Caudal	517	306	59.2%	20	3.9%
Lateral	88	31	35.2%	3	3.4%

The main question remaining to be answered is, "What proportion of the chinook approaching either fyke trap did that trap catch?" This question is typically answered where fyke traps are used by releasing groups of marked fish immediately upstream of the trap and then monitoring the proportion that are captured in the trap. This is a standard operating procedure and is called an efficiency calibration test. I was surprised to learn from the original data sheets that such a test had

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been completed by CDFG, but the results were not reported by Konoff (1988). The calibration test was performed by releasing 88 chinook, with a "lateral" fink mark, 4 m. upstream of the culvert within the bypass canal at 6:15 p.m. on May 24. Table 2, above, shows that only 35.2 percent of these fish were recovered in the upper fyke trap and 3.4 percent were recovered in the lower fyke trap. Thus, the fyke traps actually recovered a lower percentage of fish released in the bypass canal than of fish released in the intake canal. Given this low trap efficiency, the high recovery rates of marked fish released in the intake canal indicates their survival past the diversion levee and through the bypass canal was substantially higher than the estimates given by Konoff (1988) and likely exceeded the 95 percent survival criterion stipulated by CDFG. The exact survival rates cannot be calculated from this data set, because the recovery rate of marked fish varied substantially for undetermined reasons.

6.3 Konoff (1988) did not estimate the total number of marked fish remaining above the fyke traps when trapping was concluded, but an electrofishing survey on May 27 (the day trapping ending) demonstrated that many marked fish were rearing within the study area above the fyke traps in the bypass canal. With a small boat electrofisher, CDFG captured seven (7) marked and 116 unmarked chinook on May 27. Electrofishing for juvenile chinook is highly inefficient, so the seven fish captured likely represent a small portion of what was actually there. Konoff reports that they electrofished in two passes through the diversion area, and they caught 47 salmonids on the first pass and 77 on the second pass. The fact that they caught more fish on the second pass demonstrates the inefficiency of electrofishing and indicates that they had not yet begun to exhaust the number of juvenile chinook present. Obviously, many fish remained unsampled. This finding, in conjunction with the high proportion of marked fish recovered in the fyke nets strengthens evidence that the diversion canal and levee are safe for juvenile chinook passage.

7.0 MY REVIEW OF DATA ON THE SOUTH YUBA/BROPHY LEVEE FACILITIES, AS CONTAINED IN THE CDFG REPORT OF MAY 25, 1988 (KONOFF) AND THE U.S. FISH AND WILDLIFE SERVICE REPORT (SMITH 1989), INDICATES THE LEVEE IS IMPERMEABLE TO FISH AND IS NOT ALLOWING FISH TO BE ENTRAINED IN IRRIGATION WITHDRAWALS AS SUGGESTED IN THE MANAGEMENT PLAN.

7.1 The Management Plan concludes that substantial numbers of juvenile chinook pass through the pores in the South Yuba/Brophy levee in proportion to the flow diverted (p. 99). This

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conclusion is a gross error, and is refuted by every study made of the levee area. Divers, on May 25, 1988 (Konoff appendix by Sommer 1988) found abundant juvenile chinook on the river side of the levee, but none on the diverted side of the levee. An electrofishing survey by CDFG in May 1988 produced no chinook salmon in three nights of sampling behind the levee, but nearly 7,500 juvenile chinook were counted entering the canal on the river side of the levee (Konoff 1988). In the U.S. Fish and Wildlife Service study (Smith 1989), Smith concluded from his dive in front of the entire levee that, "The gabion appeared to be fairly fish tight." Additionally, Smith could not detect any noticeable head differential between the pool in front of the gabion and the pool behind. Thus, there was no current to entice juveniles to find their way through the crevices of a roughly 20-foot thick wall of rock. Smith (1989) concluded that juvenile chinook found behind the levee on some occasions got there during floods when flows over-topped the levee.

