WRINT-DFG-EXHIBIT 5

IMPACT OF WATER MANAGEMENT ON SPLITTAIL IN THE SACRAMENTO-SAN JOAQUIN ESTUARY

The splittail (*Pogonichthys macrolepidotus*) is a large minnow (Cyprinidae) endemic to the Sacramento-San Joaquin system. A closely related species, *P. ciscoides*, native to Clear Lake became extinct during the 1970's (Moyle et al., 1989). Splittail are a relatively long lived fish reaching over 14 inches in length by their fifth year (Caywood, 1974). Although splittail are considered a fresh water species, adult and sub-adult fish have unusually high salt tolerance for members of the minnow family. The salt tolerance of larvae is unknown. When splittail were more abundant, they were commonly found in Suisun Bay and the Suisun Marsh region. Additionally a population persists in the brackish Napa Marsh.

Splittail spawn from March through May. Eggs are sometimes dispersed over submerged vegetation in terrestrial areas inundated by flood waters. Eggs have been found adhering to submerged tules and primrose. Spawning apparently also occurs in dead end sloughs and in larger sloughs such as Montezuma Slough (Caywood, 1974; Wang, 1986). Splittail are generalists in their food selection, preying upon *Neomysis mercedis*, annelids, mollusks, and fish in sloughs of Suisun Marsh (Daniels and Moyle, 1983). Copepods, insect larvae, amphipods, clams, and algae are the primary food source for splittail in the Delta. Splittail sometimes consume earthworms over flooded grassy areas in the lower Sacramento River (Caywood, 1974).

Historically, splittail distribution covered low elevation waters of the Central Valley from Redding to Fresno (Snyder, 1905; Rutter, 1908). Currently, splittail abundance and distribution is much more limited than in past years. They are restricted to the lower reaches of the Sacramento and San Joaquin Rivers, the Delta, Suisun and Napa Marshes, and tributaries of north San Pablo Bay. Splittail is considered a species of special concern by the Department of Fish and Game because of its limited range. Moyle et al. (1989) believe management of splittail may be required in the future to prevent its extinction.

The ability of splittail to maintain a viable population despite loss of its marsh and slough habitat to reclamation is attributed to its salinity tolerance, high fecundity, and long breeding life. Mature fish ranging in age from two to five years are able to tolerate saline conditions in marshes surrounding the Delta and San Pablo Bay during low outflow years. However, successful reproduction is strongly associated with high outflows preceding, during and following spawning as demonstrated by high correlations between abundance of splittail in the fall midwater trawl survey and various monthly combinations of Delta outflow from the previous winter through early summer (Table 1). Figure 1 shows the association between abundance during the fall and outflow during the primary spawning months.

Table 1. Correlation coefficients between splittail abundance indices and outflow from the Sacramento-San Joaquin Delta, 1967-1990 (no data for 1974 and 1979). Coefficients are for the entire period between corresponding months on the two axes.

	JAN	FEB	MAR	APR	MAY	JUN	JUL
JAN	0.251						
FEB	0.515	0.647					
MAR	0.685	0.752	0.809				
APR	0.752	0.822	0.872	0.792			
MAY	0.781	0.844	0.880	0.815	0.798		
JUN	0.793	0.850	0.877	0.813	0.777	0.730	
JUL	0.801	0.855	0.879	0.822	0.792	0.769	0.807

