WRINT-DFG EXHIBIT 25

INTERIM ACTIONS TO REASONABLY PROTECT SAN JOAQUIN FALL RUN CHINOOK SALMON

California Department of Fish and Game
Region 4
1234 E. Shaw Avenue
Fresno, California 93710

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State Water Resources Control Board
Bay-Delta Hearing Proceedings
beginning on June 22, 1992 in Sacramento, California

I. EXECUTIVE SUMMARY

Fall-run Chinook salmon stocks in the San Joaquin Drainage have declined precipitously since 1988. Consideration for protection under the State and Federal Endangered Species Acts may be warranted unless significant interim measures are implemented.

Interim measures should focus on:

a) Improving fall habitat conditions in the South Delta, the lower San Joaquin River and Merced River to insure that adult salmon can migrate safely to their natal streams.

b) Providing acceptable temperature conditions in the lower Stanislaus River beginning in early October to avoid loss of eggs and poor recruitment. A plan of operation for the fall of 1992 is urgently needed.

c) Increasing tributary and San Joaquin River streamflows during April and May. A 30-day "controlled freshet" evaluation is proposed. Streamflows from each tributary are needed on a fair-share basis.

d) A suite of measures that link salmon smolt survival improvements in the San Joaquin tributaries with survival improvement measures in the Delta will increase the likelihood of improving fall-run salmon escapements.

On an annual basis, streamflow allocations for Chinook salmon in the San Joaquin drainage are well below the level needed to protect this beneficial use. A cumulative review of previous or pending water rights permits and licenses is needed.

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III. INTRODUCTION

The State Water Resources Control Board (SWRCB) has requested information and recommendations on measures to "ensure that available water supply is reasonably used and that the public trust uses of water are reasonably protected on an interim basis" pending long-term protection decision(s) regarding waters of San Francisco Bay and the Sacramento-San Joaquin Estuary. The SWRCB plans to establish interim measures and identify long-term protection goals by reviewing the adequacy of conditions under which diversion and use of water is authorized. This action is being taken based on the SWRCB's duty of continuing supervision under the public trust doctrine and the reasonableness doctrine in the California Constitution, Article X, Section 2.

Water quality objectives and flow and operational requirements to protect beneficial uses of the Bay-Delta Estuary waters were adopted in 1978 (D1485). The SWRCB reopened public proceedings in July 1987 to update these documents. The Department of Fish and Game (DFG Exhibit 15, July, 1987), U.S. Fish and Wildlife Service (USFWS Exhibit 31, July, 1987) provided evidence on fall run chinook salmon populations originating in the San Joaquin drainage. New water quality objectives for salinity, dissolved oxygen and temperature were set forth in the 1991 Delta Plan, adopted by the SWRCB in May, 1991. Implementation of the new objectives were to be addressed, along with additional flow-related issues, through updating of Decision 1485 in subsequent proceedings.

In response to declining public trust resources and directives in the Governor's Water Policy dated April 6, 1992, the SWRCB was charged to develop interim standards by the end of 1992 to "help restore the environment and improve the water supply." The policy emphasizes linkage of south Delta physical facilities to improved interim standards for protection of fish and wildlife. The SWRCB will consider adopting interim requirements for the Central Valley Project (CVP), the State Water Project (SWP) and other major water right holders. These interim requirements are expected to be in place for no more than 5 years.

This DFG Exhibit provides pertinent additional technical information and recommendations developed since 1987 to help restore San Joaquin fall-run chinook salmon. It identifies both short and long-term measures upstream of Vernalis on the San Joaquin River, and identifies the importance of linkages of these interim measures with those adopted in the Delta. As in 1987, it dovetails with information and recommendations presented in the new USFWS Exhibits to this hearing regarding San Joaquin fall run chinook salmon. Therefore we encourage the SWRCB and others to consider information in WRINT-DFG Exhibit 25, in addition to other related Exhibits, in developing interim measures to protect San Joaquin fall run chinook salmon.

IV. POPULATION STATUS

A. Status of San Joaquin Fall-Run Chinook Salmon

<u>1. Escapement trends</u> Fall-run chinook salmon populations are still present in the Stanislaus, Tuolumne and Merced rivers (Figure 1). Significant straying into natural and irrigation drainage channels in western Merced County has continued. Spawning escapements, the best measure of long-term population status, have suffered a precipitous decline throughout the drainage since 1987 (Figures 2 and 3). Estimates of the salmon straying into western Merced County streams have been made since 1988 (Appendix 1).

The 1991 fall spawning escapement estimates were 282, 53, and 99 salmon in the Stanislaus, Tuolumne and Merced rivers, respectively. Only 42% of this escapement were adult females.

Figure 1. Map of San Joaquin River, Tributaries and South Delta

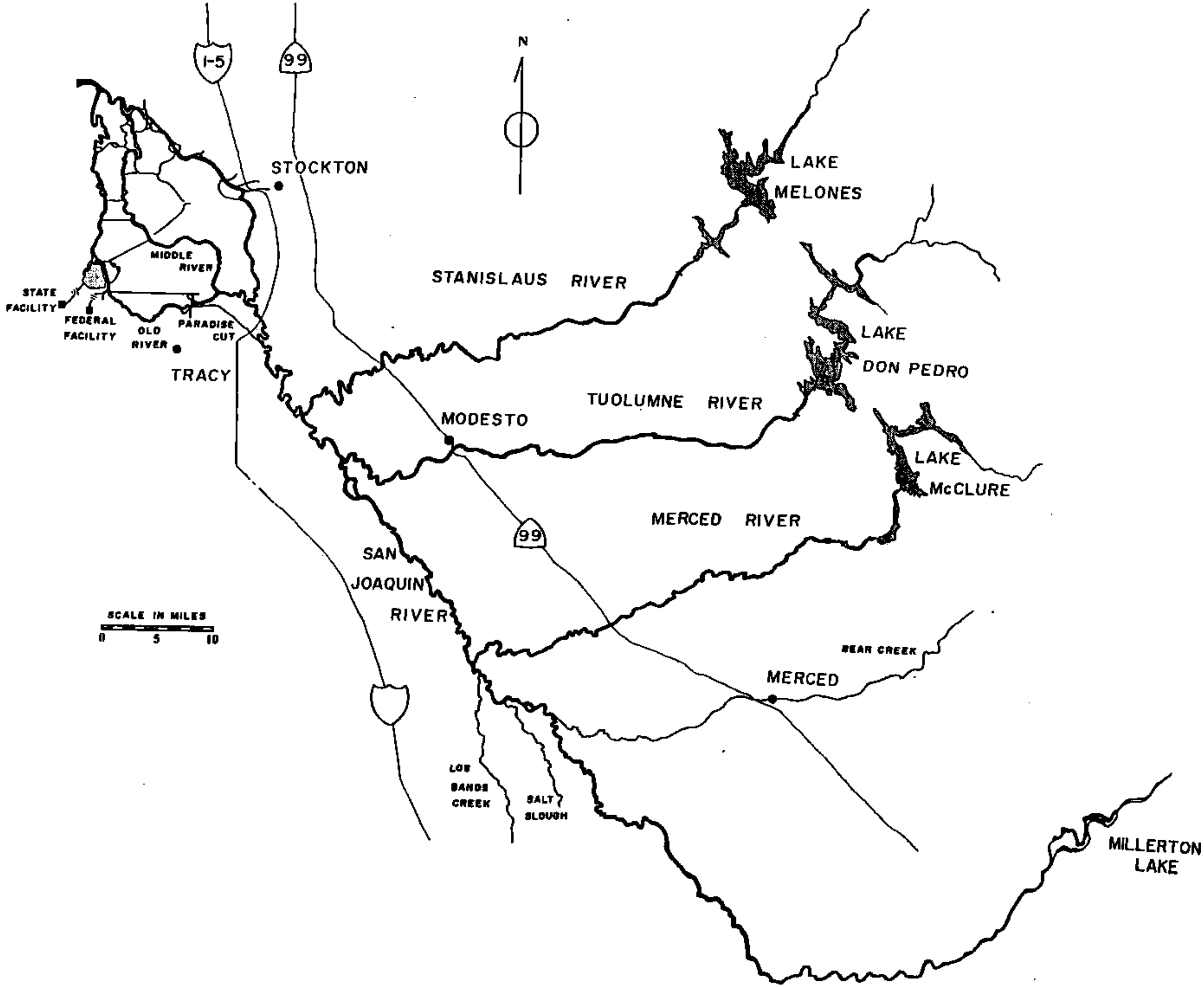


Figure 2. Recent Fall-Run Chinook Salmon Escapement in the San Joaquin Drainage

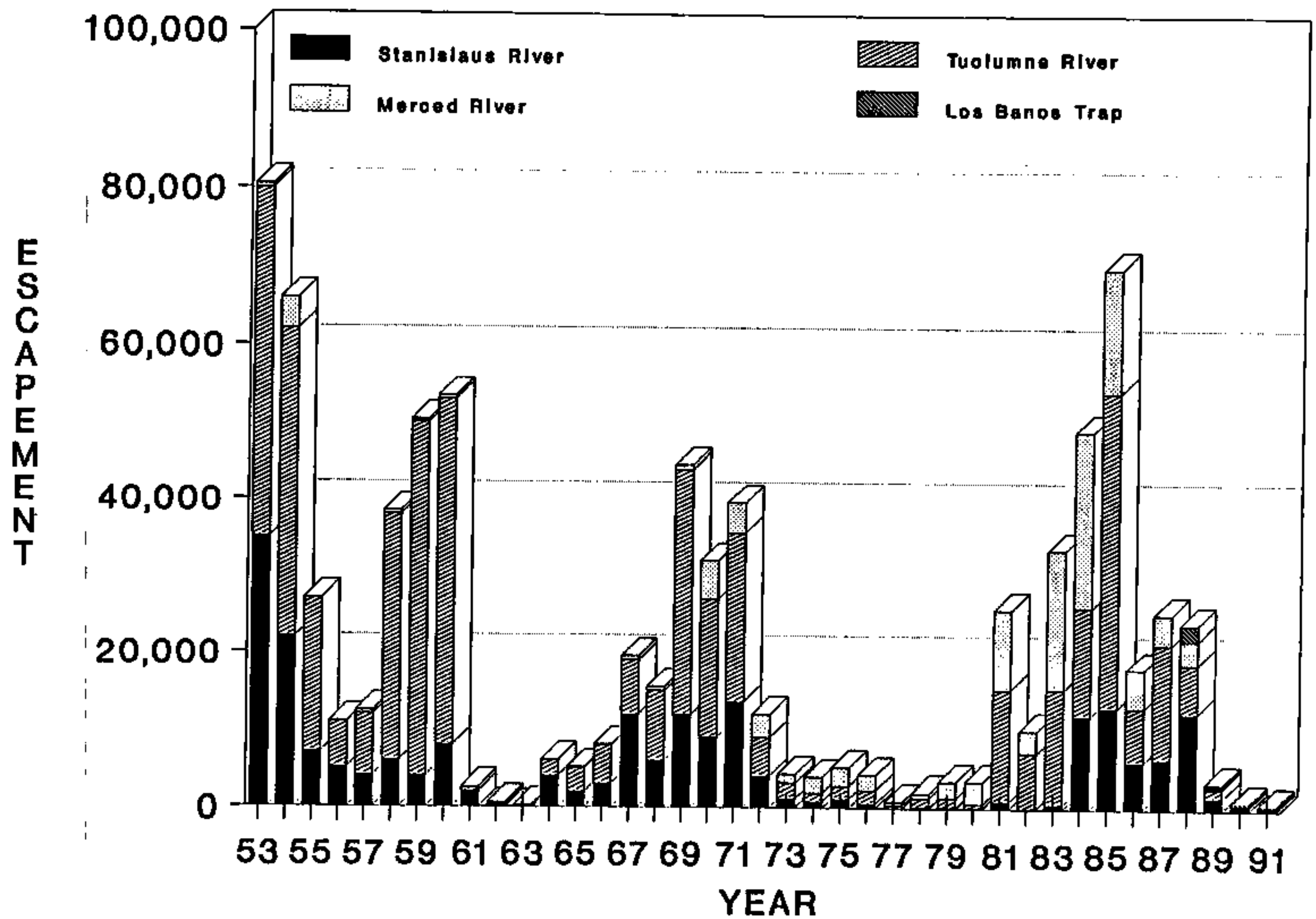
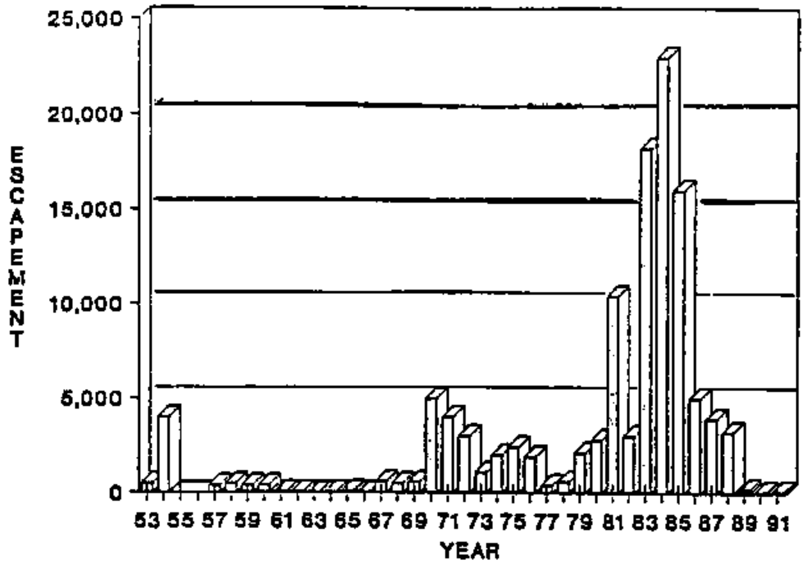
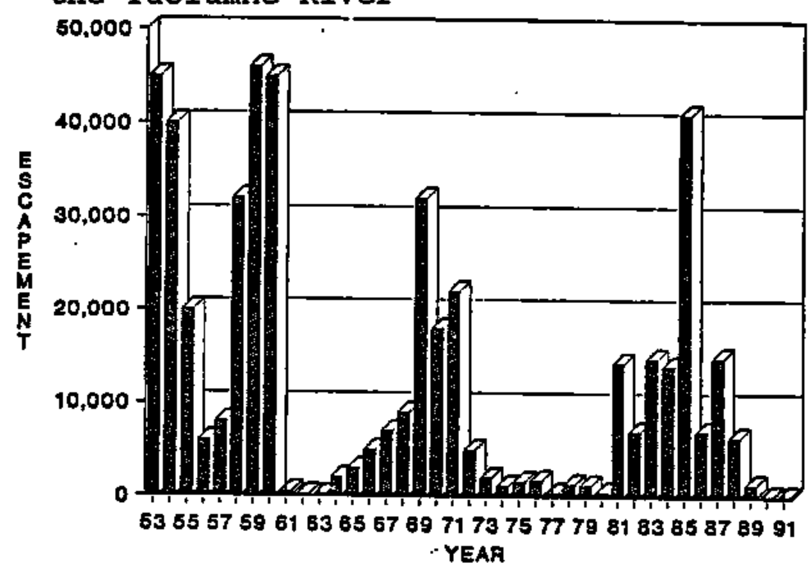


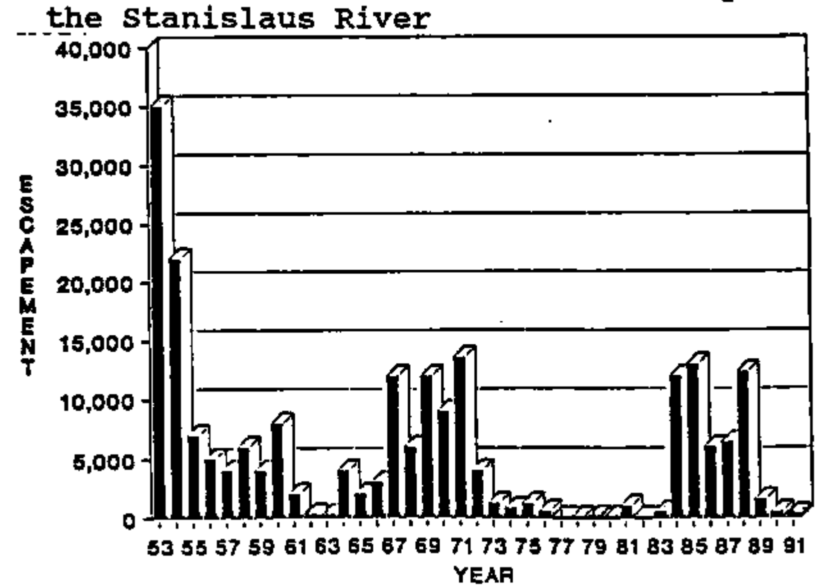
Figure 3. (A) Recent Fall-Run Chinook Salmon Escapements in the Merced River



(B) Recent Fall-Run Chinook Salmon Escapements in the Tuolumne River



(C) Recent Fall-Run Chinook Salmon Escapements in the Stanislaus River



Using an average fecundity of 5000 eggs per female yields a maximum potential egg production in 1991 of only 911,400 eggs. As a rule of thumb, egg-to-returning adult survival rates for San Joaquin fall run salmon under today's conditions may range from 0.0001 to 0.0003. Thus, the 1991 brood year may only produce a total of 100 to 300 returning adults dispersed over 1993, 1994, 1995 and 1996 escapements (primarily in 1994).

The 1990 fall spawning escapements were 492, 96, and 73 salmon in the Stanislaus, Tuolumne and Merced rivers, respectively. Using the methodology above, the 1990 brood year may only produce a total of 150 to 400 returning adults dispersed over the 1992, 1993, 1994 and 1995 escapements (primarily in 1993). Similarly, the 1989 brood year may produce as few as 700 to 2000 adults returning primarily in the fall of 1992.

