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SCREENING EXISTING AGRICULTURAL DIVERSIONS IN THE SACRAMENTO-SAN JOAQUIN ESTUARY AND ITS TRIBUTARIES, A REVIEW OF THE PROBLEM

by

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SUMMARY

Approximately 4,300 diversions in the Sacramento-San Joaquin Delta and its tributaries exist, most of which are unscreened. These diversions are causing the loss of at least 13 million chinook salmon and numerous other fish annually. The impacts of the loss of 13 million juvenile chinook salmon can be placed in perspective by computing the numbers which are lost from the fishery as a result of these diversions. The resulting estimate would be 65,000 fish lost from the ocean fishery and an additional 32,500 fish which fail to return to the spawning grounds.

The Department of Fish and Game has the authority, under existing law, to screen all of these diversions but the owners would not be responsible for paying any of the costs, installation, operation, or maintenance in most instances. Therefore, all costs of screening, operating, and maintaining these diversions would have to be accomplished with public funds. We estimate the cost of screening these diversions at approximately 23.5 million dollars.

The following recommendations should be instituted to assist in solving these problems:

1. We should continue to require that all new diversions affecting salmon and steelhead be screened under Section 6100 of the Fish and Game Code.

2. We should seek new legislation to extend the provisions of Section 6100 of the Fish and Game Code to all new diversions which, in the opinion of the Department, will impact fish resources.

3. We should continue to screen existing diversions with DFG funds as surplus funds become available.

4. We should seek funds from the General Fund or the Energy and Resources Fund to cover the costs of this program.

5. We should seek legislation to shift the Operation and Maintenance costs of all existing diversions to the water user.

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INTRODUCTION

The purpose of this report is to provide an estimate of the number of unscreened diversions in the Sacramento-San Joaquin Estuary and its tributaries, and to assess the impact of these unscreened diversions on the fishery resources of the system. The report will also propose some solutions to the problem.

Formal studies on the effects of unscreened water diversions in California date back to at least 1931, when an investigation of fish losses at the Glenn-Colusa Irrigation District's intake was conducted. Since that time a number of studies, including several recent studies in the Delta, have been conducted. This evaluation is based on the results of these studies. The estimates suffer from small sample sizes, wide variability in the results, and the irregular nature of the sampling. Obviously, a comprehensive sampling program would yield better results. In spite of these shortcomings, the results appear to be reasonable and are conservative estimates of the problem.

FISH SCREEN LEGISLATION

The Fish and Game Code has three articles which set forth requirements for fish screens on water diversions in California. The first two (Division 6, Chapter 3, Articles 3 and 4) are applicable to all diversions constructed prior to 1971 and to diversions constructed since 1971 which do not affect salmon and steelhead populations. The third (Division 6, Chapter 3, Article 5) is applicable to diversions constructed since 1971 which affect salmon and steelhead populations.

Diversions which, in the opinion of the Department of Fish and Game, will affect salmon and steelhead populations and are constructed after 1971, must have screens constructed, operated, and maintained by the owner. Screens on diversions built prior to 1971, and newer diversions which do not affect salmon and steelhead, require funds from the Fish and Game Preservation Fund. If the diversion is larger than 250 cfs, the costs of installation, operation, and maintenance are shared, while the Fish and Game Preservation Fund bears the full cost of installing, operating, and maintaining screens for diversions of less than 250 cfs. Thus, most of the diversions identified in this study would have to be screened by the Department, using funds from the Fish and Game Preservation Fund.