7.2 In carefully designed tests conducted in salt water on the east coast, Ketschke (1981) found that no larval fish (most smaller than salmon fry) passed through a nine-foot wide levee constructed of eight-inch (8") diameter stones. The author performed laboratory tests that confirmed this finding. The South Yuba/Brophy levee is substantially thicker than nine feet, and most stones are small than eight inches (8") in diameter.

7.3 Conventional fish screens are intended to be fish tight, but generally are not. I have found, for example, through extensive studies that juvenile chinook escape through very small gaps in the fish screens at the Glenn-Colusa Irrigation District diversion on the Sacramento River. In another example, the Oregon Department of Fish and Wildlife recently sampled juvenile chinook in front and behind a new state-of-the-art fish screen on the McKenzie River, Oregon, and found that about 10 percent of the fish were escaping through minute gaps at the edges of the screen. I am unaware of any fish screen that has been found to be continuously 100 percent fish tight. For this reason, I cannot imagine a fish screen that could be made any more impermeable to juvenile salmon than the present levee.

7.4 Objections are raised in the Management Plan that juveniles are carried into the pool behind the levee by flood flows, and become trapped there. Smith (1990) found healthy juveniles rearing pond behind the levee on April 25, 1989. They found no more fish once diversions began.

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Preston (1987) also captured three juvenile chinook behind the levee in 1987 prior to the beginning of diversions. Smith (1989) concluded these juveniles entered the pond when the levee was overtopped by flow in March, and that these fish left the pond in the water withdrawn for irrigation. Use of a conventional fish screen would not prevent these overtopping events.

7.5 The objection to getting fish over the top of the levee during flood flows ignores what would have happened had the levee not been present. They would have faced the same fate without the levee. I am informed that the pond existed prior to the construction of the levee and the intake canal from the river: Flood flows would have then passed juvenile fish into the pond with no means of escaping at lower flows.

7.6 There is an effective solution that can be used to rescue juveniles deposited behind the levee during flood flows. The irrigation water diverted behind the levee flows through a canal across the Yuba Goldfields, where a substantial stream flows back to the Yuba River. This stream through the Goldfields is used extensively by adult and juvenile chinook salmon (Smith 1989). The South Yuba Water District and Brophy Water District can be asked to divert, before blocking up the Goldfields, sufficient water from behind the levee back into the Goldfields stream to allow chinook an opportunity to return to the Yuba River. After several days of such a diversion, the berms for the diversion canal within the Goldfields can be closed to allow diversions to begin.

7.7 I was surprised that the Management Plan did not consider the potential benefits of the Goldfields ponds as refuges for protection of juvenile chinook during flood events. It has been shown from several decades of study on the Rogue River that winter floods are a major source of mortality to juvenile chinook (Cramer, et al. 1985). This fact has been demonstrated in numerous other studies. Studies in Oregon, Washington, British Columbia, and Alaska have shown that off-channel ponds, such as beaver dams, are an extremely important habitat for juvenile salmonids during winter and during periods of high flow. These ponds provide a place for the juveniles which would otherwise be killed by being swept away during high flows. Smith (1989) reported that fish rearing in the pond behind the levee and in the Goldfield ponds were healthy and larger than juveniles captured in the Yuba River. I would not offer an opinion without much more study, but the substantial numbers of adult chinook which are spawning in the Goldfields area may well be an

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indicator that during high flood flow periods, juveniles protected in this area prosper, emigrate to the ocean, and return to spawn in the same location.