We anticipate that San Joaquin fall-run escapements will continue to dwindle if existing conditions continue. By extending the calculation of egg potentials and survival-to-adult recruitment used above, and assuming that most salmon return in their third year of life, we would anticipate further declines in spawning numbers (Table 1). These numbers should not be considered as absolute escapement estimates, rather they are approximations to provide insight on salmon population dynamics, and the inability to recover to reasonable levels under existing conditions. San Joaquin fall-run escapements have suffered extended declines in the 1960's (Figures 2 and 3) and rebounded beginning in 1969, a very wet year. Since then the additional impacts associated with greater storage in the San Joaquin tributary basins (New Melones, New Don Pedro, New Exchequer) in combination with the State Water Project operations in the Delta have further reduced the resilience of this population. Recovery will likely be slower even with a series of better water years under existing water operations.

Table 1. A simplified projection of San Joaquin fall-run chinook salmon spawning escapements assuming that the existing environmental conditions and recruitment dynamics remain unchanged.

Brood Year	Escapement Estimate	Estimated Spawning Recruits
1989	3500 (actual est.)	1992 = 700 - 2100
1990	660 (actual est.)	1993 = 150 - 450
1991	430 (actual est.)	1994 = 100 - 300
1992	700 (1992 low est.)	1995 = 150 - 450
1993	150 (1993 low est.)	1996 = 30 - 90
1994	100 (1994 low est.)	1997 = 20 - 60

We expect San Joaquin fall-run chinook salmon spawning populations to remain at or below the 1991 estimate for the next 5 years in the absence of additional protective measures. Since 1987, spawning habitat improvements, increased rearing capacity at Merced River Hatchery, and our trapping efforts in the Stanislaus River and Salt Slough (recovering stray salmon) have collectively failed to abate the population decline. Mortality during the juvenile and smolt life stages appear to be primary bottlenecks for these populations. A program that provides additional tributary and mainstem San Joaquin River streamflows during fall and spring migrations, coinciding with and directly linked to physical and operational measures in the Delta offer the greatest opportunity for interim improvements

2. Thresholds for population maintenance No specific policy regarding determination of thresholds for considering species as threatened or endangered exists (Matthews and Waples, 1991). A Population Vulnerability Analysis (PVA) model exists but the necessary life history information for San Joaquin fall-run chinook salmon may not be available. Absent this approach, the following factors may be considered: a) absolute number of fish and their spatial and temporal distribution; b) current abundance relative to historic numbers and current carrying capacity of the habitat; c) trends in abundance based on indices or estimates of spawner-recruit ratios; d) natural and human-

influenced factors that cause variability in survival and abundance; e) possible threats to genetic integrity; and f) recent events (e.g., drought and passage improvements) that have predictable short-term consequences for abundance of the species in question are all considerations.

A stochastic extinction model (Dennis et. al., 1991) has been used to evaluate thresholds by providing an idea of the likely range of outcomes if no protective measures are taken. This model may also be useful for identifying outcomes that are most likely if protective measures are delayed. The model relies on the assumption that future fluctuations in population abundance can be determined by parameters of the population measured in the recent past. The information presented in Table 1 represents a very simplified example of this approach to threshold modeling.

Potential interim solution: The SWRCB should adopt interim measures which result in immediate and significant improvements in fall-run adult spawning escapements.

Potential interim solution: A stochastic extinction model, Population Vulnerability Analysis or other assessment tools should be used to evaluate reasonable thresholds levels for San Joaquin fall-run chinook salmon.

Potential interim solution: In the absence of effective measures fall-run chinook salmon populations in the San Joaquin drainage may warrant consideration for protections under the State and Federal Endangered Species Acts.

V. NATURAL PRODUCTION FACTORS

A. Adult migrations

1. Delays, straying and guidance flows Our concern that fall spawning migrations into the San Joaquin drainage may be impaired has heightened since 1989. Fall escapements to Merced River Hatchery are nearly three weeks later than in the recent past (Table 2). This late pattern is also reflected in natural fish escapements on the Merced, Tuolumne and Stanislaus River since the current drought began. Late or delayed spawning can result in poor egg quality and diminished survival to hatching. Incubation and delays in fry emergence resulting from late spawning can shift smolt outmigrations further into May when water temperature and other mortality factors are greater.

Table 2. Dates on which the first salmon entered the Merced River Fish Facility spawning trap, 1974 to present.

Year	Date	Julian Date
1974	October 25	298
1975	October 15	288
1976	November 05	309
1977	- no data -	---
1978	October 18	291
1979	October 21	294
1980	November 03	307
1981	October 24	297
1982	October 11	284
1983	October 14	287
1984	October 14	287
1985	October 13	286
1986	October 09	282
1987	October 14	287
1988	October 17	290
1989	November 06	310
1990	November 05	309
1991	November 07	311
Median	October 17	290

In essence, migration and spawning delays constrict the time period available to produce salmon offspring. Narrowing the "effective recruitment" period and providing low levels of protection for cold water beneficial uses can result in poor recruitment and further population declines.

We have continued trapping adult salmon straying into Mud and Salt Sloughs since 1988 to recover at least a portion of the recruitment that would otherwise be lost. This effort has been only marginally successful. The Department and the Commercial Salmon Trollers Association (Salmon Stamp Program) jointly fund the trapping and rearing effort. The cost of this effort exceeds $75,000 each year. We have experienced high mortality of adults and eggs recovered due to water temperatures exceeding 56 °F at the trap site. Adult salmon mortality is high due to handling stress, and egg quality and survival is poor. We are able to trap only a fraction of the total number of stray salmon, and only a fraction of the eggs collected survive. The magnitude of this straying has represented approximately 30% of the entire basin escapements in 1990 and 1991.

Greater attraction flows in October originating from the Merced River could greatly reduce the number of fish straying into Mud and Salt Sloughs. The Department is considering installation of a temporary electrical barrier on the San Joaquin River to help exclude salmon from entering channels in western Merced County. However, the barrier alone would not be effective in guididng adult salmon to acceptable spawning areas and these fish would lost. We have previously identified the need for additional flows released below Crocker-Huffman Dam on the Merced River (Page 46-47, DFG Exhibit 15, 1987).

Although we offer no conclusive evidence linking the late spawning since 1989 to water temperature or streamflow, the same pattern was seen during the 1976-77 drought. We remain very concerned that September and October water temperatures in the south Delta have been high, dissolved oxygen near Stockton has been below 6.0 mg/L, and streamflows into the Delta (ref. Vernalis) and at the mouth of the Merced River have been very low.

Potential interim solutions: The dissolved oxygen standard of

6.0mg/l near Stockton (D1485) should be maintained and enforced during the interim period. In addition, measures identified in the 1969 Four Agency Agreement (Appendix 2), including release of additional water measured at Vernalis, should be provided to ensure that adult salmon migrations into the San Joaquin tributaries are not impaired. The SWRCB should consider the use of water quality supplies identified in D1422 regarding the New Melones Project on the Stanislaus River to improve attraction flows and Delta water quality during late September and October.

Potential interim solution: There is high potential to significantly increase the Merced River escapements with a project that combines an electrical barrier and greater attraction flows at the mouth of the Merced River beginning October 1 each year. The SWRCB should encourage innovative projects that increase streamflow at the mouth of the Merced River beginning October 1 each year. Implementation of Article 45 of FERC License 2179 provides an interim opportunity worthy of review.

Potential long-term solution: Several water right applications regarding existing Licenses on the Merced River have been noticed by the SWRCB (Appl. # 1224, 10572, and 16186). Numerous problems including inappropriate reference gauging stations, "riparian" water use, and significant impairments to designated beneficial uses exist. We recommend that the SWRCB consolidate these and other appropriate water right applications for Merced River water supplies, and consider preparation of an Environmental Impact Report. We are initiating an Instream Flow Study to define streamflow and salmon habitat relationships in the lower Merced River in FY92-93. Completion of this study is anticipated in FY94-95.

B. Spawning habitat improvement

1. Projects and benefits Three spawning gravel restoration

projects have been completed at an estimated cost of $480,000. Over one million smolt equivalents (mitigation credits) were anticipated over the 15 year life of these project only 2,602 smolt equivalents have been produced to date. Since 1986, salmon losses associated with the Delta Pumping Plant Fish Protection Agreement (Direct Losses at the SWP Skinner Facility) total 7,954,878. As of May 1992 a total of 188,948 have been replaced.

Two additional projects are in final engineering or permitting stages, five more projects are in the preliminary engineering phase, and one is in the planning phase. Until fall run spawning escapements are restored the anticipated benefits of these projects cannot be met.

Potential interim solution: The SWRCB and others should not rely on physical habitat improvement as an interim measure to protect fall run chinook salmon during the interim period. Habitat work should continue in anticipation that other measures will be effective in restoring spawning populations to utilize improved spawning areas.

C. Juvenile outmigration timing

1. Fry movements Limited information on fry movements within the San Joaquin tributaries has been obtained since 1987. Emergence from the spawning gravels continues to peak in mid-February, and extends well into March. We continue to observe small numbers of late-spawning salmon and their offspring emerge

in late April. Runoff events, such as in February of 1986, disperse salmon fry throughout the 50+ river miles of each tributary, the lower San Joaquin River and the San Joaquin Delta.

2. Smolt migrations Annual Kodiak trawl surveys have been completed at Mossdale on the San Joaquin River since 1987. Surveys in 1987 were limited to 31 days while coded-wire tagged

salmon were migrating past Mossdale. Since 1988 the surveys generally began in March and ended in June to sample the entire period of natural smolt migration. In early spring, ten tows per day were made three days per week until catch-per-tow reached 2.0 fish. Daily trawling effort began at that point and continued until catch again dropped to this level late in the outmigration period.

The general pattern observed in our trawl catch at Mossdale since 1988 suggests that the peak in San Joaquin salmon smolt migrations into the Delta generally occurs one week before or after May 1 (Figure 4). Significant proportions of our season-total catch each year occurred within the 30-day period from April 15 through May 14. Readers should be aware that due to the difference in sampling frequencies (daily during the most intense migration period versus 3-days per week during the less intense periods) the use of uncorrected cumulative catch provides a somewhat biased temporal representation. Findings in the Annual Job Performance Reports of the San Joaquin River Chinook Salmon Enhancement Project provide additional useful information (Department of Fish and Game, 1988, 1989, 1990, and 1991). These results are generally consistent with the timing information reported in our previous Exhibit (Figure 7 on page 20 of DFG Exhibit 15 1987).

The temporal pattern of cumulative trawl catch in 1988 resembles a smooth sigmoid curve. In contrast, several abrupt increases in catch, representing 10 to 25% of the seasonal total cumulative catch, are evident in the 1990 and 1991 catch. These sharp changes in catch all occurred during the period of daily sampling at Mossdale and do represent periods when our trawl catch increased substantially.

Naturally produced salmon smolts passing Mossdale are primarily of San Joaquin tributary origin. The majority of spawning activity in the fall of 1989 (89%) and 1990 (74%)

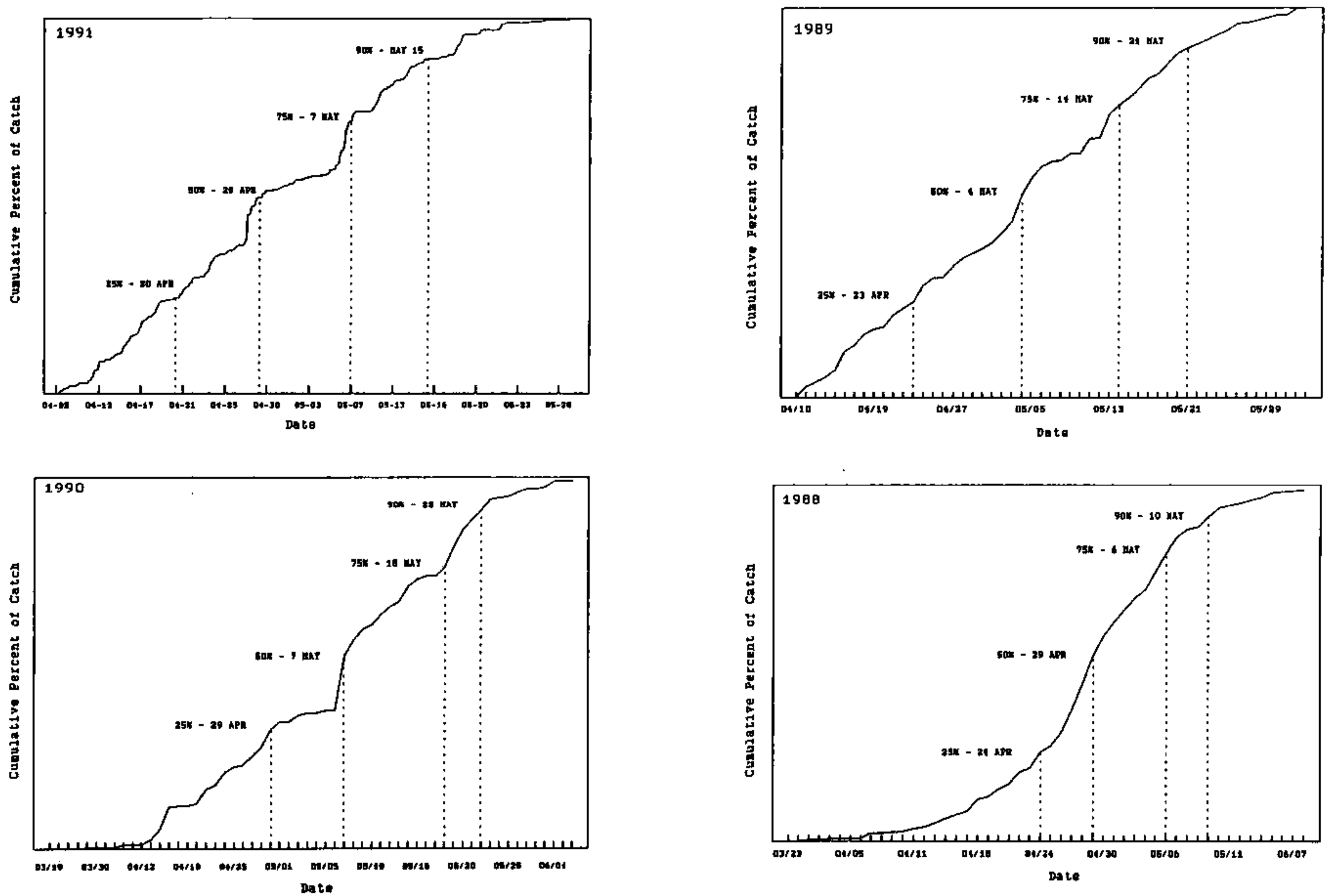


Figure 4. Temporal pattern of fall-run chinook salmon outmigration from the San Joaquin River from 1988 through 1991.

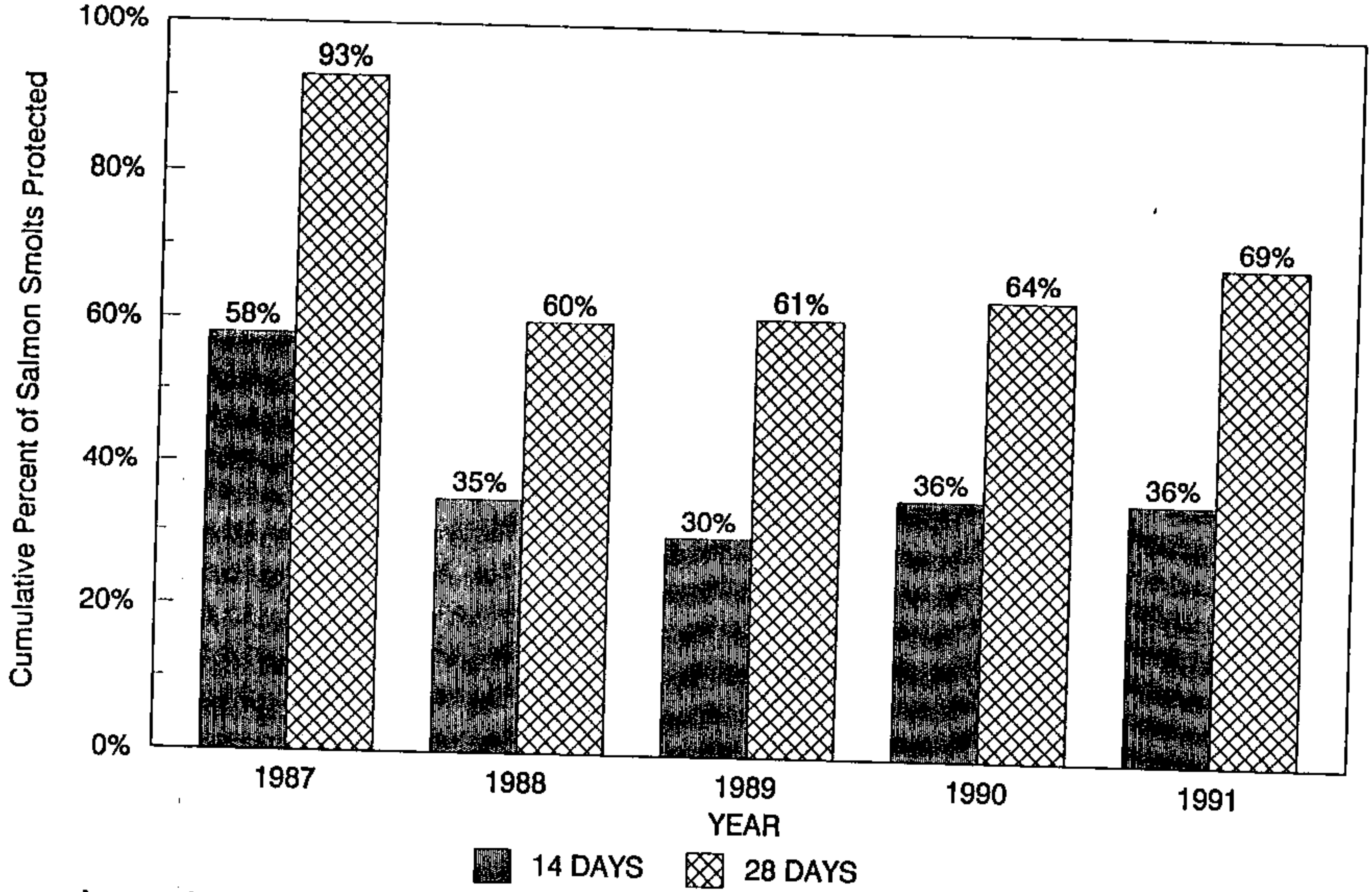
occurred in the Stanislaus and Tuolumne Rivers. Offspring from these brood years migrated into the Delta during the spring of 1990 and 1991, respectively. Streamflow schedules on the Stanislaus and Tuolumne River were modified to provide short "pulses" in flow to help stimulate migration, to reduce travel time to and through the Delta, and to improve habitat conditions en route. We believe the pulsed flows scheduled on the Tuolumne and Stanislaus River during the outmigration period in 1990 and 1991 are largely responsible for the stair-step increases apparent in the cumulative catch at Mossdale.