RESULTS

Number of Diversions

Estimates of the number of diversions were obtained from two sources. The first, DWR Bulletin #130 (series for various years), allows an accurate inventory of the number of sites and pumps and size of pumps for the areas covered (Table 1)

TABLE 1

Summary of Diversions from DWR Bulletin 130 Series

	Sites	Pumps	Size Range in Inches
Sacramento System			
Sacramento River	688	945	1¼" - 50"
Feather River	78	101	3" - 46"
Yuba River	17	22	4" - 24"
American River	17	32	4" - 36"
Sub Total	300	1,100	
San Joaquin System			
San Joaquin River	492	602	2" - 36"
Merced River	39	44	4" - 20"
Stanislaus River	24	31	8" - 20"
Tuolumne River	23	28	3" - 21"
Mokelumne River	116	125	1½" - 18"
Sub Total	694	830	
TOTAL	1,494	1,930	

Unfortunately, these records do not include the bulk of the interior Delta diversions. The second source of information is the list of property owners within the legal Delta. This list, prepared for the dry year hearings by the State Water Resources Control Board, shows 2,842 individual property owners. Assuming a minimum of one diversion per property owner, we have 2,842 diversions within the legal Delta to contend with. It is highly probable that this number if higher, since many owners have more than one parcel and many parcels have more than one diversion point.

Combining the results of the two inventories and eliminating duplication, we get a figure of 4,336 diversion sites. These diversions range in size from 1½" to 50". The larger diversions such as the Glenn-Colusa Irrigation District facility near Hamilton City on the Sacramento River have in some cases already been screened. Larger unscreened diversions include the Contra Costa Canal intake in the Delta, Sunset Pumps on the Feather River, and the Tisdale Diversion on the Sacramento River.

Estimates of internal Delta water diversions vary, by time of the year and by water year. However, during the months in question (A, M, J, J, A) the gross volume of water diverted is comparable to the Federal pumping plant in the south Delta, on the order of 4,000 cfs.

Estimates of the diversions upstream of the Delta were developed from the Central Valley Consumptive Use of Applied Water figures provided by the Department of Water Resources. These figures underestimate the magnitude of the diversions because they are net losses and account for tailwater returning to the river.

Diversions on the Sacramento River and its tributaries above the Delta range in size from one to 306,000 acre-feet annually. The maximum monthly diversion capacity is approximately 19,000 cubic feet per second of which approximately 12,000 cfs remains to be screened. On the San Joaquin River side, the diversions range in size from one to 190,000 acre-feet annually with a maximum monthly diversion capacity of approximately 13,000 cfs, of which approximately 7,500 cfs remains unscreened. Combining all the estimates, we arrive at a grand total of approximately 23,500 cfs of unscreened diversions in the system.

Chinook Salmon Impacts

Chinook salmon are present in the system on a year-round basis today, however, the bulk of the population migrates past the diversions between February and June of each year. Thus, many of the agricultural diversions would only impact a portion of the run. This is in marked contrast to the CVP-SWP and other municipal and industrial diversions which operate continuously throughout the year.

Several studies are available which allow us to estimate the impact of unscreened diversions on juvenile chinook salmon. As a result, many of the larger, older diversions have been screened by the Department and all new diversions (since 1972), which in the opinion of the Department would affect salmon or steelhead, have been required to screen their intakes.

The most recent surveys of unscreened diversions in the Delta were conducted in 1976 by the U. S. Fish and Wildlife Service and the Department of Fish and Game (Table 2). Comparing these data to similar figures collected at the State and Federal Fish Protective facilities shows that the unscreened diversions studied had significantly higher losses per unit of water diverted than did the larger State and Federal facilities. Since the salvage of chinook salmon at the Federal facility during the spring of 1976 was approximately 100,000 fish, one estimate of the losses to the unscreened Delta diversions during the spring of 1976 would be 1,500,000 chinook salmon, the ratio of salmon catches times the salvage of fish at one of the facilities ($1.38 \div 0.09 = 15.3 \times 100{,}000 \cong 1{,}500{,}000$). Since 1976 was a low flow year and a year of low chinook salmon numbers in the Delta, this estimate is likely to be conservative. Salmon salvage totals at the Federal facility for wetter years such as 1974 have been as high as 250,000 fish, a figure which would produce a loss estimate for Delta diversions of 3,825,000 fish.