8.0 PREDATION AT THE SOUTH YUBA/BROPHY LEVEE OR HALLWOOD/CORDUA DIVERSION.

8.1 I now will discuss the evidence as to whether predation at the South Yuba/Brophy diversion is a substantial problem. First, we must begin with the understanding that the mark/recapture tests with juvenile chinook just described indicate that survival of juvenile chinook during their transit from the intake canal, past the diversion levee, and down the bypass canal is near 100 percent. Thus, the effect of predation must be small. This conclusion tends to be confirmed by snorkeling and electrofishing data at the diversion. During the snorkel survey through the diversion area reported by Sommer (appendix to Konoff 1988), only 12 adult squawfish were sighted. We found from sampling hundreds of juvenile and adult squawfish in the vicinity of the Glenn-Colusa Irrigation District diversion during 1991 that juvenile squawfish smaller than 20 centimeters rarely eat fish (Cramer, et al. 1992). Snorkel surveys throughout the Yuba River in May 1988 showed limited numbers of adult squawfish in the river (89 in Table 7, p. 26). They also showed that most squawfish observed were juveniles (761 juveniles to 89 adults; 89.5%). The electrofishing survey of fish throughout the Yuba River, as reported in the Management Plan (p. 100), produced only two out of 16 adult squawfish with chinook in their stomachs in February and May (peak chinook abundance). This is similar to the findings of our study at the Glenn-Colusa Irrigation District diversion where we found whole or partial fish parts in 14.5 percent of squawfish captured by angling (Cramer, et al. 1992). Vondracek (1987) found that Sacramento squawfish, in 60°F water, required 15 hours to complete 90 percent evacuation of their gut. Thus, although squawfish have been found to eat juvenile chinook, the total losses of juvenile chinook to predation are small.

8.2 The deep pool adjacent to the levee is viewed by CDFG as a haven for predators. This is true of any deep pool throughout the river, but we would not eliminate the pools from the river. This same pool may serve as an important refuge from high flows for juvenile chinook and steelhead, as described earlier.

8.3 The Management Plan cites the study by Hall (1979) as demonstrating that predation by squawfish was believed responsible for losses of 19.0 percent to 50.2 percent of juvenile chinook

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released above the screen. It is highly probable that the fish released by Hall were subject to the same tendency for upstream migration that we discovered in 1991 among marked fall chinook released in the vicinity of the Glenn-Colusa Irrigation District (GCID) diversion (Cramer, et al. 1992). At GCID, we recaptured a number of marked juvenile chinook up to 1.5 miles upstream of their release point, including some that had been released behind the fish screens that found their way through gaps in the seals and back into the river. We estimated at GCID from differences in recovery rates between release groups that as many as 50 percent of the juvenile chinook in some release groups migrated upstream rather than downstream. Reimers (1973) found that juvenile chinook released into a test stream consistently swam upstream following release during daylight, but drifted downstream following release at night. I strongly suspect that many of Hall's experimental fish swam upstream and that predation at the Hallwood/Cordua screen is much lower than estimated by Hall (1979), but I cannot draw final conclusions until I have reviewed his original data. Further tests will probably be necessary to resolve this issue.

9.0 THE MANAGEMENT PLAN'S CONCLUSION THAT FALL CHINOOK PRODUCTION IN THE YUBA RIVER HAS NOT INCREASED SINCE COMPLETION OF NEW BULLARDS BAR IS BASED ON AN INCOMPLETE AND ERRONEOUS ANALYSIS. A MORE COMPLETE ANALYSIS INDICATES THE POPULATION HAS BEEN SUBSTANTIALLY ENHANCED.

9.1 The Management Plan concludes that New Bullards Bar Dam has not benefitted fall chinook runs because they have averaged the same before (1953 to 1968) and after (1969 to 1989) completion of New Bullards Bar Dam (p. 7). This is a very naive comparison, considering that CDFG is well aware there have been substantial increases in mortality of smolts as they migrate through the Sacramento-San Joaquin Delta and that the majority of adult chinook are harvested in ocean fisheries before they return to fresh water. Meaningful comparisons of fall chinook production in the Yuba River cannot be made without including these factors. Additionally, the post-impoundment run should be averaged for 1972 to 1989 rather than 1969 to 1989, because juveniles rearing after dam completion did not begin returning as adults until then.