A more discrete measure of smolt migrations in the Delta was developed to help evaluate the potential incremental benefits of pulsed flows at Vernalis. Early- and late-season data from 1987 through 1991 (3-day/week sampling) were extrapolated to "mean daily" values to improve comparison with the mean daily data collected mid-season (Figure 5). The percentage (cumulative) of outmigrants that could be protected by a 28-day pulsed-flow period is represented by the cross-hatched bars. The darker shaded areas represent 14-days of protection. Using this temporal analysis and assuming similar outmigration timing in the future, the minimum percentages (cumulative) of San Joaquin smolts that could be protected during 14- or 28- day periods near the peak of outmigration are 30 to 36% and 60 to 69%, respectively (Figure 5).

<u>Potential interim solution: Interim protection for a minimum of 60% of the San Joaquin fall-run salmon smolts entering the Delta could be provided by establishing annual streamflow objectives at Vernalis that increase streamflows during the 30-day period from April 15 through May 14.</u> The actual level of protection provided (eg. % survival) to smolts entering the Delta during these periods would depend on the streamflow objectives and water temperature at Vernalis, presence or absence of the Upper Old River Barrier, CVP and SWP export rates, predation rates, travel times and other factors. The actual number of fish benefiting from the additional protection would generally depend on the

Figure 5.

Minimum percentage (cumulative) of San Joaquin chinook salmon smolt outmigrants sampled at Mossdale from 1987 through 1991 potentially protected by 14 day or 28 day pulsed streamflows from upstream tributaries



Assumptions:
1. Survival would increase with flow in the tributaries and through the South Delta
2. The seasonal timing & general magnitude of outmigration would not change due solely to the pulses

previous fall's spawning escapements and the number of smolts surviving to Vernalis, which appear to be largely dependent on spring water conditions (Figures 12, 13, 15 and 16, DFG Exhibit 15, 1987 and recent updates in Appendices 3 through 5 in this Exhibit). Potential interim and long-term streamflow schedules for San Joaquin River tributaries are provided in the "Tributary Streamflow Allocation" section.

<u>Potential long-term solution: A detailed monitoring effort coordinated through the Interagency Ecological Study Program, and other efforts, should evaluate the salmon survival and water quality benefits, and water project impacts associated with a full range of hydraulic conditions established during periods (eg. 30-day) of improved streamflows at Vernalis. Valuable information on long-term objectives at Vernalis can be developed through the understanding gained through the interim program. Long-term solutions should consider that smolt outmigration occurs from March through early June in most years.</u>

<u>3. Yearling migrations</u> Limited information is available on the magnitude or significance of natural yearling emigration from the San Joaquin drainage. Face-plate surveys through late summer and early fall suggest that yearling emigration from the Stanislaus River takes place when ambient air and water temperatures cool in October and November. Diverse reproductive strategies have allowed salmon populations to withstand the major habitat changes that have occurred over time. Remaining in fresh water for a full year instead of emigrating in the first spring of life represents a strategy that avoids the rigors of poor habitat conditions (e.g., low flows, high water temperature, and lower CVP/SWP exports).

Unfortunately summer water temperatures exceed tolerance levels for salmon on the Tuolumne and Merced rivers in most years. We would expect to again see natural yearling salmon in the event that summer water temperature conditions were improved on these rivers.

Potential interim solution: The SWRCB should examine opportunities for conjunctive water use through instream conveyance of agricultural, domestic or other water supplies in the San Joaquin tributaries. Conversion of agricultural supplies to domestic use, existing domestic diversions, and water bank sales, exchanges and wheeling arrangements all offer the potential to improve instream flows through the summer months which could improve protection of cold water beneficial uses.

Potential long-term solution: Any changes in Delta water operations that increase water exports during fall and winter months should include measures to avoid impacts to migrating fall run yearling salmon (natural or hatchery origin).

D. Water temperature

1. Spawning and egg incubation The Water Quality Control Plan for the Central Valley Regional Water Control Board, the San Joaquin Basin 5C, does not protect the designated cold water beneficial use.

Salmon spawning and egg incubation were impaired in 1990 and 1991 within the designated salmon spawning reach of the lower Stanislaus River (Appendix 6). An effort to provide adequate water temperatures there (<56 °F) was implemented in 1991. The stored heat above the power outlet elevation in Tulloch Reservoir was evacuated to Woodward Reservoir in September for irrigation within South San Joaquin Irrigation District. Cold water from the hypolimnion in New Melones Reservoir was drafted from the bottom outlet, below the power outlet elevation, to back-fill Tulloch Lake to the normal fall elevation. Thereafter cold water releases from both Tulloch and New Melones storage resulted in substantial temperature protection in late October for salmon using the upper one-third of the spawning reach.

Based on limited information it appears that each time late summer carry-over storage (minimum pool) in New Melones Reservoir drops below 350,000 to 375,000 AF, fall water temperatures in the designated spawning area below Goodwin Dam exceed 56 °F in October. We believe this causes both direct and indirect mortality and reduces recruitment to subsequent generations. This situation is somewhat analogous to the temperature problems on the Sacramento River below Keswick Dam.

The authorized minimum pool for New Melones Reservoir is 300,000 AF. In 1990, 1991 and now again in 1992 the late summer storage will be well below the authorized minimum pool. The interim measure implemented in 1991 (Appendix 9) may not be feasible because of extremely low carryover storage anticipated (approx. 50,000 AF by September 1992). New Melones Reservoir has a capacity of 2.4 MAF.

Potential interim solution: The SWRCB should direct the affected parties to immediately identify a range of options for providing water temperatures <56 °F throughout the designated salmon spawning area beginning October 1, 1992, and report back to the Chairman by no later than August 1, 1992. Failure to identify and select the preferred option by August 1, 1992 may render such options for 1992 infeasible due to administrative or logistical constraints. A crucial loss of recruitment to subsequent generations would represent a serious threat due to low spawning escapements.

Potential interim solution: The SWRCB should direct the Central Valley Regional Water Quality Control Board to initiate the process of revising the Water Quality Control Plan (Basin 5C) to make changes that avoid impairments to designated cold water beneficial uses. Pursuant to Sections 303(d) and 304(l) of the Clean Water Act an "action plan" should be developed to remedy such impairments.

Potential interim solution: The Stanislaus/Calaveras Conjunctive Use Study Scope and Alternatives should be modified to define and incorporate measures necessary to avoid the impairment of cold water beneficial uses in the lower Stanislaus River.

Potential interim measure: The SWRCB could request USBR to reevaluate the 300,000 AF minimum pool authorized in context with existing water rights, water quality, updated instream flow needs and anticipated contractual deliveries.

Potential interim measure: The SWRCB could order USBR to halt deliveries of "interim" water contract supplies (totalling 105,000 AF) until a new reservoir operations study of minimum pool and reliable yield at New Melones are completed and submitted to the SWRCB an participating agencies for review (ref. paragraph 2 and 3 page 30 of D1422. It is time for a 5-year update. It is likely that the 1980 Supplemental EIS needs significant revision based on recent beneficial use information.

Potential interim measure: The SWRCB could schedule a hearing to consider new evidence and interim changes in the minimum fishery and water quality allocations, minimum pool storage to provide temperature protection, and dry year criteria pursuant to Conditions 2, 3, 5 and 6 of D1422, and consistent with Water Right Orders 80-20 and 83-3.

The long-term solutions will probably include physical and perhaps operational changes that either increase the late-summer minimum pool, modify the power intake such that cold water can be released each year, power bypass, or some combination of measures. Planning studies such as the Stanislaus/Calaveras Conjunctive Use Study should include consideration of this problem. The long-term solution should avoid temperature impairment of the cold water beneficial uses throughout the spawning reach beginning October 1 each year.

Potential long-term solution: The SWRCB should request U.S.B.R. to complete both stream and reservoir temperature models, that are satisfactory to responsible parties, and will provide reasonable prediction accuracy for fall water temperature conditions below Goodwin Dam. A full range of operational schemes at New Melones and Tulloch Reservoirs should be evaluated using these models. Reservoir operations in the Stanislaus River drainage above New Melones that influence temperature regulation below Goodwin Dam should be evaluated and incorporated into the model(s) as appropriate. A report summarizing the results of this effort and a range of possible solutions should be provided by January 1, 1995.

2. Outmigrant protection Previously we submitted evidence (Pages 23-29 DFG Exhibit 15, 1987) identifying concerns that May temperature conditions were frequently stressful to San Joaquin fall run chinook salmon and that stress factors are cumulative. Since then the USFWS has developed considerable evidence regarding the relationships between water temperature and salmon smolt survival. They will be providing that information during this and subsequent hearings. We reaffirm our concern that in many years May water temperatures at Vernalis are at levels which cause chronic thermal stress. Water temperatures in the 64 to 78 °F range are negatively correlated with survival. Factors such as fish health, acclimatization temperatures, ambient temperature, and exposure times all play a significant role in the net temperature effect on salmon smolts.

Potential short-term solution: The SWRCB should focus first on interim measures that provide acceptable water temperatures throughout the outmigration route, and second on interim measures that shorten the exposure time and minimize repetitive stress factors for smolts entering the south Delta.

Potential short-term solution: The CVRWQCB could list the lower San Joaquin River from Vernalis to Stockton as "impaired" due to potential high temperature impacts to San Joaquin and Sacramento River fall-run chinook salmon smolts, pursuant to Sections 303(d) and 304(1) of the Clean Water Act. An Action Plan should be developed.

Potential long-term solution: The SWRCB could fund and oversee development of appropriate temperature criteria to protect chinook salmon smolts during migration periods. Such an effort should be based on both field and laboratory study results. Effective new standards could be adopted using the study results.

E. Update of Streamflow vs. escapement relationships

1. Streamflow at Vernalis vs. escapement No change in this relationship has occurred as a result of the low streamflows and escapements in the San Joaquin drainage since 1987. Appendix 3 is an update of Figure 12, page 35 of DFG Exhibit 15, 1987.

2. Tuolumne River streamflow vs. escapement No significant change in these relationships have occurred as a result of the low streamflows and escapements in the Tuolumne River since 1987. Appendices 4A, 4B and 4C are updates of Figure 15, page 41 of DFG Exhibit 15, 1987. A typographical error was found in the top graph in Figure 15 depicting the relationship between streamflow at Tuolumne City and escapements during the late 1930's and early 1940's. The correct probability level for the regression coefficient is $p<0.40$, not $p<0.05$, as reported in 1987 (Appendix 4A).

3. Stanislaus River streamflow vs. escapement No significant change in these relationships have occurred as a result of the low streamflows and escapements in the Stanislaus River since 1987. Appendices 5A and 5B are updates of Figure 16, page 43 of DFG Exhibit 15, 1987.

In general, our conclusions presented on pages 35, 36, 38, 42 and 44 in DFG Exhibit 15 (1987) remain unchanged.

Potential interim solution: The SWRCB should focus on interim measures in the Delta that are linked to equitable increases in instream flows in the San Joaquin River at Vernalis. Additional streamflow contributions from the Tuolumne River, the Stanislaus River, the Merced River, and other upstream tributaries during the period of active smolt outmigrations each year are needed. The increases should vary by water year type based on the "60-20-0" San Joaquin Basin Index developed by the Water Year Classification Workgroup.

Potential long-term solution: The SWRCB may need to evaluate the cumulative effects of all the separate Water Rights actions on public trust resources in the San Joaquin drainage. The interrelationship of all permits, licenses and pending applications should be evaluated in context with public trust needs. This should be accomplished during the interim period so the information will be available for the final Water Rights Phase of this Hearing Process.

F. Preliminary streamflow vs. smolt survival relationships

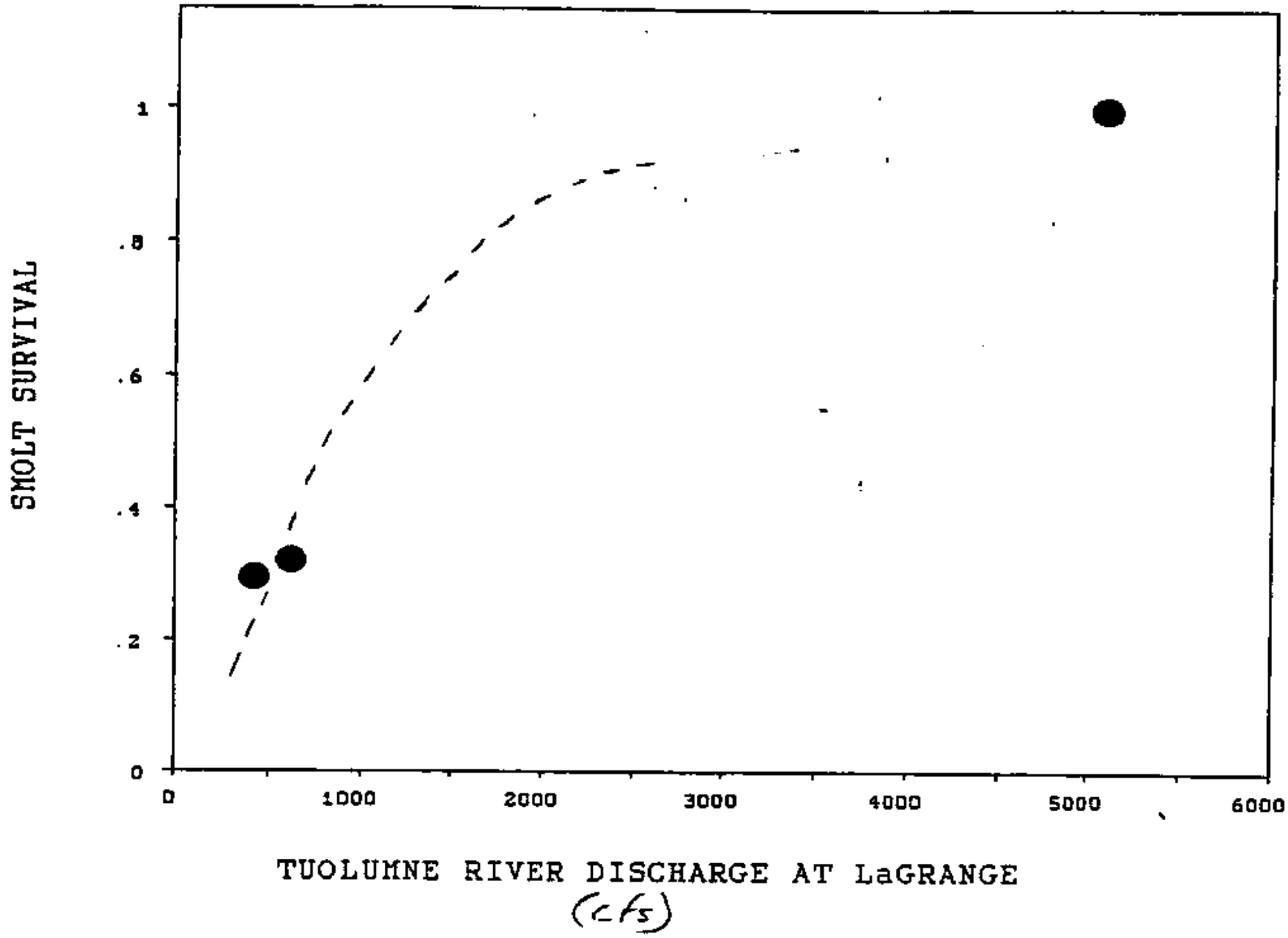
1. Tuolumne and Stanislaus river smolt survival Survival indices were developed through proportionate recoveries of two or more coded-wire-tag groups released at strategic locations and times. The survival rate index is determined by the differential survival between the test and control groups which migrated through the study reach. As replications of these studies are completed over a broad range of habitat conditions relationships between smolt survival and habitat conditions (e.g., flow and temperature) will be developed.

Survival studies have been under way in the San Joaquin drainage since 1985. Unfortunately, the availability of smolts for study purposes have been very limited due to the declines in spawning escapements. Out-of-basin salmon stocks are not used for smolt survival studies in the San Joaquin drainage to avoid the possible loss of unique genetic stocks.

Smolt survival study results available are limited (Figure 6). Obviously no major conclusions can be drawn about the relationship between survival and flow on either of these rivers yet. However, the long-standing relationships between flow and escapement continue to focus our attention on mortality problems during the smolt life stage. It is logical that there is a curvilinear relationship between flow and survival, and perhaps other factors. Survival in nursery tributaries generally increases as habitat conditions improve until some optimum point is reached, beyond which habitat improvements create no further immediate survival benefit. A "theoretical relationship" has been drawn on Figure 6 for conceptual purposes. The more general relationship between flow and escapement presented in Appendix 4C compares well with this "theoretical relationship."