Similar studies at the Sunset Pumps on the Feather River (Table 2), conducted during 1977 and 1978, showed higher loss figures for unscreened diversions along the upper river (Menchen, MS). The total loss for the unscreened diversions on the Sacramento River could reach 10.4 million fish ($4.66 \div 0.09 = 51.8 \times 100{,}000 \times 2 \cong 10{,}400{,}000$). We doubled the total because the upper river diversions are approximately twice as much in total as those of the pumping plant. Again, this estimate could be larger if it were expanded by the catches at the facilities in a wetter year. All of these recent studies are similar to those presented by Hallock and Van Woert in 1979, as well as the results of other evaluations conducted by the Fish Facilities Program of the Interagency Ecological Study Program.

Combining these estimates, we get a number of approximately 13 million juvenile chinook salmon lost to these diversions. The impact of this loss can be placed in perspective by computing the numbers which would be lost from the fishery as a result of these diversions.

If we assume that the return rates for marked hatchery smolts released upriver are a conservative estimate for the survival of these fish, we can generate estimates of the returns we would expect from a screening program.

Our experience has been that marked hatchery smolts released upriver return to the fishery at a 0.5% rate (Jack Robinson, pers. comm.), with half again as many showing up in the escapement. Applied to the 13 million loss estimate, we get approximately 65,000 fish ($13 \times 10^6 \times 0.005 = 65{,}000$) in the catch and 32,500 fish in the spawning escapement.

STRIPED BASS IMPACTS

Several studies are also available which allow us to estimate the impact of unscreened diversions on juvenile striped bass. Both Heubach (MS) and Allen (1975) directly sampled diversions in the Delta to establish losses. A third estimate of losses can be obtained by adjusting the salvage totals from the State's Fish Protective Facility by the efficiencies established during the evaluation of the facility (Skinner, MS), to produce an estimate of the number of fish entrained to the facilities.

TABLE 2

Summary of Chinook Salmon Evaluations

	Salmon/AF	
DELTA		
USFWS and DFG (A M J - 1976)		
Ryer North	1.25	
Ryer Superintendent	4.09 - 0.05	
Sherman Island	0.19	
Shelley Ranch	0.00	
$\bar{x}$		1.38
State and Federal Fish Facilities (A M J - 1976)		
State	0.15	
Federal	0.03	
$\bar{x}$		0.09
FEATHER RIVER		
Sunset Pumps (1972, 1977-1978)		
1972	5.81	
1977	6.15	
1978	2.03	
$\bar{x}$		4.66

Comparing Heubach's (MS) results for the Contra Costa Canal intake and Allen's (1975) results for unscreened diversions on Sherman Island with the data from the State's Fish Protective Facility establishes that the smaller unscreened diversions in the Delta have similar losses per unit of water diverted as do the larger facilities (Table 3).

To put this in perspective, during 1974 the Federal Pumping Plant salvaged over eight million juvenile striped bass during the period from May to August. Thus, the unscreened Delta diversions could be resulting in a loss of striped bass of at least of this magnitude.

We can also relate the impact of these unscreened diversions to the Striped Bass Index, using statistical relationships between the Index, water flow, and water diversions. This results in an estimate that screening or relocating these diversions would result in an increase of about 15 index units. We should keep in mind that we are extrapolating beyond our data points in making these estimates. The Striped Bass Index has ranged between 8.7 and 118.4 during the period between 1959 and 1979 and our goal has been an index of 106. Thus, this approach indicates screening Delta diversions might increase the Striped Bass Index by more than 10%.

Impacts on Other Species

Throughout the sampling which was conducted to identify the losses of chinook salmon and striped bass, other species were taken. These species include almost all of the fish identified from the Delta. Since a number of these organisms are the food source of the larger fish in the Delta and many also provide recreation and food for people, these losses are significant. Quantifying these losses has not been attempted and it is only mentioned to point out that these unscreened diversions have a broad impact on the system. Screening or relocating the diversions would reduce the impacts on the populations of more than just the two species selected for this analysis.