9.2 I did not have time to analyze all of the data indicating that survival of smolts in the lower Sacramento River and Delta have declined in recent years, but such data are numerous. Kjelson, et al. (1989) found from extensive mark/recapture data from juvenile chinook migrating

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through the Delta that smolt survival was negatively correlated to water temperature, the fraction of water diverted at Walnut Grove, and the total water exports to the State Water and Central Valley Projects. Kjelson, et al. (1989) found that variation in these environmental parameters accounted for 95 percent of the variation in smolt survival from Sacramento to Chipps Island in the estuary. Each of these environmental variables has increased since 1968, particularly the volume of water exports. The USFWS (1987) found that average water temperatures in late May through June in the Sacramento River between the mouth of the Feather and American Rivers increased 2 to 3°C between 1975 and 1985. The USFWS (1987) used a simpler model than that of Kjelson, et al., to compare smolt survivals for average conditions in 1990 to those for average conditions in 1940 and they estimated that survival had decreased 25 to 40 percent. The more accurate model developed by Kjelson, et al., could be used to estimate the change in smolt survival outside of the Yuba River since New Bullards Bar Dam was completed. Bottom line, these analyses indicate that the Yuba River must be producing more or healthier smolts now than in the 1960's in order to maintain the same production of adults.

9.3 The majority of adult fall chinook are caught in the ocean before they return to fresh water. The Pacific Fisheries Management Council (1990) estimates that the average harvest rate of California Central Valley chinook averaged 67 percent during 1980 to 1989. Reisenbichler (1986) compiled CDFG's data on ocean catch and river escapement of chinook salmon in California since 1947 and showed that ocean harvest rates varied between years, but trended strongly upward between 1945 and 1975 (Figure 2). Thus, the number of Yuba chinook harvested in the ocean per fish returning to spawn is substantially higher today (by roughly a factor of 1.5) than it was during the 1960's. Even if ocean harvest rates had not changed, I concluded from my analysis of all CWT data from the Sacramento Basin (Cramer 1989) that present ocean harvest rates were too high for natural populations to sustain themselves without hatchery supplementation. This means that even if harvest rates did not change after 1970, natural populations of chinook throughout the Sacramento Basin would have gradually declined.

9.4 The fact that the escapement of fall chinook in the Yuba River has sustained itself without hatchery supplementation, in spite of high ocean harvest and environmental degradation in

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the lower Sacramento River and Delta, is remarkable and must be attributable to high productivity of the system. I conclude from the foregoing review that production of fall chinook in the Yuba River has increased substantially since completion of New Bullards Bar Dam. Simulation analysis could be used to estimate the magnitude of that change.

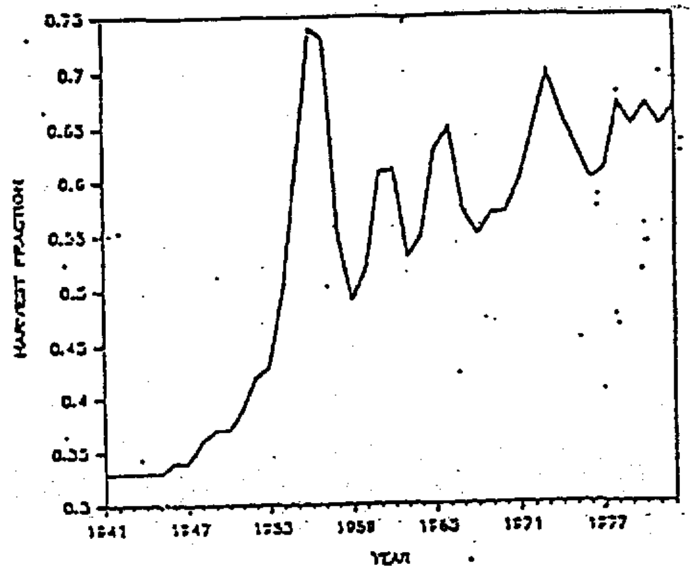

Figure 2. Estimated fraction of chinook salmon that were harvested in the ocean (from Reisenbichler [1986]).