The Department is signatory to study agreements on the Tuolumne and Stanislaus rivers which provide for smolt survival studies under a range of tributary streamflow conditions. A recent agreement (March, 1992) with the Turlock and Modesto Irrigation Districts recognized the need for 10 years of additional streamflows during smolt outmigrations, and provides for significant additional water for this purpose in the Tuolumne and lower San Joaquin rivers. We believe these Districts will present this new agreement as an Exhibit in these proceedings. We support the incremental improvement in Tuolumne River and lower San Joaquin River streamflows that can be provided under this new agreement.

The study agreement on the Stanislaus River (Appendix 5D in DFG Exhibit 15, 1987) needs to be amended to allow evaluation of a more adequate range of spring streamflow conditions, and to provide additional protection for in-basin uses. We are hopeful



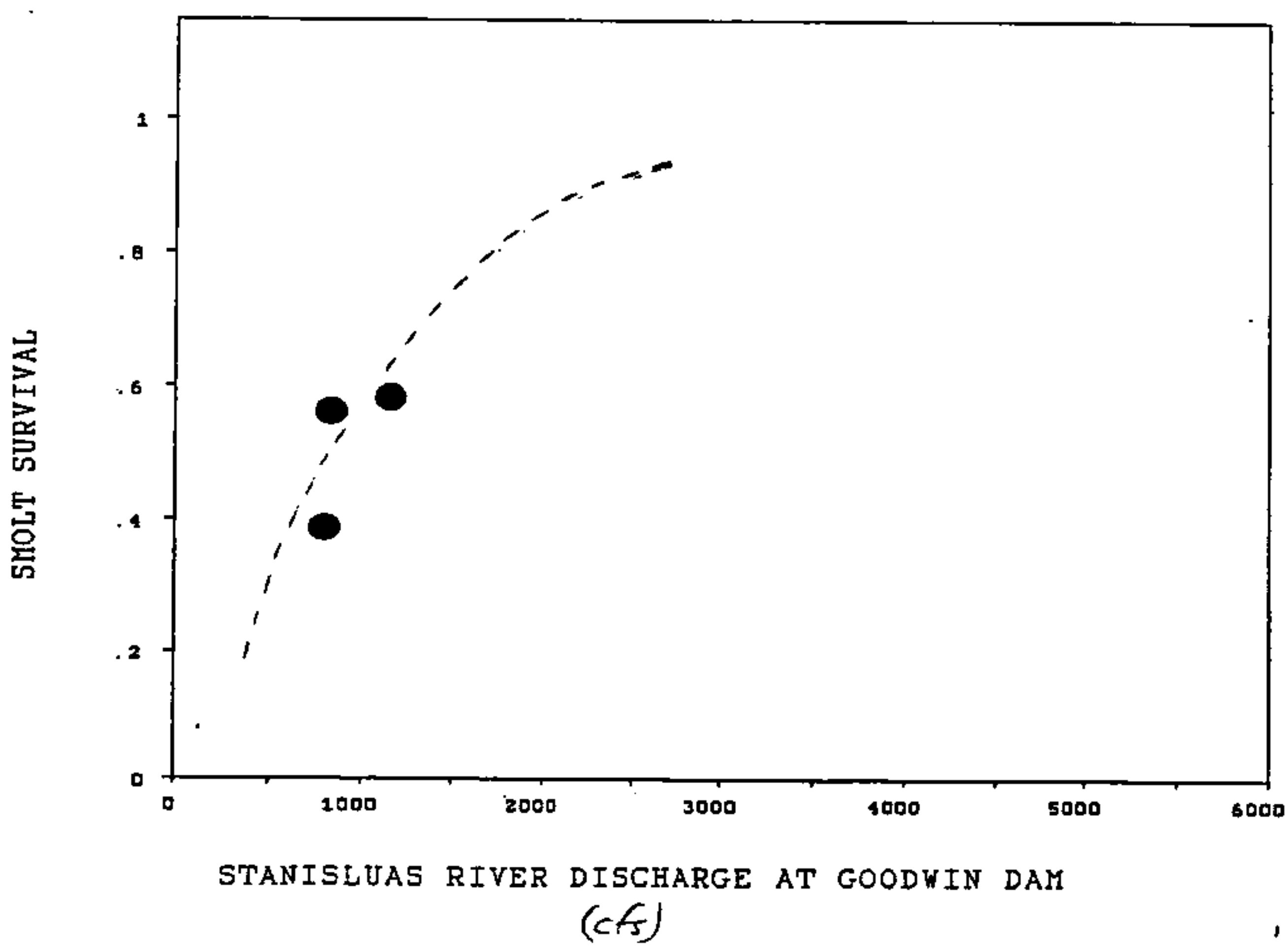


Figure 6. Preliminary Chinook Salmon Smolt Survival Indices and Streamflow Relationships in the Tuolumne and Stanislaus River

that additional fair-share streamflow contributions from the Merced River and the San Joaquin River (in-lieu supplies from various sources) tributaries will also be made available as interim measures.

Smolt survival studies upstream of Vernalis and those downstream are linked by virtue of the common migration route and habitat conditions. Information being developed by the Interagency Ecological Study Program, in combination with the study results upstream, provide a good monitoring tool to evaluate the benefits and impacts of any interim measures adopted to increase San Joaquin salmon survival. Modification of the study programs may vary with interim measures adopted.

Potential interim solution: Based on the information in the record since 1987, and the new smolt survival information provided in this Hearing we encourage the SWRCB to use its best effort to establish the following interim streamflow objectives on the San Joaquin river at Vernalis. These streamflow objectives should target the period from April 15 through May 14 to benefit a large proportion of smolt outmigrants. Water Years would be determined on the basis of the "60-20-20" index.

Critical Years	2,000 cfs
Dry Years	4,000 cfs
Below Normal Years	6,000 cfs
Above Normal Years	8,000 cfs
Wet Years	10,000 Cfs

Potential interim solution: The SWRCB could encourage and facilitate interim measures which increase the April and May streamflows at Vernalis through equitable contributions from each tributary in the San Joaquin drainage. Voluntary water sales or exchanges, wheeling arrangements, temporary use of storage south of the Delta, conjunctive use opportunities and other proactive measures which benefit affected parties are all useful measures to consider on an interim basis.

2. Benefit of linkage with Delta survival improvements Survival improvements in one portion of the migration route by itself is a positive step toward improving San Joaquin fall-run spawning escapements. If interim improvements in smolt survival are made through tributary streamflow increases, the additional water, plus accretions and minus any loss or diversions, will increase the San Joaquin streamflow entering the Delta. It is not intuitive how the linkage of upstream improvements with measures that improve smolt survival through the South Delta can increase the number of adults returning to the San Joaquin drainage.

Interim measures should be considered in terms of their Net Survival Benefits. Smolts migrating from the tributary nursery areas all the way out to the Pacific Ocean migrate through a range of habitat conditions which can impose different survival rates. Starting at the upstream segment, the survival rate in each segment is multiplied by the number of smolts entering that segment. The product from each successive calculation then defines the number of smolts that number of smolts that survived to enter the next reach. Using this logic and actual data obtained in 1987 and 1988, as an example, it becomes obvious that improvements in any one reach alone can be eliminated or be insignificant in relation to impacts in other reaches (Figure 7).

The net survival from the upper ends of the San Joaquin tributaries out to Chipps Island in both examples was very low (0.05 vs. 0.04). In 1987, fewer tagged smolts (by number) survived the migration down the Tuolumne River in comparison to those migrating successfully through the South Delta. In the 1988 example, nearly equal numbers of smolts survived migrations through both reaches, even though the survival rate indices are vastly different.

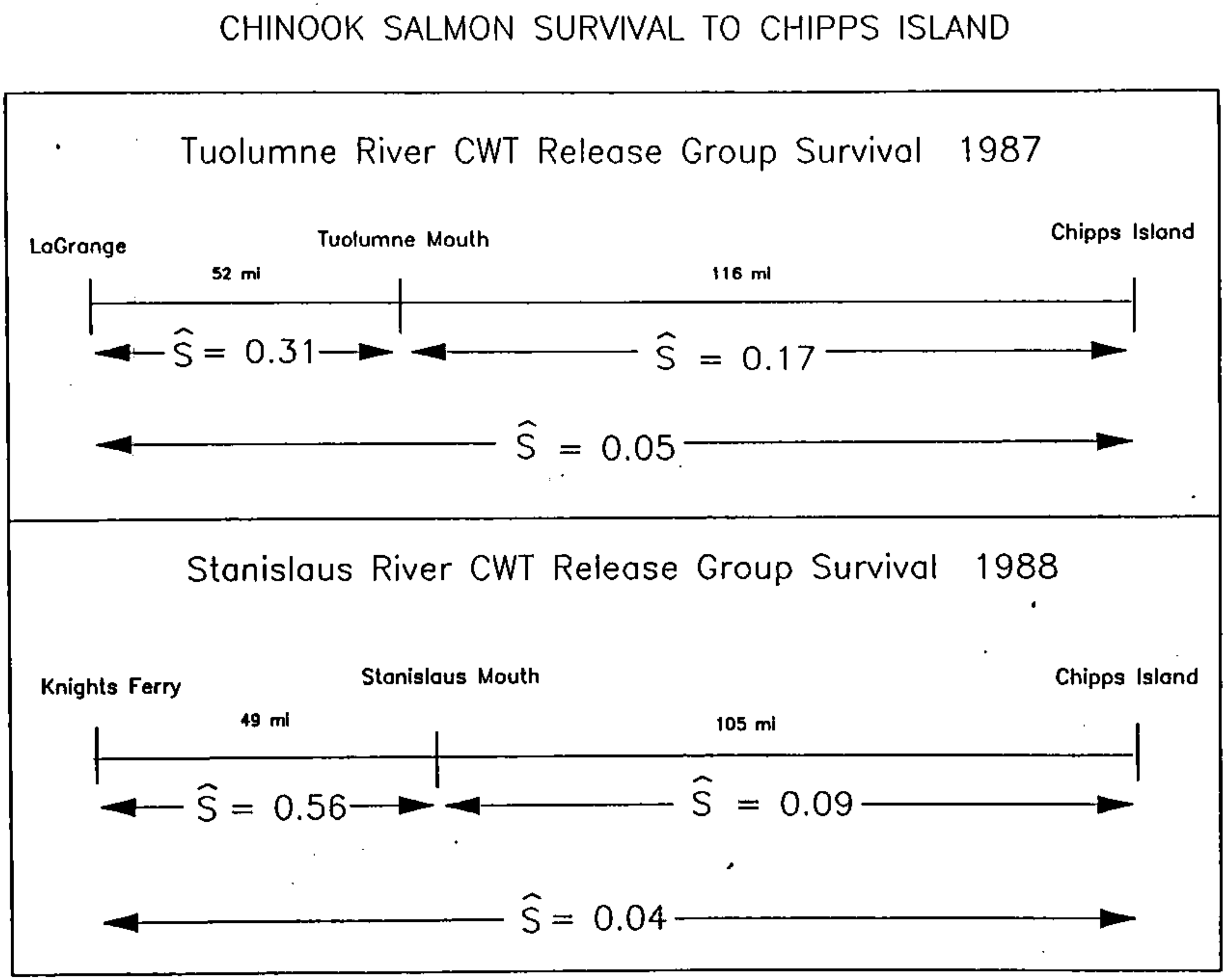


Figure 7. An Example of San Joaquin Fall-Run Chinook Salmon Smolt Survival within Two Reaches of the Migration Route in 1987 and 1988

Due to this mathematical linkage, the net improvement in San Joaquin salmon escapements resulting from any interim smolt survival improvement measures within the Delta reach can be determined by the level of protection provided in the upstream tributaries. Conversely, the net benefit (more adult salmon) resulting from interim measures in the tributaries can be significantly determined by the level of protection (survival rates times number of fish) provided in the Delta. Again, the net benefits are not intuitive.

A two-fold smolt survival rate increase in the tributaries linked to a two-fold smolt survival rate increase in the Delta can result in a four-fold benefit. If survival rate improvements were only applied during a portion of the smolt outmigration period, some fraction of the four-fold benefit would result.

Potential interim solution: The SWRCB should recognize that interim measures linking increases in salmon smolt survival through the entire outmigration periods, and in each successive segment of the migration routes (e.g., tributary, mainstem, and South Delta), will result in the greatest likelihood of increasing San Joaquin fall run chinook salmon escapements and protecting this public trust resource. Shorter protective periods or measures affecting only one segment of the migration route may not protect public trust resources.

Potential interim solution: Link the establishment of new interim streamflow objectives at Vernalis with 1) the installation and detailed monitoring of a complete barrier the upper Old River from April 1 through May 31 each year, and 2) limitations on total CVP and SWP exports during the "controlled freshets."

Potential interim solution: The SWRCB should continue to provide the forum for the exchange of information obtained through the monitoring evaluations associated with any interim measures adopted.

G. Controlled Freshets (pulsed flows)

1. Description and basis We analyzed daily San Joaquin River flow at Vernalis and the daily combined exports (CVP and SWP) to index the net spring flow passing through South Delta during the smolt outmigration period from 1967 to 1985. A total of 12 out of the 18 years had net negative flow conditions. Seven (7) of these 12 years had short periods of net positive flow during the normal outmigration months. Of these 7 years, 4 of the years with short periods of daily positive flow were associated with reasonable spawning escapements. Our conclusion was that there may be an opportunity to provide a "window of protection" during the primary outmigration period that would result in improved escapements.

Since 1987, we have evaluated the potential to improve salmon smolt survival and spawning escapements using short duration pulsed flows. We were striving to use the existing water allocations the best way possible. Short duration pulses were not effective for several key reasons. The limited amount of water available provided "controlled freshets" of only 500 to 900 cfs for short durations (3 to 5 days). Juvenile salmon distributions in the upper reaches of the tributaries did change slightly in response to these flows, but no significant outmigrations were detected.

In most years, smolt travel times from the tributaries to Chipps Island in the Delta are much longer (12 to 16 days) than the duration of the freshets we could provide with existing water supplies (DFG Annual Performance Reports, 1988 through 1991 and USFWS Annual Progress Reports, 1988 through 1991). This meant that any benefits created by stimulating smolts to leave the tributaries, if indeed this happened, would likely be eliminated through the long delays and high mortality rates in the South Delta. Smolts must keep moving through the South Delta towards the ocean to avoid high mortality.

Controlled freshet experiments on the Stanislaus River in 1991 exceeded 1200 cfs (for 4 days; up to 1750 cfs for 6 hours each day). We perceived increases in our trawl catch at Mossdale following these larger events (Figure 4). Using the "theoretical relationship" in Figure 6, it is reasonable to assume that Stanislaus River flows in that range may improve smolt survival to Mossdale (Figure 6). However, improvements in survival over such a short period influence only a small percentage of the offspring in that year class. A single freshet of high flow does appear to move smolts into the San Joaquin River but their fate in the South Delta under low Vernalis flows, warm water temperatures and high exports is questionable.

It does appear that large controlled freshets, if sustained long enough, could benefit significant percentage of the smolts present. A suite of interim measures that moves smolts safely to and through the Delta should be evaluated. This may represent an effective way to improve San Joaquin salmon spawning escapements in a relatively water-efficient manner.

Potential interim measure: Larger controlled freshets could be released from San Joaquin drainage storage reservoirs during the primary outmigration periods. If a complete barrier in upper Old River and reasonable CVP/SWP exports (relative to Vernalis flows) are linked to the freshet timing it is more likely to benefit spawning escapements. A full range of hydraulic condition (freshets and exports) should be evaluated during the interim period.

2. Fair-share contributions by water year type If controlled freshet objectives at Vernalis were established, a fair-share approach to apportioning the responsibility for meeting those objectives will be needed. One logical basis to use is the unimpaired historical runoff contribution that each

tributary made to the San Joaquin River flows at Vernalis (Figure 8). The focus then would be on allocating the responsibility among the various water rights in each drainage. As an example, a variety of options are available to meet the 30.4% responsibility from the upper San Joaquin River.

Figure 5 and Appendices 3, 4C and 5B provide a basis to identify an interim range of streamflows at Vernalis that would likely result in smolt survival improvements in each tributary (unimpaired historic runoff basis) and through the South Delta. The extent to which survival would improve in the South Delta may be strongly influenced by the presence of a complete barrier in upper Old River, the CVP/SWP exports, the extent of flow reversal and other factors. Using this approach, survival benefits would be provided in each segment of the outmigration route making measurable improvements in adult escapements more likely.

Figure 9 illustrates the range of streamflows, in addition to the actual flows at Vernalis, under existing agreements from 1987 to 1991, that would likely provide a good range of smolt survival improvements in the San Joaquin tributaries. These streamflows are all well short of providing optimum smolt survivals but would make measurable improvements. A numerical summary of this information is provided in Appendix 10. Release times could be based on the information in Figures 4 and 5 and known travel times for water reaching Vernalis.

Figure 10 identifies the additional water (1989 base case) needed from each tributary to meet a 28-day freshet in 5 water year types. Instead of using the 1906 through 1989 unimpaired runoff basis, in this example we assumed the following proportions of contributions from each river: Stanislaus, 15%; Tuolumne, 35%; Merced, 15%; and San Joaquin, 35%. A numerical summary of this option is also provided in Appendix 10.