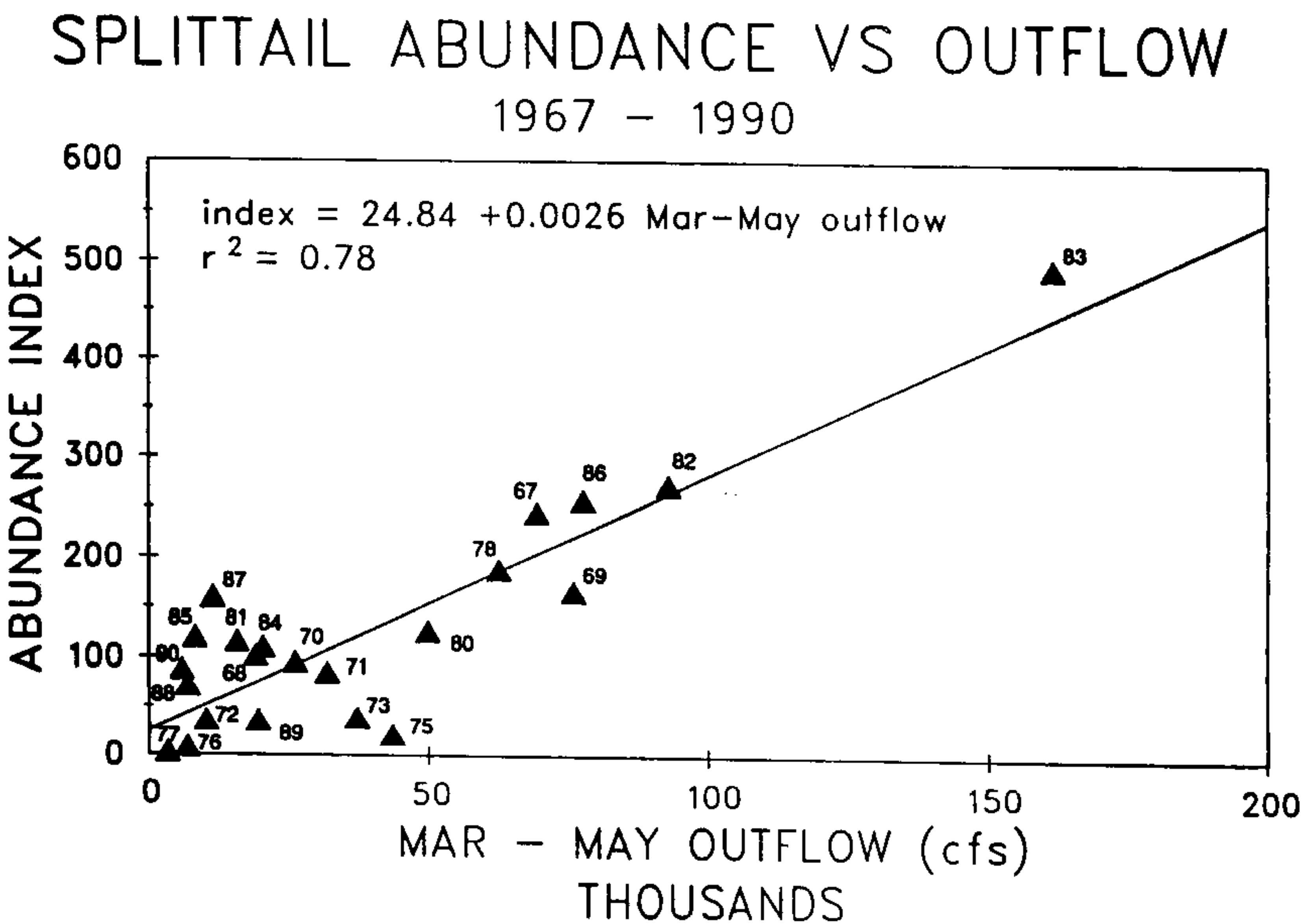

Figure 1. Association between splittail abundance and Delta outflow during the primary spawning months. Numbers next to data points indicate years.

Based on: 1) the association between splittail abundance and Delta outflow and 2) water project operations studies reflecting changes in flows due to water development, we have estimated that the present splittail population is only about 35 to 60% as abundant as in it was in 1940 (Figure 2). These estimates are probably underestimates of the actual reduction in abundance of splittail because the estimates only reflect changes in flow related factors and do not account for other environmental perturbations. While such perturbations are not necessarily negative, the greatly reduced range of splittail indicates the predominant effects have been negative. The predominant change has probably been loss of spawning and nursery habitat from reclamation activities.