10.0 THE AUTHORS OF THE REPORT HAVE SET THE TEMPERATURE REQUIREMENTS TOO LOW FOR ADULT MIGRATING SALMON AND STEELHEAD. TO PRESUME THAT A LOW TEMPERATURE IS REQUIRED WHEN IN FACT CHINOOK AND STEELHEAD HAVE MIGRATED SUCCESSFULLY FOR YEARS AT HIGHER TEMPERATURES IS UNJUSTIFIED.

10.1 On page 42, it is suggested that the maximum temperature criteria for adult salmon migration should be 57.5°F for fall chinook, 55.9°F for spring chinook, and 52°F for steelhead. Fall chinook and steelhead enter the Sacramento River and migrate to the Feather and Yuba Rivers at much higher temperatures than these. I have personally sampled the peak of the chinook and steelhead runs entering the Rogue River in August when daily maximum temperatures of the river often exceeded 70°F. Ignoring the temperature criteria, the habitat surveys reported in the Management Plan indicated that only 100 cfs were needed for upstream passage (p. 94). Any

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predicted delay of fall chinook at the mouth of the Yuba River when temperatures exceed 57.5°F (p. 47) is undocumented and unfounded. If there was such a delay, how would the fish get to the mouth of the Yuba River to start with if they must migrate through much higher temperatures in the lower Sacramento River?

I DECLARE under penalty of perjury under the laws of the State of California that the foregoing is true and correct. If called to testify in this matter, I would provide the testimony stated above of my own knowledge and opinion, except as to those matters stated on information and belief, and as to those matters I believe them to be true and correct.

EXECUTED on January 19, 1992, at Corvallis, Oregon.

Steven P. Cramer
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QUALIFICATIONS

Steven P. Cramer
Principal
S.P. Cramer & Associates

EDUCATION

1968 Wilson High School, Portland, Oregon

1972 Oregon State University - B.S. in Fisheries Science
Grade point average: 3.4 of 4.0

1974 Oregon State University - M.S. in Fisheries Science
Minor: Statistics
Funding: Research assistantship with Oregon Cooperative Fishery Research Unit
Major Professor: Dr. John D. McIntyre
Thesis Title: The Heritability of Resistance to Gas Bubble Disease of Columbia River Fall Chinook Salmon, Oncorhynchus tshawytscha

EXPERIENCE

Fisheries Consultant

1990-91
Client: Glenn-Colusa Irrigation District (GCID)
344 East Laurel St
P.O. Box 150
Willows, CA 95988
(916) 934-8881

During 1990, I designed and supervised mark-and-recapture studies of juvenile chinook and squawfish in the vicinity of the GCID pumping plant and fish-screens where up to 3,000 cfs are diverted from the Sacramento River. Fishery agencies were concerned about losses of juvenile chinook salmon to impingement on the screens, entrainment through the screens, and predation in the intake channel. We found that losses of juvenile chinook to predation were negligible, but that losses to impingement increased from 10% up to 70%, proportional to flow diverted by the pumps. We found a deficiency in the design of the screen that caused juveniles to become entrapped at its base. We are continuing studies in 1991 to evaluate structural and operational remedies.

1990-91
Client: Nez Perce Tribal Council
P.O. Box 365
Lapwai, ID 83540
(208) 843-2253

During 1990, I analyzed the feasibility of reintroducing extinct populations of coho, sockeye, and chum salmon into the Grande Ronde and Walla Walla Rivers, tributary to the Columbia River. I assembled and analyzed an extensive historic database to estimate life-history parameters of the extinct populations and of the existing kokanee population in Wallowa Lake. I used these parameters to evaluate compatibility of potential donor stocks. I analyzed temperature and flow data and used findings from studies of fish passage at Columbia River dams to predict optimum survival of reintroduced stocks.