<u>Potential interim solution: The SWRCB should describe the</u>

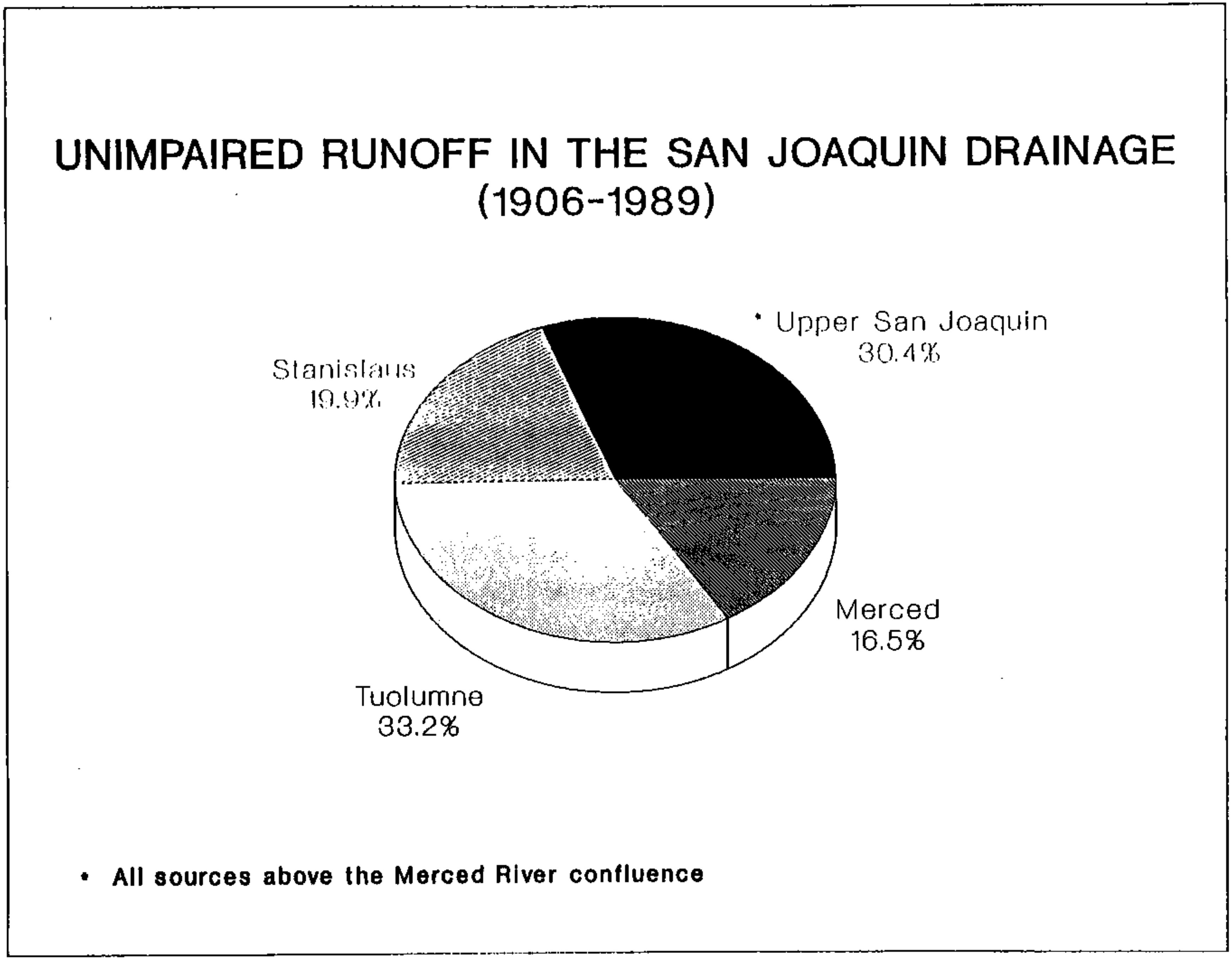


Figure 8. Composition of the Unimpaired Historic Runoff from 1906 through 1989 at Vernalis on the San Joaquin River

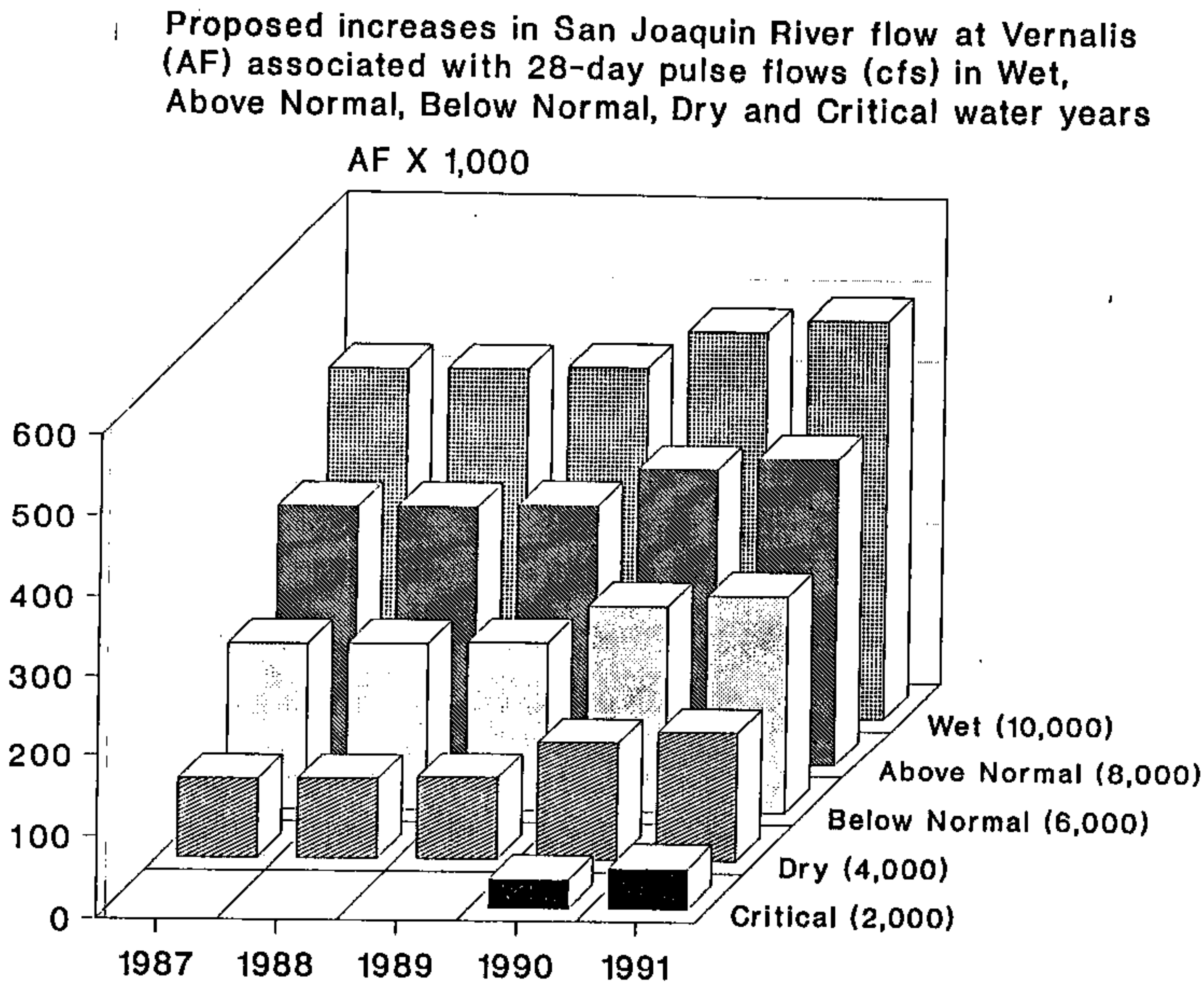


Figure 9. Proposed Increases in San Joaquin River Flow at Vernalis Associated with a 28-Day Pulse Flow in Wet, Above Normal, Below Normal, Dry and Critical Water Years

Proposed increases (ref. 1989) in fishery allocations (AF) associated with 28-day pulse flows (cfs) in Wet, Above Normal, Below Normal, Dry and Critical water years

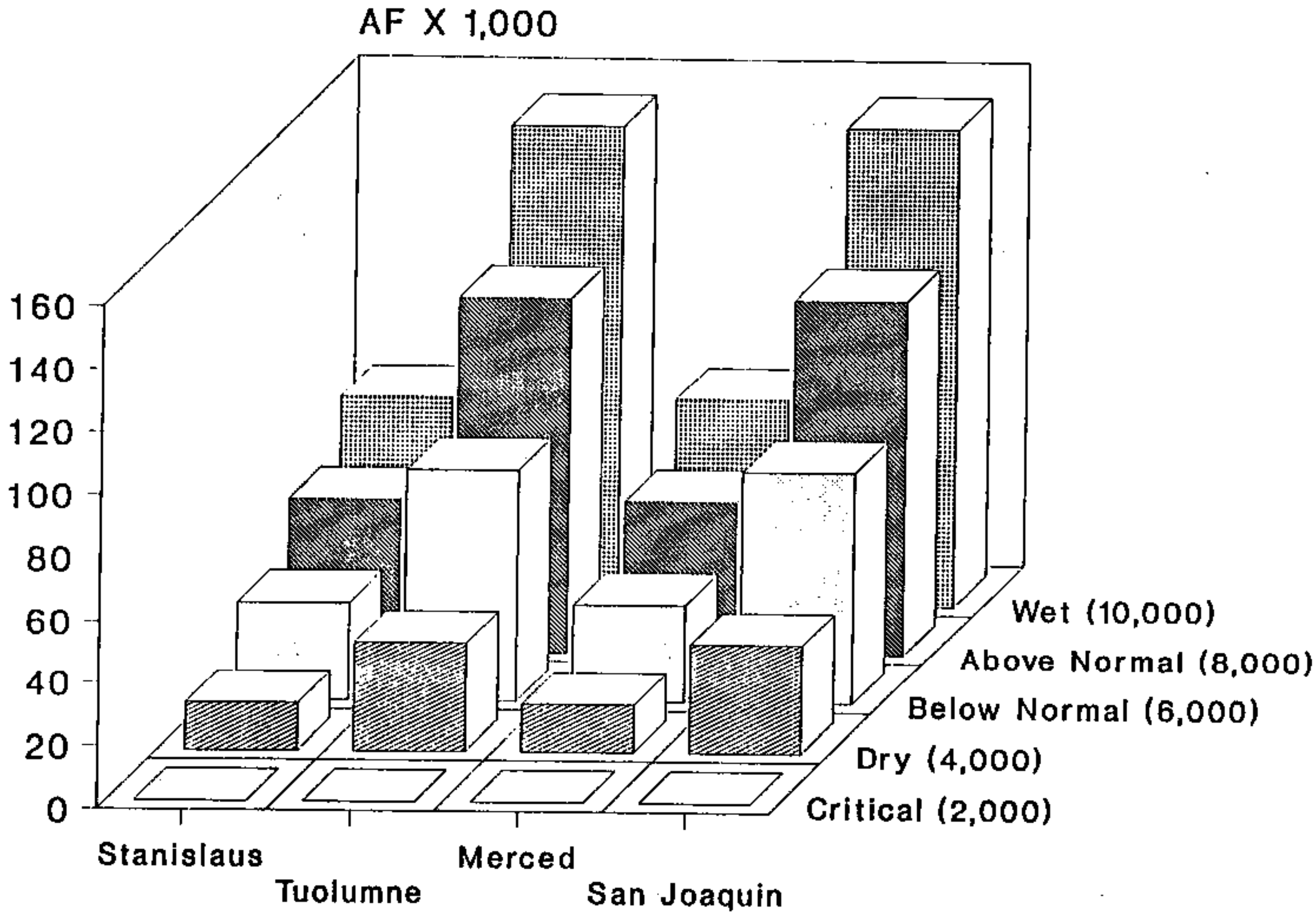


Figure 10. Proposed Increases in Fishery Allocations Associated with 28-Day Pulse Flows (cfs) in Wet, Above Normal, Below Normal, Dry and Critical Water Years

procedures it intends to use in allocating any additional instream flow responsibilities as soon as possible.

Potential interim solution: The SWRCB could encourage and facilitate interim measures which increase the April and May streamflows at Vernalis on an equitable basis.

Potential interim solution: Interim flow objectives for "controlled freshets" could be set at levels that are anticipated to improve adult salmon escapements in the San Joaquin drainage.

H. Interim annual streamflow schedules

1. Base and proposed interim schedules Instream flow studies (IFIM), temperature models, smolt survival studies, channel maintenance flow requirements and other information necessary to develop final streamflow schedules on each tributary in the San Joaquin drainage are not yet available. Studies on the Stanislaus and Tuolumne rivers do provide enough information to recognize that existing water allocations fall short of needs for instream beneficial uses. A recent agreement on the Tuolumne River provides an opportunity for improvements there. There are very obvious impairments to cold water beneficial uses occurring on the Merced River. Finally, the use of "controlled freshets" to make interim improvement in smolt survival and adult escapements would require additional instream flows.

Using the information available, we developed baseline and a range of interim streamflow allocations below major storage reservoirs in the San Joaquin drainage (Table 3). These schedules primarily target fall-run chinook salmon, but also provide improved summer flows and water quality conditions during the remainder of the year, that are expected to benefit other fisheries as well as other beneficial uses.

The base was developed by summarizing existing instream flow allocations in various agreements and licenses pertaining to

Table 3.

**BASE STREAMFLOW ALLOCATIONS (1992 IN TAF)
BELOW MAJOR SAN JOAQUIN DRAINAGE STORAGE RESERVOIRS
AND PROPOSED INTERIM INCREASES (1992-2000)
SOURCE: DEPARTMENT OF FISH AND GAME, REGION 4**

	Existing Base (TAF)		1992 - 2000 (TAF)		2000 - 2020 (TAF)
Tributary	Dry	Normal	Proposed Interim[1]	Net Increase	Proposed Final
San Joaquin River	0	0	16.6 - 356.9[2]	16.6 - 356.9	Define through studies, projects, mitigation and enhancement strategies.
Merced River	67.1	72.1	82.1 - 331.0[3]	15.0 - 258.9	Define through studies, projects, mitigation and enhancement strategies.
Tuolumne River	70.1	135.3	63.7 - 374.5[4]	(-6.4)- 239.2	Define through studies, projects, mitigation and enhancement strategies.
Stanislaus River	98.3	98.3	193.1 - 420.0[5]	94.8 - 321.7	Define through studies, projects, mitigation and enhancement strategies.
	235.5	305.7	355.5 - 1,482.4	120.0 - 1,176.7	355.5 - 1,482.4[6]

[1]Assumes a range of interim increases based on water year types and water availability.

[2]Based on 30% CVP contribution to San Joaquin River flow at Vernalis released at/near the Merced River confluence to improve smolt survival. Range derived by 14-60 day spring flow contributions (30%) of wet, above normal, below normal, dry and critical flows at Vernalis of 10,000, 8,000, 6,000, 4,000, 2,000, respectively. Consistent with alternative 5 under review by the State Water Resources Control Board (Bay-Delta hearing). Studies should be implemented to define streamflow needs from Friant to the Merced River confluence. Amendments to Friant Unit Contracts may be necessary for implementation. Evaluation of tributary and Delta water management compatibility during immigration and emigration needed.

[3]Based on 17% Merced River contributions to April and May flows in San Joaquin River at Vernalis plus 15,000 AF in September-October all released at Crocker-Huffman Dam near Snelling, California. Range derived by 14-60 day spring flow contribution (17%) as in Footnote 2. IFIM, temperature-model development and biological study underway in FY 92-93. 15,000 AF additional needed each fall, all year types, plus 150 cfs summer flow (42 TAF)

[4]Range based on March 1, 1992 agreement with Turlock and Modesto Irrigation Districts. Eleven (11) different schedules released at La Grange Dam pursuant to recent agreement (March 1, 1992) with Modesto and Turlock Irrigation Districts. Increase based on 15% of inflow to New Don Pedro Reservoir up to 1.324 MAF; 16% of inflow thereafter. Agreement language provides 14-60 day flow contribution from Tuolumne River consistent with Footnotes 2 and 3, with evaluations to determine future refinements.

[5]Minimum (193.1 TAF) is equivalent to the base recommendation in a 1992 U.S. Fish and Wildlife Service report (140 TAF) plus 150 cfs summer flows (42 TAF), plus 20% contribution to Vernalis flows (14-60 days) as in Footnotes 2, 3 and 4 (14 day at 400 cfs in critical year = 11.1 TAF).

[6]Refine Interim schedules through time as new information is available and innovative solutions develop, and modify through State Water Resources Control Board/FERC proceedings or agreements.

chinook salmon. The proposed interim schedules for the Stanislaus, Tuolumne and Merced rivers are based on our current understanding of the water needs in those streams. Each interim schedule includes a 14 to 60 day controlled freshet apportioned on the basis of historic unimpaired contributions to the runoff at Vernalis. A 30% contribution to the controlled freshet was assumed for the San Joaquin River above the mouth of the Merced River. Water in-lieu of Friant Dam releases could be provided to make a fair-share contribution to benefit smolts migrating from the Merced, Tuolumne and Stanislaus rivers.

We estimate that from 355,500 (dry year) to 1,176,700 AF (wet year) of water is needed to meet instream needs of fall run chinook salmon in the San Joaquin drainage. Information on streamflow necessary to restore salmon production in the San Joaquin River near Fresno is lacking, so this estimate excludes that portion of the drainage, except for the controlled freshet contributions. For comparative purposes, the annual streamflow totals at Vernalis in the 1977 and 1982 water years were approximately 417,000 and 5,500,000 AF, respectively.