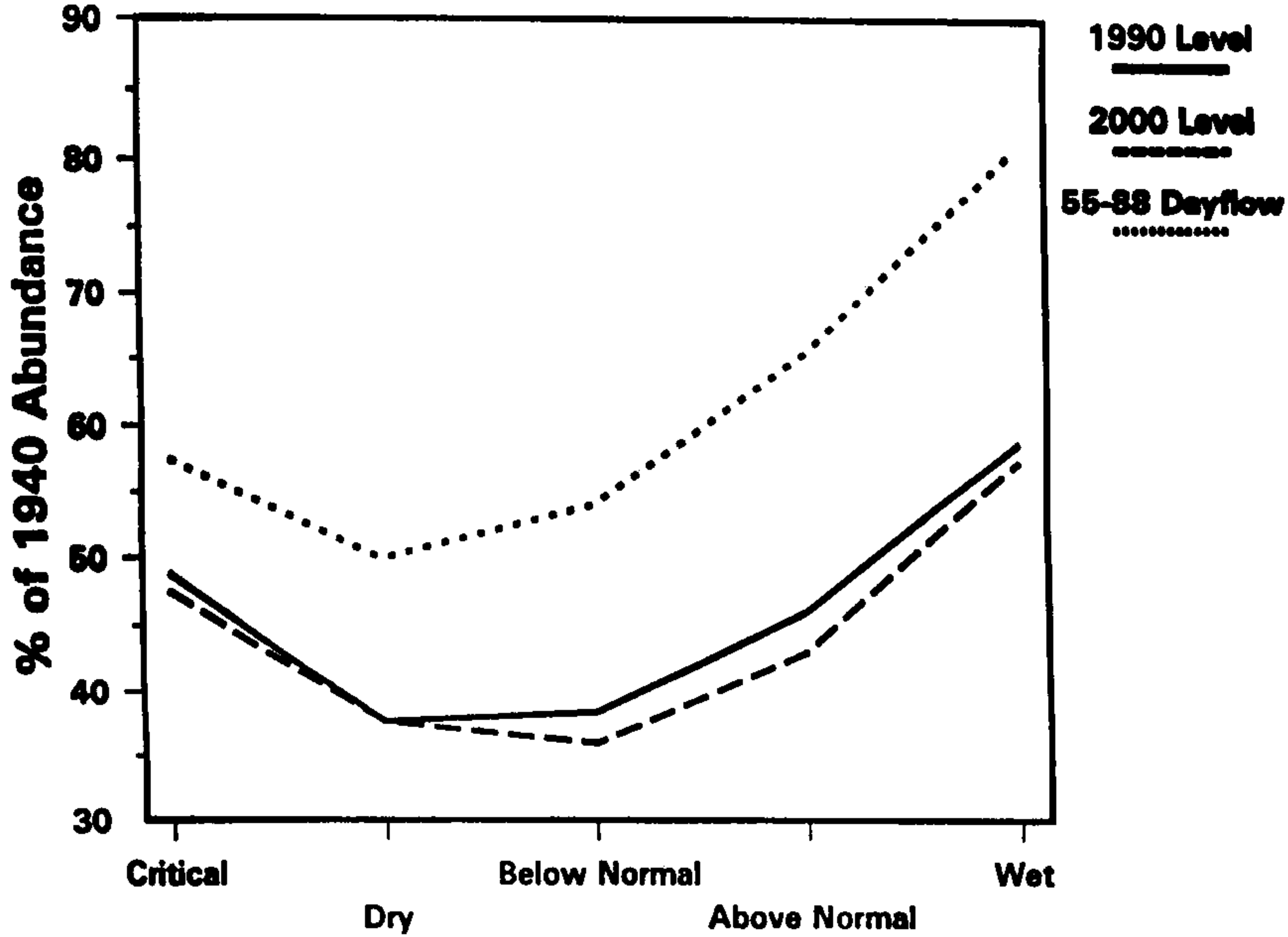

Figure 2. Estimated decline in splittail abundance relative to water year type and several levels of water development. Estimates are based on: 1) the association between splittail abundance and Delta outflow, and 2) estimates of changes in outflows from DWR operations studies.