Screening Technology

Prevention of the loss of juvenile fish, that is fish larger than three-quarters of an inch in length, is readily attainable. Perforated plate with an opening of 5/32" will protect all chinook salmon, steelhead rainbow trout, American shad, and striped bass larger than 3/4" in length. Alternately, continuous slot material with a 3/32" slot width will attain the same results. Of these, the profile wire continuous slot material has been identified as the slowest to clog, requiring the least maintenance, and thus would be preferable.

Screening technology to protect eggs and larvae is available, however, its cost and complexity makes it an unlikely solution to this problem. An alternate solution would be to develop an overland water supply from outside the striped bass nursery area for the Delta farms. However the cost of such a solution would be high and it is unlikely to be politically acceptable. Further, the reduction in instream flows which would accompany this solution would be undesirable.

TABLE 3

Summary of Striped Bass Evaluations

	Eggs/acre-foot	Young/acre-foot
Heubach (MS)		
Contra Costa Canal		
1972		207.38
1973		24.44
Allen (1975)		
Sherman Island		
1972	2467	641.42
State Fish Protective Facility		
1972		519.87
1973		360.49

Cost figures for a number of recent screens were obtained. From these figures, it appears an estimate of $1,000 per cfs would be reasonable for a program such as we are contemplating. Using this figure and the estimates of unscreened water being diverted developed earlier, a total cost of 23.5 million dollars would be required (Sacramento 12 million, Delta 4 million, and San Joaquin 7.5 million dollars).

CONCLUSION

To summarize the results, we have established that losses are occurring at unscreened diversions in the Sacramento-San Joaquin Estuary and its tributaries and that these losses are a substantial detriment to the resources.

Screening the diversions identified in this report would be a monumental task and some source of funds other than the Fish and Game Preservation Fund would have to be developed. Technology is now available to effectively eliminate the loss of salmonids and a program to screen these diversions could be rather quickly initiated. Unfortunately, the limited technology available to screen striped bass eggs and larvae is both more complex and more expensive. Alternatives to screening would require providing an overland water supply to the users in the striped bass nursery area.

The problem then, is whether to screen several thousand diversions ranging in size from 1½" to 50" in diameter and how to implement such a program. The technology is available to protect a large proportion of the resource presently being lost, although the operation and maintenance of these structures would be a major endeavor. Such a program could be implemented under existing legal authority if a source of funding could be developed. Alternatives which include a finding by the U. S. Army Corps of Engineers or the State Water Resources Control Board that the present method of diversion was unreasonable would, in the opinion of DWR Legal Counsel, result in the Department of Fish and Game bearing the full costs of meeting the new requirements on existing diversions. Finally, new legislation could be introduced to achieve these objectives.

Major unscreened diversions which require attention include Sunset Pumps on the Feather River, the Tisdale Diversion on the Sacramento River, and the Contra Costa Canal Intake in the Delta. The first two have already been scheduled for screening by the Department and the Contra Costa Intake will be covered by its proposed relocation to Clifton Court Forebay. Other diversions of concern include the Tehama-Colusa Canal intake at Red Bluff and the existing State and Federal export pumps in the south Delta. Negotiations are presently underway to rescreen the Tehama-Colusa Canal intake and should be completed as soon as possible. For the purposes of this report, we shall assume the Peripheral Canal fish screens will solve the south Delta problems.

While these programs are underway, we believe diversions in the Delta should be targeted and screened. Of the diversions studied, the Ryer Island Superintendent, identified by the USFWS, would be most appropriate for a beginning. Other Delta diversions, in order of size and location, could then be screened as funds become available for installation, operation, and maintenance. The program should concentrate on the Sacramento River side to start with.

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