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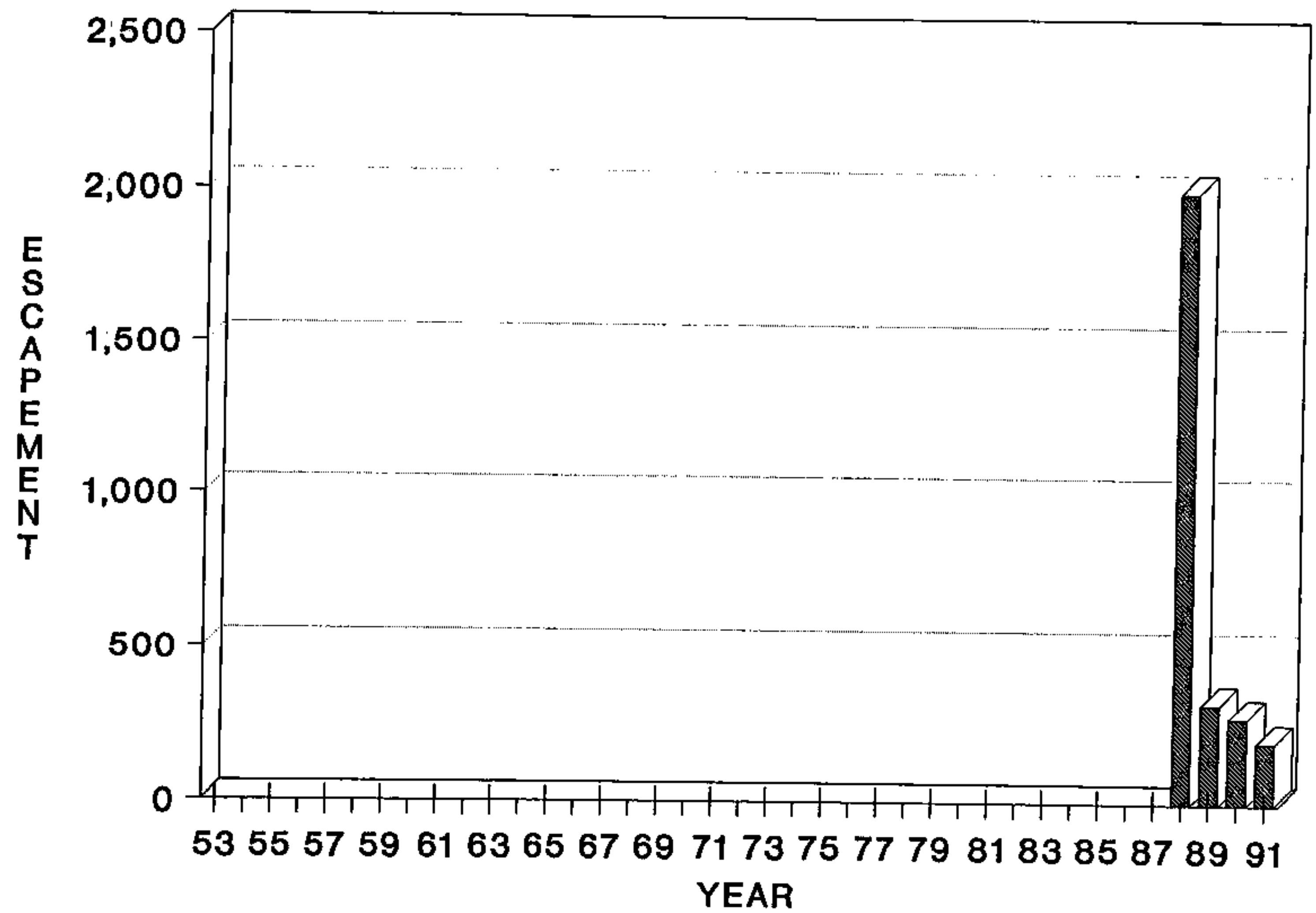
Matthews, G.M. and R.S. Waples, 1991. Status Review for Snake River Spring and Summer Chinook Salmon. NOAA Technical Memorandum NMFS F/NWC-200 (ESA Administrative Record).

U.S. Fish and Wildlife Service, 1989 through 1991. Abundance and Survival in the Sacramento-San Joaquin Estuary, 1988 through 1991 Annual Progress Reports.

Appendix 1. Estimated Number of Fall-Run Chinook Salmon Straying into Western Merced County Streams, 1989-91



Appendix 2.

Memorandum of Understanding on Interim Measures to Protect Fish in the Sacramento-San Joaquin River Delta Prior to the Construction of the Peripheral Canal

It is recognized that fishery problems exist in the Sacramento-San Joaquin Delta. A factor affecting these problems is the operation of the Central Valley Project and State Water Project. Certain operation procedures could reduce these problems until the Peripheral Canal is operational.

The attached report by the Bureau of Reclamation on "Interim Measures for Protection of Fish and Water Quality", dated January 1968, is accepted as a statement of the current problems associated with fish in the Sacramento-San Joaquin River Delta, need for interim measures, types of measures, priorities, and costs.

This Memorandum of Understanding summarizes objectives to reduce the problems, actions which have been taken to meet these objectives, and a procedure to implement a protection program in the period prior to operation of the Peripheral Canal. This Memorandum will be reevaluated and revised as may be necessary in 1976 if the Peripheral Canal is not operational by that time.

Objectives

Objectives have been established to achieve desirable measures that are compatible with other water resource needs until the proposed joint Federal-State Peripheral Canal can be put in operation. Among these objectives and actions to meet these objectives are:

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section 1201.13 have been complied with and this document is exempt from review by the Department of Finance.

[signature]

I. Improve fish salvage operation at the Tracy Pumping Plant of the Bureau of Reclamation.

A. Modify tank trucks to relieve problems of plugging with fish and debris.

B. Select, develop, and construct two sites in the western Delta for release of fish offshore in deep water.

C. Employ a full-time fishery biologist with responsibilities for developing operational procedures for fish handling.

II. Maintain remnant salmon stocks in the San Joaquin River tributaries.

A. Rear juvenile salmon to yearling size by trapping and artificially spawning fall run king salmon in San Joaquin River tributaries and taking sufficient eggs to produce 200,000 yearling fish annually.

B. Transport yearling salmon in years of low river flow from the San Joaquin River tributaries by live car or truck to release points in the Delta out of the influence of the pumps.

III. Minimize detrimental effects of flow reversal and low levels of dissolved oxygen on salmon runs of the San Joaquin River.

A. Have control structure in Old River in operation when fall flows in the San Joaquin River at Vernalis drop below 1800 cfs and/or critical problems with salmon migration are predicted.

B. Supplement the flows of the San Joaquin River when the control structure is in place to maintain the dissolved oxygen content in the Stockton Ship Channel generally above 6 ppm when necessary. Supplemental flow not to exceed 60,000 acre-feet in any year.

IV. Protect striped bass eggs and larvae and provide a water quality suitable for bass migration and spawning.

A. Annually plan to reduce pumping during the striped bass spawning period to the maximum extent possible consistent with other project purposes.

B. Annually plan to increase outflow during the period of curtailed pumping to the extent possible consistent with other project purposes.

Action in Progress

To date there has been substantial progress in meeting the above objectives. A summary of the action in progress -- numbered to correspond with the objectives enumerated above -- is as follows:

I. A. Modification of tank trucks is in progress by the Bureau of Reclamation and should be completed about April 1, 1969.

B. Tentative sites for release of fish in deep water in the western Delta have been selected and their development has been discussed with California

Department of Fish and Game and U. S. Bureau of Sport Fisheries and Wildlife. Cost of development of each site is estimated to be from $15,000 to $20,000. Two sites will be constructed by the Bureau of Reclamation as soon as possible deperding on budget limitations. Two sites already developed by the Department of Water Resources are operational and can be utilized by the Bureau of Reclamation pending completion of other sites.

C. Preliminary action has been taken by the Bureau of Reclamation to employ a full-time fishery biologist by July 1970. (The Department of Water Resources has employed a fishery biologist under contract with the Department of Fish and Game to guide the fish salvage program at the State's Delta Pumping Plant and coordinate the operation of the state fish facilities with that of the federal facilities at the Tracy Pumping Plant.)

II. A program to meet these objectives has been carried out by the California Department of Fish and Game for the past three years at a cost of $30,000 annually.

III. The California Department of Water Resources and the U. S. Bureau of Reclamation have acted in 1963, 1964, and 1968 when critical levels of dissolved oxygen have developed in the Stockton Ship Channel to achieve a substantial part of the desired objective. This was accomplished by installing a temporary control structure in Old River together with augmentation of flow in the San Joaquin River.

IV. Action on this objective has not been necessary to date because of the limited diversions of the state and federal projects.

The Secretary of the Interior has accepted a proposal of the Bureau of Reclamation to operate the Central Valley Project, beginning in 1969, to achieve certain water quality objectives in the Delta for striped bass migration and spawning until September 30, 1972.

Future Implementation

After reviewing the progress to date and work now in progress, it is apparent that objective No. I will be substantially achieved and should be continued as planned. The California Department of Fish and Game will continue to fulfill objective No. II as required. To achieve objectives Nos. III and IV, it will be necessary to provide for a year-by-year review of conditions relating to the total operational requirements of the federal and state water projects. To insure that objectives Nos. III and IV are given full consideration, the following procedure will be adopted.

1. In March of each year, the four agencies will meet to consider the striped bass needs in the forthcoming spring months in relation to runoff conditions, operation schedules, and local Delta needs. Differences which cannot be resolved at this meeting will be decided upon at a special meeting of the Directors of the agencies.

2. In June of each year the four agencies will meet for the purpose of discussing the needs of the salmon fishery during the fall, and more specifically, to determine the need and/or scheduling of a closure of Old River and the estimated flow augmentation required. The same procedure for considering operational plans and resolving differences will be followed as set forth in Item 1 above.

Division of Responsibilities

Subject to the availability of funds, the initial assignment of responsibility for implementing measures to achieve protection of San Joaquin salmon is as follows:

1. The Department of Fish and Game will be responsible for the rearing and transporting of yearling salmon.

2. The Department of Water Resources will be responsible for the control structure in Old River.

3. The U. S. Bureau of Reclamation will be responsible for San Joaquin River flow augmentation.

4. The U. S. Bureau of Sport Fisheries and Wildlife will be responsible for coordination of measures with the Department of Fish and Game and continued evaluation of the adequacy of the current measures.

Approved as to legal form and sufficiency: [signature] Chief Counsel, DWR

CALIFORNIA DEPARTMENT OF WATER RESOURCES

By [signature]

CALIFORNIA DEPARTMENT OF FISH AND GAME

By [signature]
Administrative Officer

U. S. BUREAU OF RECLAMATION REGION II

By [signature]

U. S. BUREAU OF SPORT FISHERIES AND WILDLIFE, REGION I

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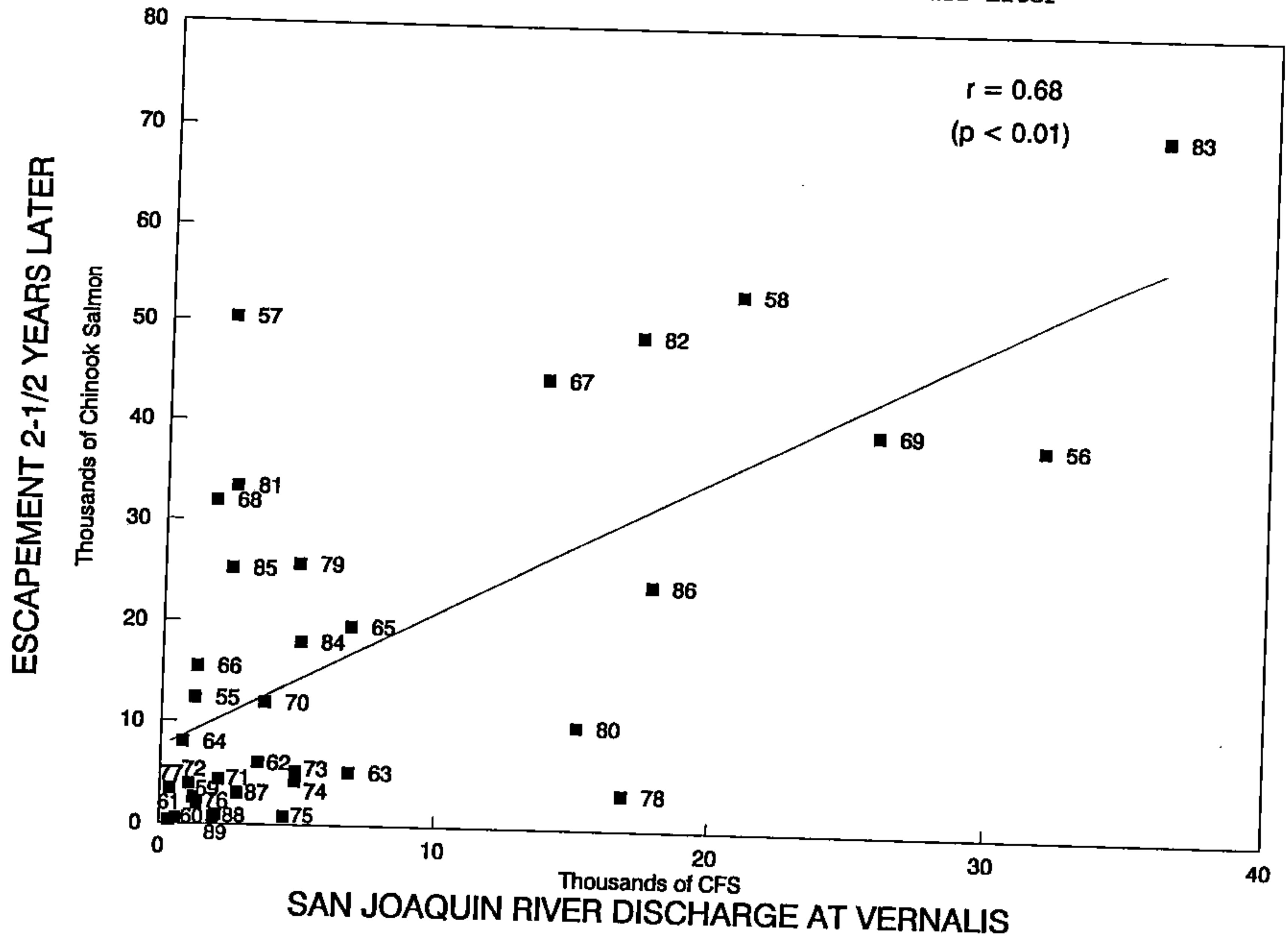
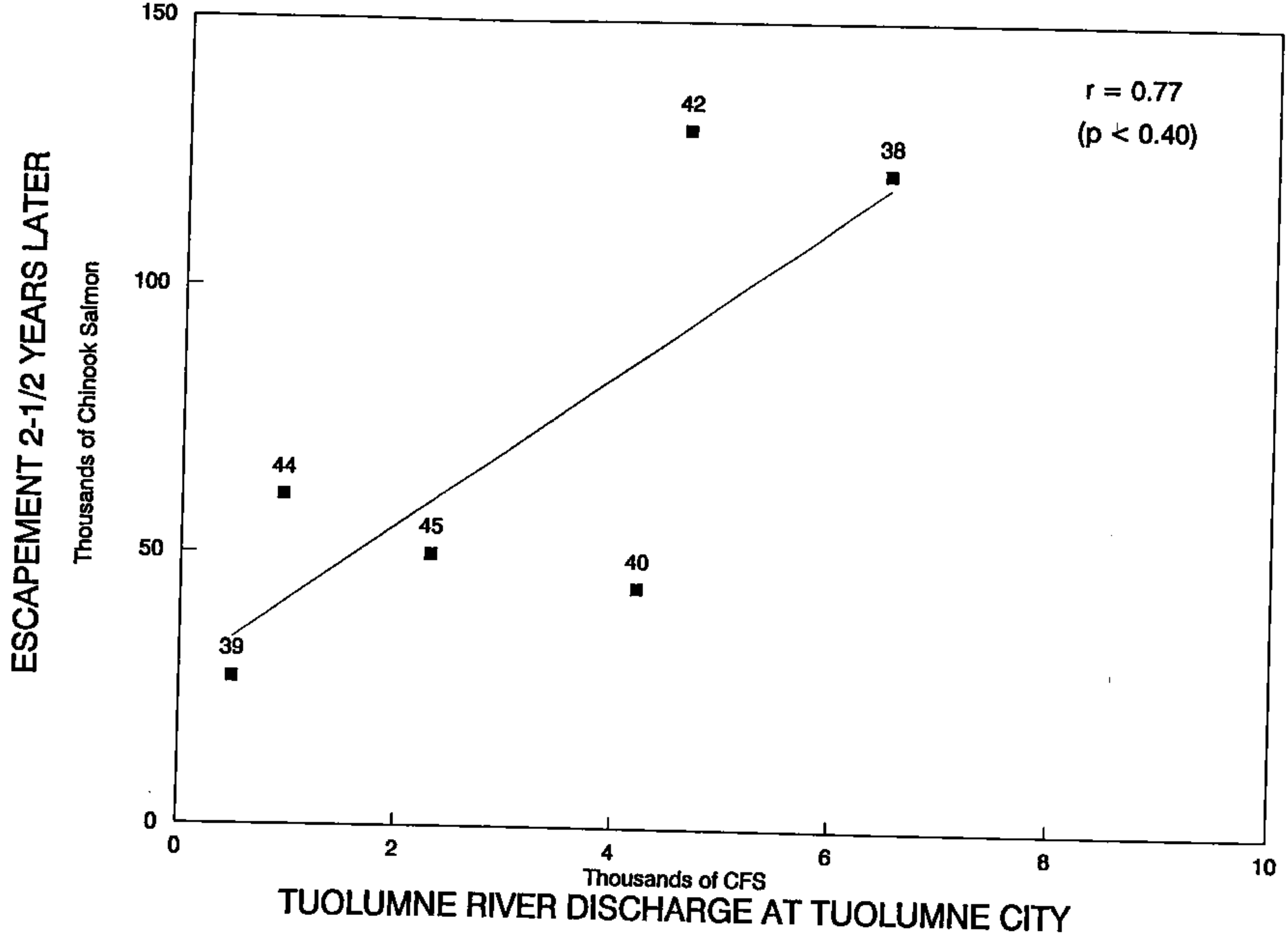
Attachment