References Cited

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Alter.	Year Type	Close Delta Cross Channel[1]	Close Georgiana Slough	Max Total CVP/SWP Exports[2]	Full Barrier Upper Old River	Minimum Flow Vernalis[2]	Minimum Flow Jersey Point[2]	Minimum Flow Rio Vista[2]	Survival Index[4] Sac .24	Survival Index[4] SJ .10
									1995 LOD (Base X)	
A	W AN BN D C	5/1-31 5/1-31 5/1-31 2 wks May 2 wks May	—	--	4/1 to 5/31 and 9/1 to 11/30 all year types	--	0 cfs during time cross channel gates closed	4/1 to 6/30 2500 cfs all water year types	.39 .30 .27 .21 .19 $\bar{X}$ = .29	.38 .19 .16 .16 .16 $\bar{X}$ = .23
B	W AN BN D C	5/1 to 5/31 all year types	--	May and June 5000 cfs all year types	4/1 to 5/31 and 9/1 to 11/30 all year types	3500 cfs 4/1-5/31 3000 cfs " 2500 cfs " 2000 cfs " 1500 cfs "	500 cfs during time cross channel gates closed	4/1 to 6/30 2500 cfs all water year types	.40 .31 .27 .23 .21 $\bar{X}$ = .30	.39 .21 .19 .17 .16 $\bar{X}$ = .24
C	W AN BN D C	4/15 to 6/15 all year types	--	6000 cfs 4/23-5/6 5000 cfs " 4000 cfs " 3000 cfs " 2000 cfs "	4/1 to 5/31 and 9/1 to 11/30 all year types	10000 cfs 4/23-5/6 8000 cfs " 6000 cfs " 4000 cfs " 2000 cfs "	4/15-4/22 and 5/7-6/15 / 4/23-5/6 1000 cfs / 3000 cfs 1000 cfs / 2500 cfs 1000 cfs / 2000 cfs 1000 cfs / 1500 cfs 1000 cfs / 1000 cfs	4/1 to 6/30 2500 cfs all water year types	.40 .32 .30 .26 .24 $\bar{X}$ = .31	.42 .25 .21 .19 .18 $\bar{X}$ = .27
(D)	W AN BN D C	4/1 to 6/30 all year types	4/15 to 6/15 all year type	6000 cfs 4/15-5/15 5000 cfs " 4000 cfs " 3000 cfs " 2000 cfs "	4/1 to 5/31 and 9/1 to 11/30 all year types	10000 cfs 4/15-5/15 8000 cfs " 6000 cfs " 4000 cfs " 2000 cfs "	4/1-4/14 and 5/16-6/30 / 4/15-5/15 1000 cfs / 3000 cfs 1000 cfs / 2500 cfs 1000 cfs / 2000 cfs 1000 cfs / 1500 cfs 1000 cfs / 1000 cfs	4/1 to 6/30 4000 cfs all year types	.48 .39 .37 .32 .29 $\bar{X}$ = .38	.46 .30 .26 .23 .20 $\bar{X}$ = .31
E	W AN BN D C	2/1 to 6/30 all year types	2/1 to 6/30 all year types	4/1 to 6/30 zero export all year types	2/1 to 6/30 and 9/1 to 11/30 all year types	10000 cfs 4/1-6/30 8000 cfs " 6000 cfs " 4000 cfs " 2000 cfs "	3000 cfs 4/1-6/30 2500 cfs " 2000 cfs " 1500 cfs " 1000 cfs "	2/1 to 10/30 6000 cfs all year types	.49 .40 .38 .33 .30 $\bar{X}$ = .39	.62 .49 .41 .34 .26 $\bar{X}$ = .44

[1] During time periods when no cross channel closure, export level or Rio Vista is specified then those standards required under D-1485 are to be implemented. SWRCB 1991 WQCP for Delta also is to be implemen

[2] Flows and exports are mean daily averages

[3] Average survival ($\bar{x}$) indices are based on the average of the 5 water year type estimates (n=5).

[4] Estimates of survival for all the alternatives were derived from superimposing the new flow, export, and diversion conditions on the 1995 LOD operation study (1989 demands) and then using the survival models estimate survival as described in the text.