Summary of Direct Testimony of

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Part 1

Part 1 of my testimony will be a summary of results of salmon studies conducted by the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary.

My testimony will describe the water quality and flow conditions necessary for the protection of chinook salmon in the Estuary. These conditions will be compared to the water quality standards in the 1978 Delta Plan.

The evidence presented will demonstrate how flow, temperature and water diversions affect juvenile outmigrant survival in the Delta and thus influence adult salmon production. Additional information on the estuarine ecology of salmon will be provided to include juvenile rearing, juvenile and adult migration, plus a general overview of the status of Central Valley stocks and salmon management strategies.

I will refer to U.S. Fish and Wildlife Service Exhibit Number 31 provided to you for this testimony.

Part 2

In Part 2 of my testimony I will present the specific comments of the U.S. Fish and Wildlife Service on the Interagency Ecological Study Program's salmon report.

Section 1

SYNOPSIS OF SALMON MANAGEMENT NEEDS IN THE ESTUARY

Introduction

The main objective of this report is to describe the conditions that provide for the protection of chinook salmon in the Sacramento-San Joaquin Estuary. This information should help the Board in setting standards that will provide reasonable protection of beneficial uses in the Estuary. Chinook salmon are a beneficial use that support an intense commercial and recreational fishery whose annual catch averages about 400,000 fish. This represents a significant economic and recreational resource for California.

Chinook use the Bay and Delta habitat as a salmon nursery and for juvenile and adult migrations to and from the ocean and their freshwater habitat. Available evidence indicates that existing water quality standards in the 1978 Delta Plan are inadequate for salmon protection and will result in the survival of juvenile chinook migrating through either the Sacramento or San Joaquin Delta being substantially less than historical survival rates.

Stock Status and the Delta Problem for Salmon

Four runs of chinook salmon (fall, late-fall, winter and spring) are produced in the Central Valley. Fall-run are the focus of this report and comprise over 90% of all spawners. The Sacramento Basin accounts for over 80% of the production. Naturally produced chinook stock in Valley streams have declined by over 50% since the early 1950's. These losses are attributable to habitat reduction in both upstream and estuarine areas.

Exhibit 31, entered by the U.S. Fish and Wildlife Service for the State Water Resources Control Board 1987 Water Quality/Water Rights Proceeding on the San Francico Bay/Sacramento-San Joaquin Delta.

The Needs of Chinook Salmon, Oncorhynchus tshawytscha,. in the Sacramento-San Joaquin Estuary

USFWS Exhibit 31

The evidence presented in this report will demonstrate that habitat alterations in the Delta limit salmon production primarily through reduced survival during the outmigrant (smolt) stage. These lower survivals are associated with decreases in the magnitude of flow through the estuary, increases in water temperatures and water project diversions in the Delta.

Smolt mortality in the Estuary will impact resulting adult salmon population levels. However, other factors that influence stocks and their measurement in upstream and oceanic waters make that impact difficult to quantify. Nevertheless, increasing smolt survival rates through the Delta is a critical step toward restoring natural salmon production in the Central Valley.

Since the early 1970's, juvenile chinook salmon produced at the Feather River, Nimbus and Mokelumne River hatcheries have been trucked downstream and released in the Sacramento River at Rio Vista or adjacent to Carquinez Strait. Since these fish are not exposed to Delta hazards their contribution to the ocean fishery and to subsequent spawning runs is often high. Chinook salmon from Coleman and Merced River hatcheries are released in upriver areas near the hatcheries to prevent the straying of returning spawners which occurs when juvenile salmon from upriver are released in the Estuary. The release of hatchery fish in the lower estuary has enabled a relatively intense ocean fishery to remain stable concurrent with reduced natural salmon populations. The success of the hatchery program, however, increases the risk of overharvesting natural stocks or of hatchery fish that must pass through the Delta.

Estuarine Salmon Ecology and Conditions for Improved Salmon Protection

Juvenile Salmon Migration and Abundance

Fall-run salmon migrate through the Estuary to the ocean from April through June with peak abundances seen in May. Salmon of the other three runs migrate between fall and early spring.

The abundance of smolts at Chipps Island is positively correlated to Sacramento River flow at Rio Vista.

Smolt migration through the Bay/Delta system takes about 10 to 15 days. Rough estimates of the annual number of fall-run smolts leaving the Delta from 1978 to 1986 ranged from about 10 to 50 million fish. These represent about 200,000 to one million adults respectively to the ocean fishery.

Smolt Survival

Sacramento River Delta

The survival of marked hatchery smolts through the Sacramento Delta between Sacramento and Suisun Bay is positively correlated to flow and negatively correlated to both temperature and the percent of the flow diverted off the Sacramento River through the Delta cross channel and Georgiana Slough at Walnut Grove.

Smolt survival increased with increasing Sacramento River flow at Rio Vista, with maximum survival observed at or above

20,000 to 30,000 cfs. This relation was based on two independent measures of survival.