During 1991, I have been retained again to complete a Genetic Risk Assessment, as now required by law, for initiation of hatchery programs in five river basins. I will be preparing a detailed characterization of the natal stocks, listing specific genetic risks, estimating the magnitude of the risks, and recommending methods for minimizing the genetic risks.

1990
Client: Don Chapman Consultants, Inc
3180 Airport Way
Boise ID 83705
(208) 383-3401

I completed a comprehensive analysis and report on the status of wild coho in tributaries to the Columbia River below Bonneville Dam. These wild coho are under review by NMFS for Threatened or Endangered Status. I assembled and analyzed an extensive database on the catch, escapement, spawning time, juvenile rearing, and hatchery influence on these wild fish. I estimated harvest rates for hundreds of CWT and fin mark groups. I found lower Columbia coho comprise several distinct stocks and that selection for early spawning in the hatcheries has dramatically altered spawning time of hatchery stocks. I concluded the principal causes of decline were over harvest and displacement by outplanting of poorly adapted hatchery fish.

1989
Client: California Department of Water Resources
3251 S Street
Sacramento, CA 95816
(916) 322-7165

I developed a comprehensive analysis, based on existing data, of the roles of hatchery and natural reproduction in supporting fall chinook salmon populations in the Sacramento River Basin. The primary basis for my analysis was cohort analysis of recoveries from over 200 CWT groups. I estimated key life history parameters for each major subpopulation of fall chinook in the basin, and quantified statistically significant relationships of these parameters to physical and biological factors. The study findings had important implications for resource management. The extensive report I produced will be used for water resource planning.

1989
Client: Pacific Northwest Utilities Conference Committee
One Main Place
101 Main St, Suite 810
Portland, OR 97204-3216
(503) 223-9343

I prepared tabular summaries of Columbia River subbasin plans for salmon and steelhead. I also developed a summary of assumptions included in the System Planning Model developed by the NW Power Planning Council. These summaries were intended to aid review of the subbasin plans by utility companies.

1989
Client: U.S. Fish and Wildlife Service
Fisheries Assistance Office
4001 N. Wilson Way
Stockton, CA 95205
(209) 466-4421

I reviewed a report for USFWS entitled, "A Model for Estimating Mortality and Survival of Fall-Run Chinook Salmon Smolts in the Sacramento Delta between Sacramento and Chipps Island." I suggested data transformations and model revisions that were subsequently included. I reanalyzed portions of the data as required for revision of the model. The model was to be used for evaluating the effects of alternate water-project operations on smolt survival.

1989
Client: D.W. Kelley & Associates/Aquatic Biologists
P.O.Box 634
Newcastle, CA 95658
(916) 663-4271

I reviewed a report by D.W. Kelley & Associates entitled, "The Roles of Feather and Nimbus Salmon and Steelhead Hatcheries and Natural Reproduction in Supporting Fall Run Chinook Salmon Populations in the Sacramento River Basin." I advised Don Kelley during his preparation to witness in court hearings regarding water withdrawals from the American River. My primary task was to determine the defensibility of analytical procedures used in the report and to provide additional analyses for support or for new direction.

1987-1988
Client: Oregon Department of Fish and Wildlife
850 S.W. 15th Street
Corvallis, OR 97333
(503) 754-3241

I represented ODFW as chairman for the Klamath River Technical Advisory Team (KRTAT). This team is composed of biologists representing state and federal agencies, Indian tribes, and user groups involved with harvest of chinook salmon off the coasts of northern California and southern Oregon. I was responsible for guiding this team to consensus in such matters as predicting chinook abundance in the ocean, recommending harvest levels, recommending and reviewing monitoring programs, and developing a technical basis for evaluating the consequences of alternative management actions. I also completed special analyses and developed analytical approaches for managing offshore harvest of salmon.