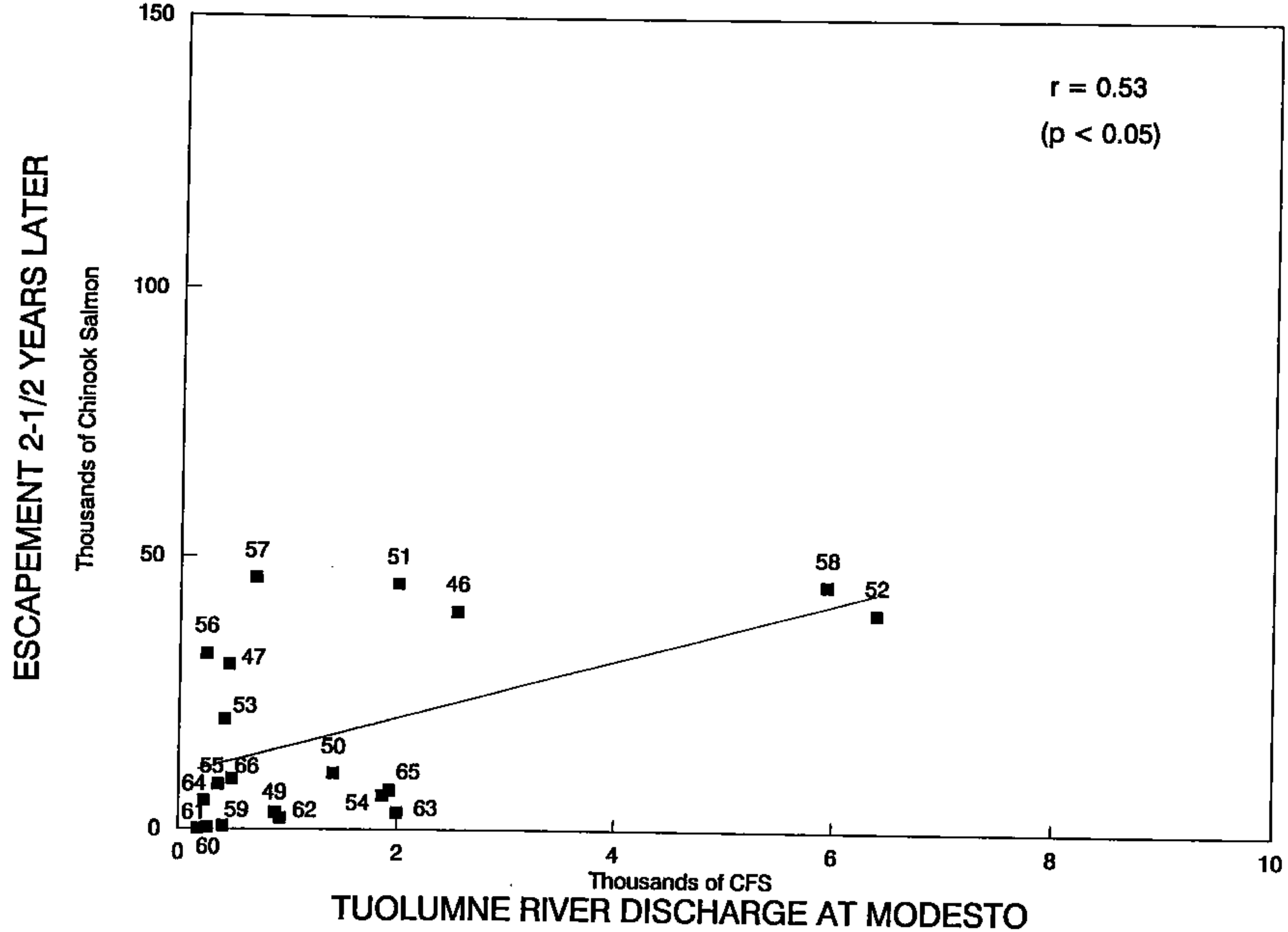
Appendix 3. Flows in the San Joaquin River during Juvenile Emigration (1955-1989) and Corresponding Adult Spawning Populations 2+ Years Later



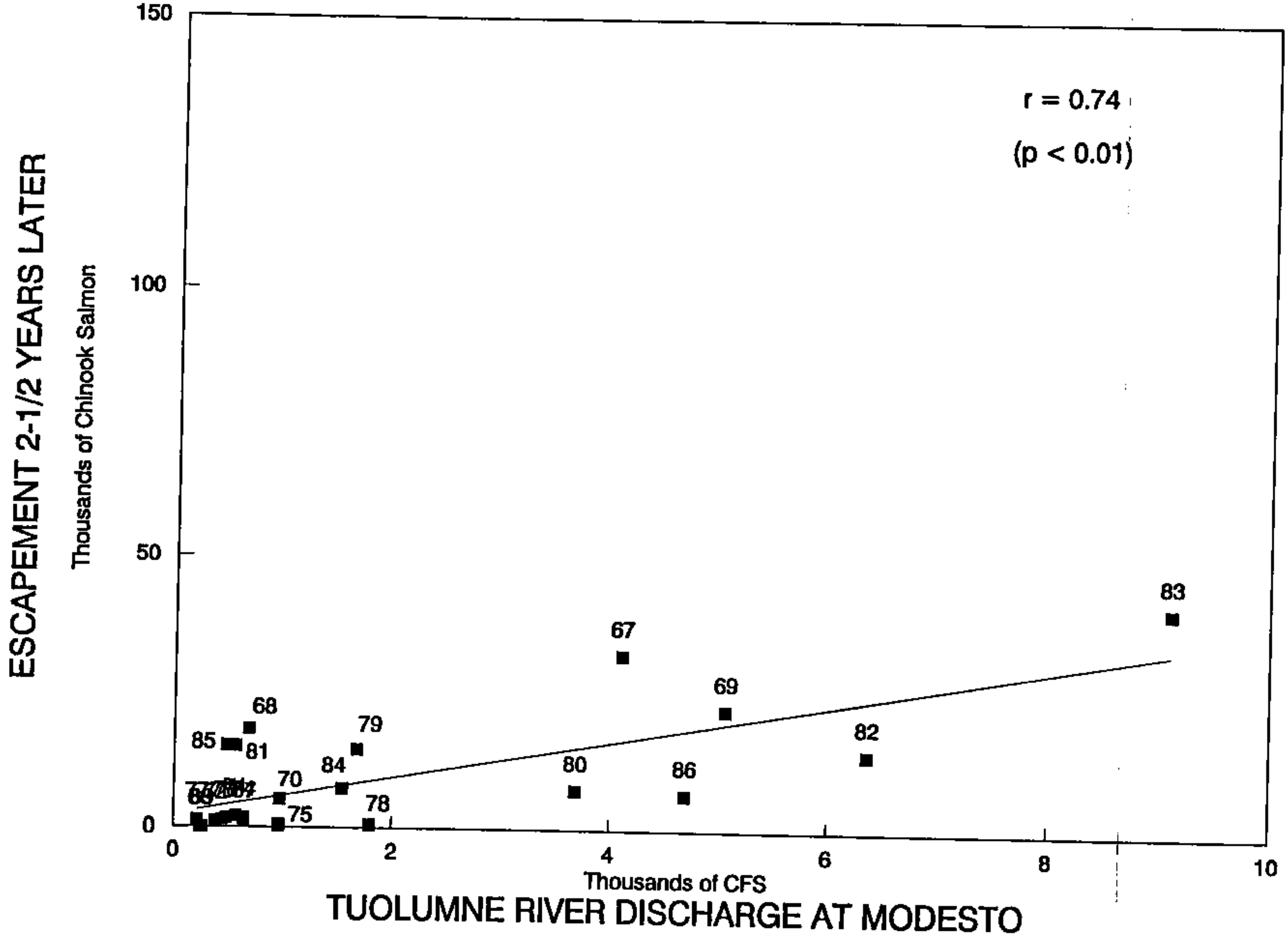
Appendix 4. (A) Relationships of Tuolumne River Fall-Run Chinook Salmon Escapement to Mean Daily Spring Flows from 1938-1945



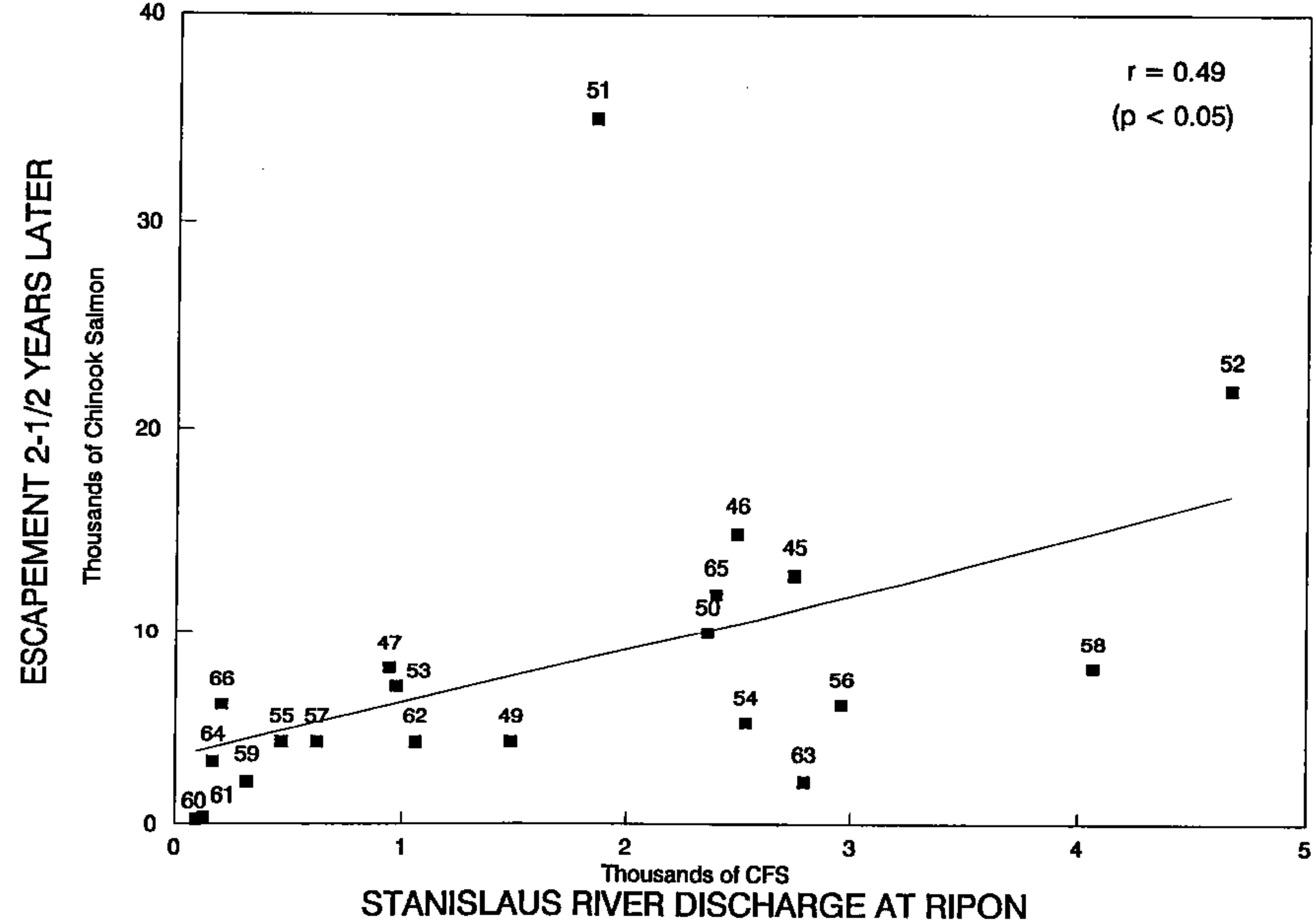
Appendix 4. (B) Relationships of Tuolumne River Fall-Run Chinook Salmon Escapement to Mean Daily Spring Flows from 1946-1966



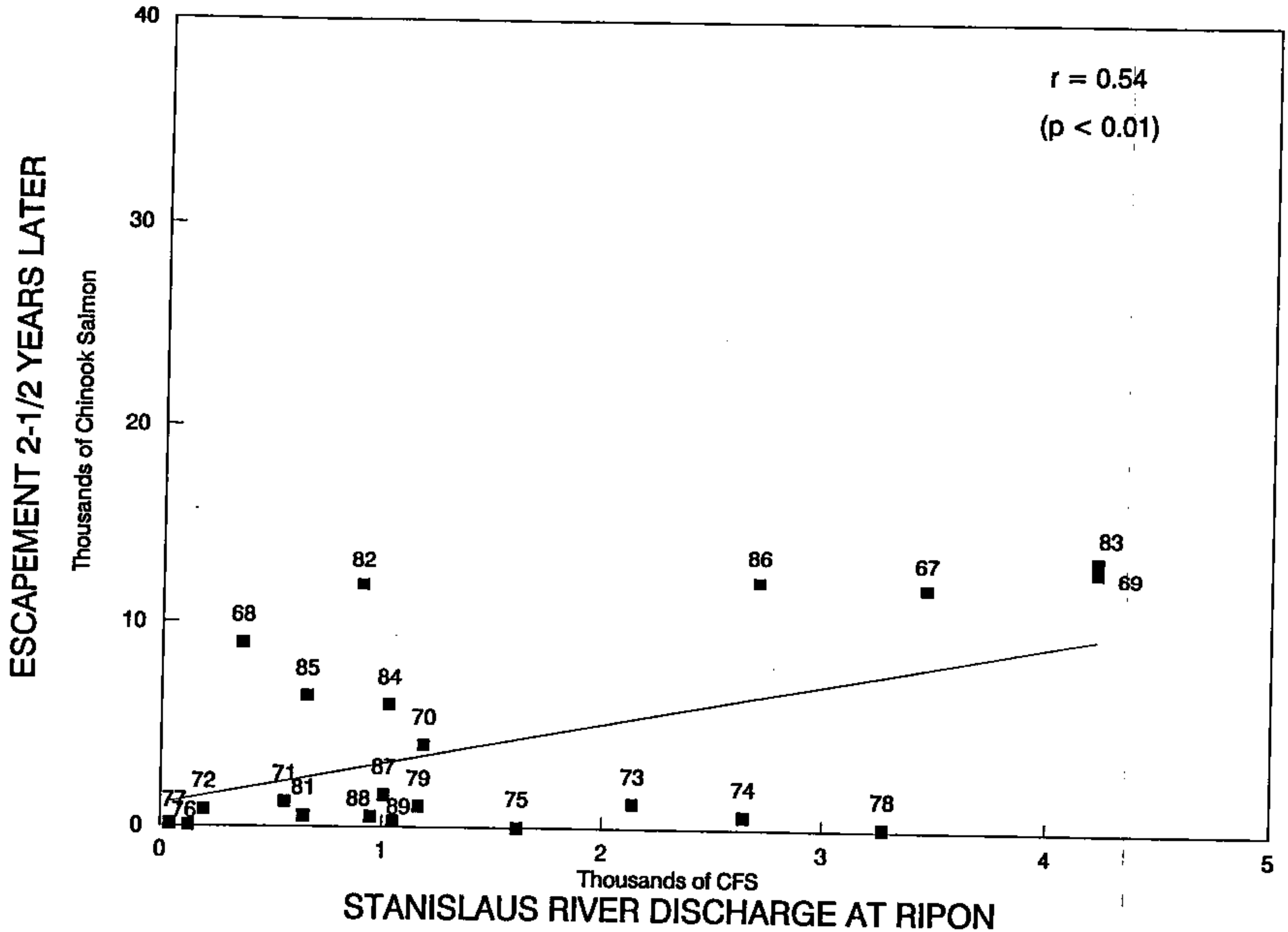
Appendix 4. (C) Relationships of Tuolumne River Fall-Run Chinook Salmon Escapement to Mean Daily Spring Flows from 1967-1988



Appendix 5. (A) Relationships of Stanislaus River Fall-Run Chinook Salmon Escapements to Mead Daily Flows from 1947-1966



Appendix 5. (B) Relationships of Stanislaus River Fall-Run Chinook Salmon Escapements to Mead Daily Flows from 1967-1988



Appendix 6.