Smolt survival is highest when water temperatures are below 66°F. Temperatures of 76°F or higher are lethal to salmon and stress would occur as temperatures approach that level.

Diverting smolts off the Sacramento River into the Central Delta lessens their survival. Evidence of this is 1) when about 65% of the Sacramento River was diverted to the Central Delta, tagged smolts released immediately above the Walnut Grove diversion point survived at only 50% of the rate of those released immediately below Walnut Grove, 2) when the cross channel was closed, the difference in survival for the two groups was zero at high flows, and about 25% at low flows, and 3) survival of tagged smolts released in the Central Delta was about 50% less than those released in the Sacramento River below Walnut Grove during years of low flow and similar temperatures. Hence, closing the Cross channel is of considerable benefit to salmon survival at low flows when temperatures are acceptable.

Since both temperature and diversions increase as flows decrease, it is difficult to detemine the relative contributions of these factors to changes in survival observed in the Estuary. We believe, however, that both temperature and diversions cause survival to decrease as flows decrease.

Existing flow and operational standards in the 1978 Delta plan are inadequate. Salmon flow standards at Rio Vista range

from 1,000 to 5,000 cfs which would yield from zero to 2% survival based on the relationship between smolt survival and flow. Striped bass Delta outflow standards in May and June afford higher protection and would improve survival to an estimated 5% in dry years to 35% in wet years.

Water development in the Sacramento Valley has reduced inflow to the Delta during the April-June smolt migration period. These reductions combined with the present Delta diversions off the Sacramento River have been enough to reduce average smolt survival in the Sacramento Delta by at least 30% since 1940.

Potential measures to improve smolt survival through the Sacramento Delta include: increasing flows, closure or screening of the Delta cross channel, elimination of reverse flows in the lower San Joaquin and reducing Project export levels in the southern Delta.

San Joaquin Delta

Typical conditions in the San Joaquin Delta are detrimental for smolt survival. This is attributed largely to low Delta inflow from the San Joaquin River, the effect of which is accentuated by diversions typically exceeding inflow during smolt migration periods. High water temperatures (typically 70°F in May) associated with low flows also stress juvenile salmon.

Survival of tagged smolts migrating from the San Joaquin drainage through the Delta increased with increased Delta inflows. Smolt survival and resulting adult production was most favorable

in wet years when flows at Vernalis during smolt migration was greater than total CVP-SWP exports. The benefit of increased river flows to returning spawner numbers reflects benefits to juvenile survival both upstream and in the Delta.

Survival of tagged smolts released in the southern Delta was higher for smolts migrating down the San Joaquin River than for those diverted to the west toward the CVP-SWP pumps via upper Old River indicating that diversion is a key factor affecting smolt survival. In two of the three years studied, survival of fish released in upper Old River, and thus exposed to the Projects' diversions, was 40% to 80% lower than those released in the San Joaquin below the upper Old River Junction. In the third year there was no difference observed.

The rate at which smolts migrated through the San Joaquin Delta about doubled as inflow at Vernalis increased from 2,000 to 7,000 cfs.

There are no existing San Joaquin River flow standards in the 1978 Delta Plan for smolt survival. Project export limits in May and June provide some protection. Fish screen operational criteria also provide some protection after the fish are diverted from the river.

Potential measures to improve smolt survival in the San Joaquin Delta include: reductions in CVP-SWP export levels, a barrier or a screen at the head of upper Old River, increased flows, and elimination of reverse flows in the lower San Joaquin River. Continued juvenile survival studies are needed in the San

Joaquin system to better enable us to evalute varied salmon protective measures.

San Francisco Bay

Available data is too sparse to draw any conclusions on the influence of Delta outflow on smolt survival in the Bay. Data from 1984 indicates survival through the Bay for large juvenile salmon was relatively high (81%) for a rather low Delta outflow index of 10,000 cfs. Ocean tag recoveries available in 1988 and 1989 reflecting smolt tag releases in the Bay in 1985 and 1986 will provide two more estimates of survival through the Bay at outflows of 10,000 cfs.

Salmon Rearing

Fall run chinook fry rear both upstream and in the Estuary with peak abundances seen in the Delta in February and March. As Delta inflow increases, fry become both more numerous and more widely distributed in the estuary.

The survival of tagged fry was greater in the upper Sacramento River than in the Delta, while that in San Francisco Bay was the lowest.

Fry released in the northern Delta appeared to survive better than those released in the Central Delta except in years of very high Delta inflow.

Chinook fry that rear in the Delta contribute some portion of Central Valley salmon production with that proportion increasing

as runoff increases. That contribution is probably small relative to that upriver rearing but still significant.

Adult Migration

Chinook spawners of the four runs migrate through the Estuary at different times throughout the year. Adult migration data was gained with CDFG sonic tag studies in the mid 1960's. Findings from that work indicated that: migrations through the Estuary are aided by positive downstream flows of "homestream water" and temperatures less than 66^{o}F.

Dissolved oxygen concentrations below 5 mg/l block upstream migration.