Research Biologist
Employer: Oregon Department of Fish and Wildlife (ODFW)
Job Title: Research Program Leader
Duration: October 1977 to July 1987

I supervised extensive studies of anadromous salmonids in the Rogue and Columbia Rivers. My general responsibilities have included planning project objectives and experimental design, directing and participating in complex data analyses, writing proposals and progress reports, managing budgets, supervising program personnel, coordinating research activities and recommendations with other public agencies, and performing special assignments for ODFW. The projects I supervised through the years are described here

Rogue Basin Fisheries Evaluation Program. The goal of this program, funded by the U.S. Army Corps of Engineers (USACE), was to determine the fishery impacts and develop criteria for operating Lost Creek (Rogue River) and Applegate (Applegate River) dams to optimize benefits to anadromous salmonids downstream. We extensively sampled salmonids at all phases of their freshwater life history and determined how the basic life history parameters varied with changes in temperature and flow. We used these relationships to construct a simulation model of fish production and harvest as they were influenced by changes in temperature and flow released from the dams. We identified several operating practices for each dam that could be modified to increase fish production and harvest.

We also studied the effects of size and time at release on returns of chinook and steelhead to Cole Rivers Hatchery at the base of Lost Creek Dam, and of physiological indicators (primarily the enzyme ATPase) of parr-smolt transformation in chinook.

Evaluation of the Ice-Trash Sluiceway at Bonneville Dam as a Bypass System for Juvenile Salmonids. The goal of this study, funded by the USACE, was to determine the volume of flow and combination of opened sluice-gates that would bypass the greatest proportion of out-migrating salmon and steelhead around the dam. We also studied the diel distribution of fish passage through the sluiceway to determine if high bypass efficiency could be maintained while operating the sluiceway only a portion of each day. We found that the volume of flow into the sluiceway and the combination of opened sluice-gates greatly affected bypass efficiency. We were able to bypass a maximum of 58% of the chinook and 83% of the steelhead.

Evaluation of the Ice-Trash Sluiceway at The Dalles Dam as a Bypass System for Juvenile Salmonids. The goal of this study, funded by the USACE, was similar to that for the study at Bonneville Dam. Additionally, we attempted to develop a method of sampling fish in the sluiceway that would provide a consistent index of the abundance of salmonid outmigrants passing the dam. The maximum bypass efficiency we achieved was 24% for yearling salmonids and 32% for subyearling salmonids. We succeeded in developing an airlift pump system with a fyke trap that was effective for indexing abundance of salmonid out migrants.

Estimation of Predation on Salmonids by Squawfish at Bonneville Dam. The primary goal of the study, funded by the USACE, was to estimate the number of salmonid smolts passing Bonneville Dam that were eaten by squawfish in the dam's forebay. We also tested electrofishing off of the powerhouse deck as a means of reducing squawfish concentrations, but found the method to be ineffective. We estimated that 1.7 million juvenile chinook were eaten by squawfish between April 13 and August 30 of 1980, and that up to 11% of the out-migrating chinook may have been eaten by squawfish in the dam's forebay.

Brood Stock Development and Evaluation of Rearing and Release Procedures at Bonneville Hatchery. The goals of this study were to develop a self-sustaining brood stock of upriver bright fall chinook and to determine the best size and date at release for their smolts to maximize contribution to the ocean and river fisheries. We found that survival of brood fish was only adequate if holding ponds were lined with nonabrasive material. Preliminary returns indicated that the greatest survival was achieved by chinook released as yearlings, but that chinook released as subyearlings in the fall provided the highest benefit-to- cost ratio.

Evaluation of Fishery Contribution from Fall Chinook Reared at Oregon Hatcheries in the Columbia Basin. The goal of the study was to determine the quantity and distribution of catch for fish released from each of the five rearing facilities, and to determine the benefit-cost ratio for rearing fall chinook at each facility. Returns of coded-wire tags indicated there were differences in fishery contribution rates for fish from various facilities.

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