State of California

M E M O R A N D U M

To : Fisheries Files; Stanislaus River Salmon

Date : 29 May 1992

From: **Department of Fish and Game** - Mark Pisano

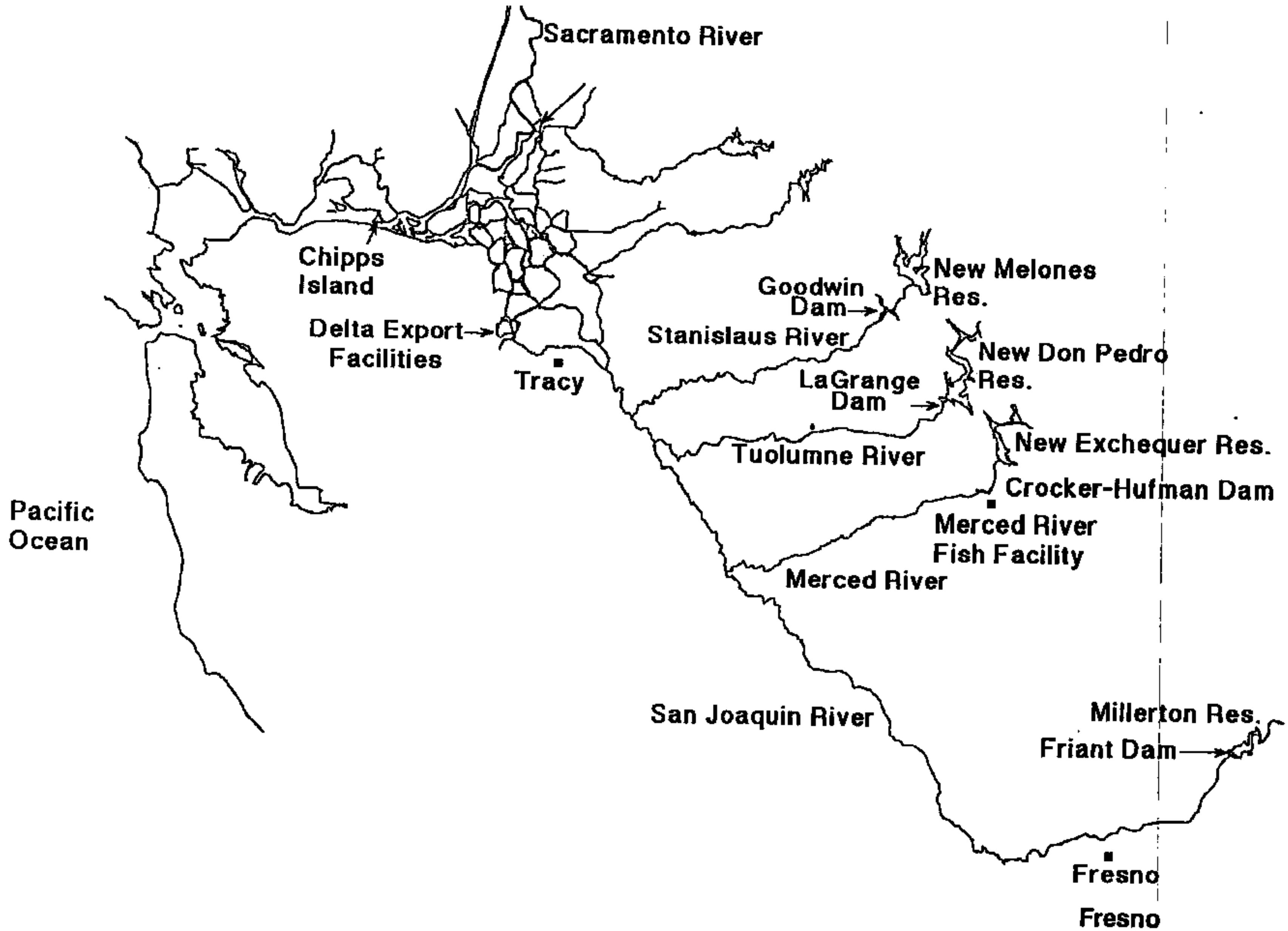
Subject: Tulloch and New Melones Reservoir Operations and Resultant Stanislaus River Water Temperatures Below Goodwin Dam During the Fall of 1991

High water temperatures in the salmon spawning and rearing portions of the Stanislaus River have been a concern since New Melones Reservoir began operation. Water temperatures below Goodwin Dam in September, October and even early November typically exceed the 13.3°C needed to reduce temperature related mortality of adult salmon and minimize the reduction in egg viability (ref. Exhibit 15, Phase I Bay/Delta Hearing Process). High water temperatures during the fall months can also delay immigration and spawning (ref DFG-San Joaquin River Chinook Salmon Enhancement Project Annual Report Fiscal Year 1990-1991). Delayed spawning results in delayed fry emergence and smolt outmigration. High water temperatures and low river flows during the late spring create unfavorable conditions for progeny of late spawners and results in decreased survival for these fish. Six consecutive years of drought conditions and seriously depleted San Joaquin salmon stocks have exacerbated water temperature concerns.

In 1991, storage in New Melones fell below minimum pool (300 TAF) in late August and remained there for the balance of the calendar year. In anticipation of warm river temperatures below Goodwin Dam, a special reservoir operation was implemented to try and provide temperature relief for immigrating and spawning salmon below Goodwin Dam. This special operation involved releasing the warm water which accumulated over the summer in Tulloch Reservoir to "off-stream" storage areas where it was used to meet irrigation demands and then refilling with cold water stored deep in New Melones Reservoir.

To document the effects of this reservoir operation, three Ryan TempMentors (automatic temperature recording devices) were placed at various locations throughout the river. The first was placed at Two-Mile Bar (RM 56), the second at the Yahi Archery Range at the town of Riverbank (RM 34), and the third near the confluence of the San Joaquin River (RM 1). River water temperatures were recorded hourly. Additional temperature information was provided by the U.S. Geological Survey (USGS) from their Knights Ferry (RM 58) and Oakdale gages (RM 41) (Figure 1). For the purposes of this report, mean daily water temperature is defined as the average of the daily minimum and maximum temperature values. Similar temperature information from 1990 (also a drought year, but no temperature protection plan implemented) is provided wherever possible for

Figure 1. San Joaquin River Basin and general location of the Stanislaus River



comparison.

Water temperature and Dissolved oxygen profiles were taken approximately every two-weeks as near as possible to the outlet structures in New Melones and Tulloch reservoirs from August through October/November. These profiles provided information on the degree of temperature stratification in the reservoirs and helped define the location (elevation) of the cold water stored in the hypolimnion of New Melones.

Provisional mean daily flow information for the Stanislaus River was obtained from the California Data Exchange Center (CDEC) for the Orange Blossom Bridge gage (RM 49) and is presented in Figure 2. Daily minimum and maximum air temperatures were provided by the Modesto Irrigation District and were taken at their office in Modesto.

RESULTS AND DISCUSSION

Warm water stored in Tulloch Reservoir was released to off-stream storage areas beginning on 15 September 1991 and continued through the end of September (Figure 3). Surface elevation in Tulloch was reduced by about 25 feet. Tulloch was then refilled (back to original surface elevation) with cold water released from outlets below the power generating facilities at New Melones Dam beginning on 1 October and ended on 15 October.

Reservoir temperature profiles indicate that substantial cooling had occurred in Tulloch as the reservoir was refilled with cold water from New Melones (Figure 4). Water temperature well below that considered to be the maximum allowable (13.3°C) to prevent mortality and egg loss was found at an elevation about 50 feet above the intake to the Tulloch Dam Powerhouse. Under normal operation, water from the powerhouse is subsequently released below the dam to the Stanislaus river. By comparison, water temperature in 1990 at the powerhouse intake had not fallen below 13.3°C when the final profile was taken in October (Figure 5).

Mean daily water temperatures measured at the Knights Ferry gage showed a dramatic decrease (from 21°C to 15.5 °C) as soon as Tulloch began to refill (Figure 6). River temperatures below 13.3°C however, were not observed until 24 October. Temperature data are unavailable from USGS for Knights Ferry between 13 November 1990 and 21 November 1990 and after 22 November 1991. A similar decrease in water temperature was observed at the Two-Mile Bar location in 1991. However, a malfunction of the Two-Mile Bar TempMentor caused erroneous minimum temperature values to be recorded in 1991. Consequently, only maximum values for 1990 and 1991 were used to describe temperature differences between the two years. At Two-Mile Bar, maximum daily water temperatures descended below 13.3°C on 24 October and remained there for the rest of the year (Figure 7).

At the Oakdale location, a 5°C (from 22°C to 17.5 °C) decrease was also observed shortly after the refilling of Tulloch began (Figure

Figure 2. Provisional mean daily streamflows in the Stanislaus River at Orange Blossom Bridge in 1990 and 1991

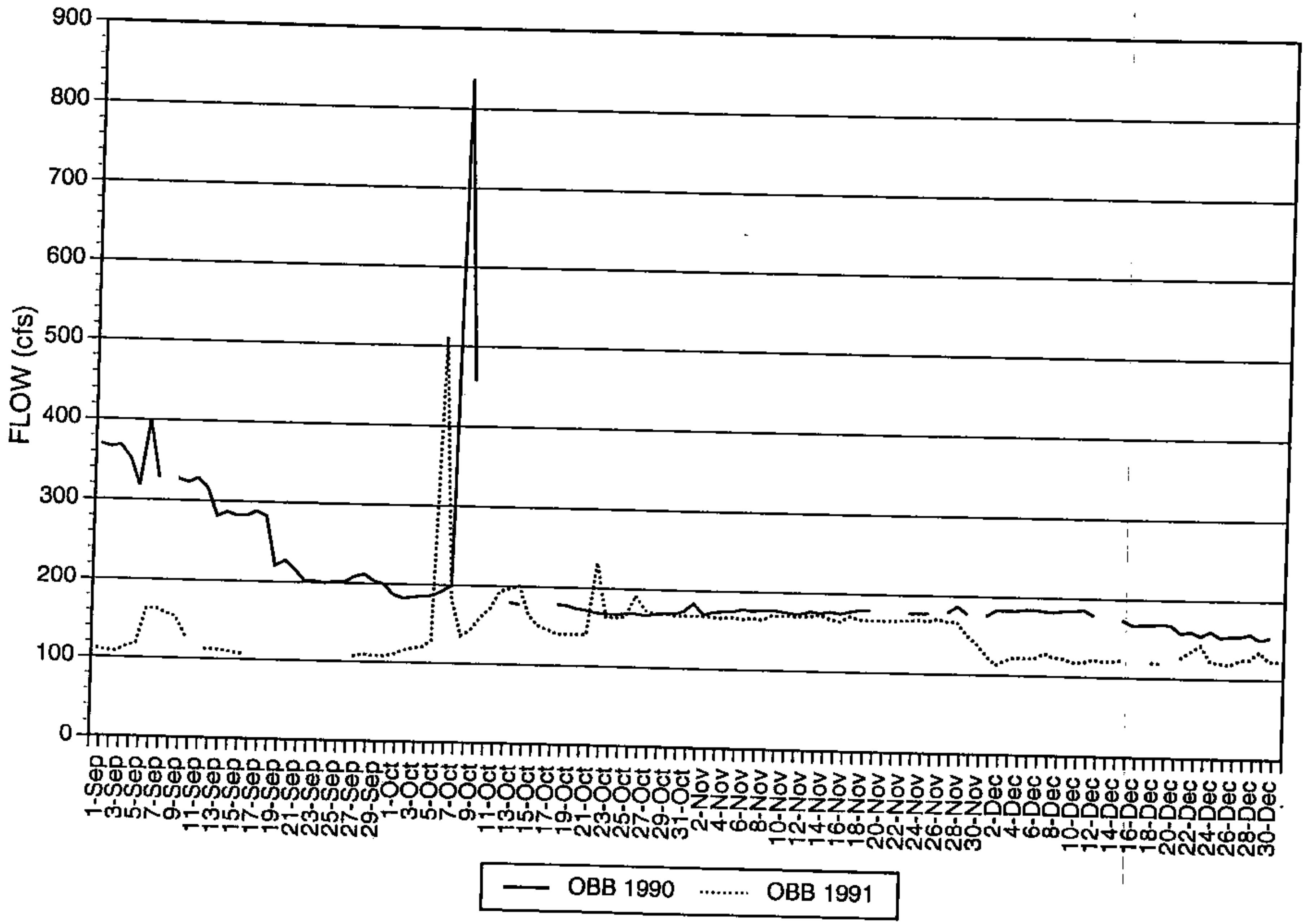
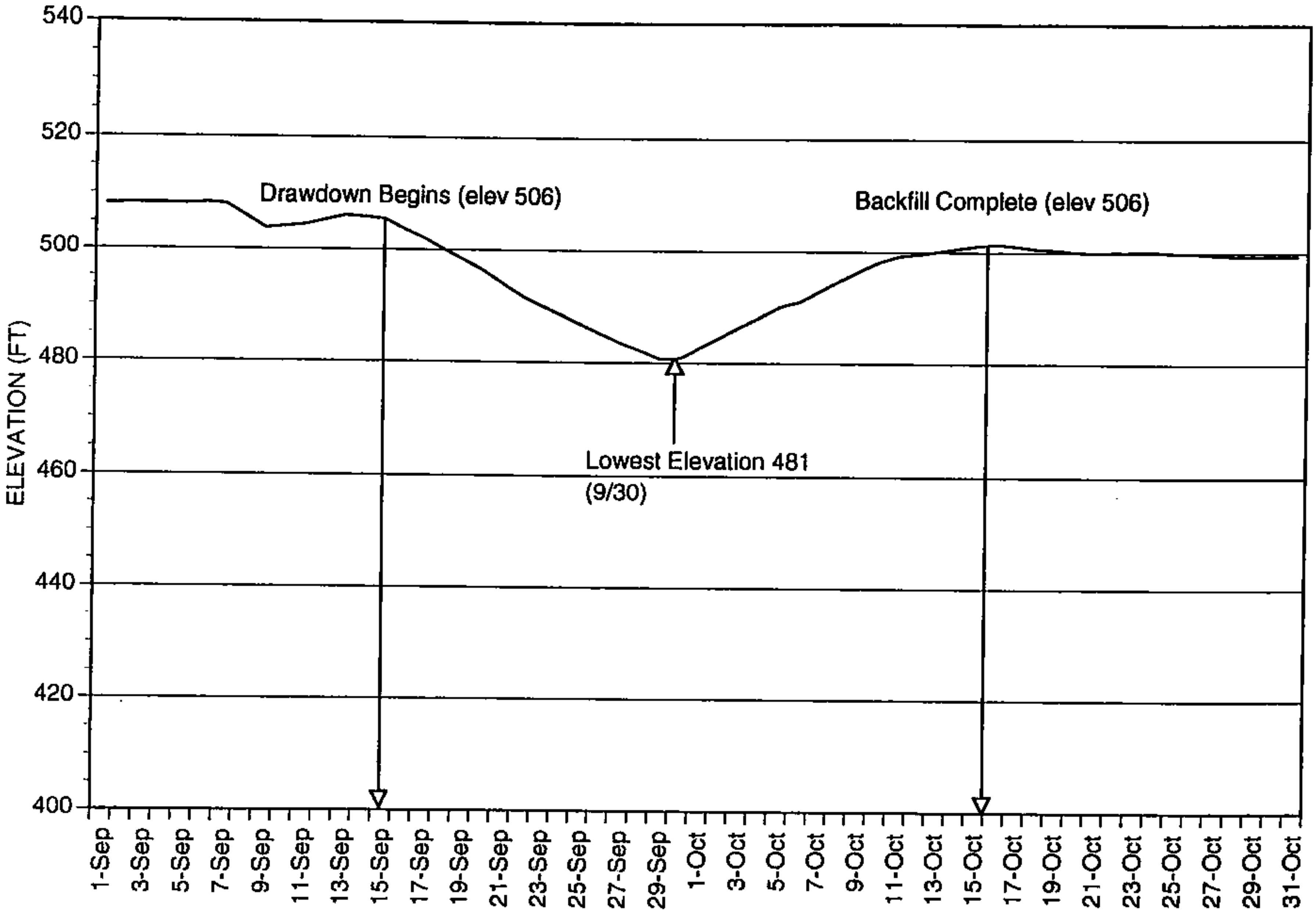


Figure 3. Tulloch Reservoir surface elevations for 1991



Data provided by CDEC

Figure 4. Tulloch Reservoir temperature profiles for 1991

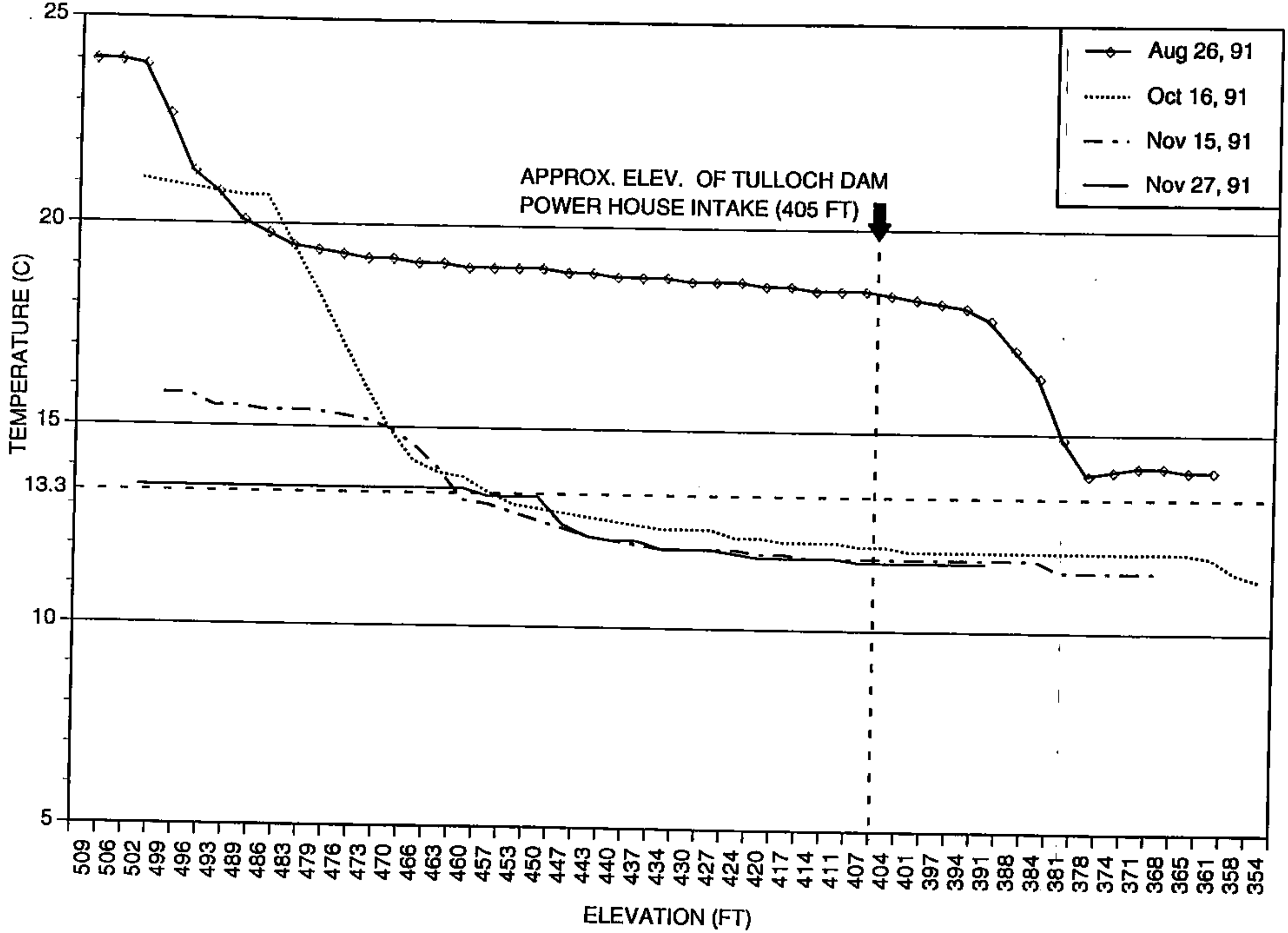


Figure 5. Tulloch Reservoir temperature profiles for 1990.

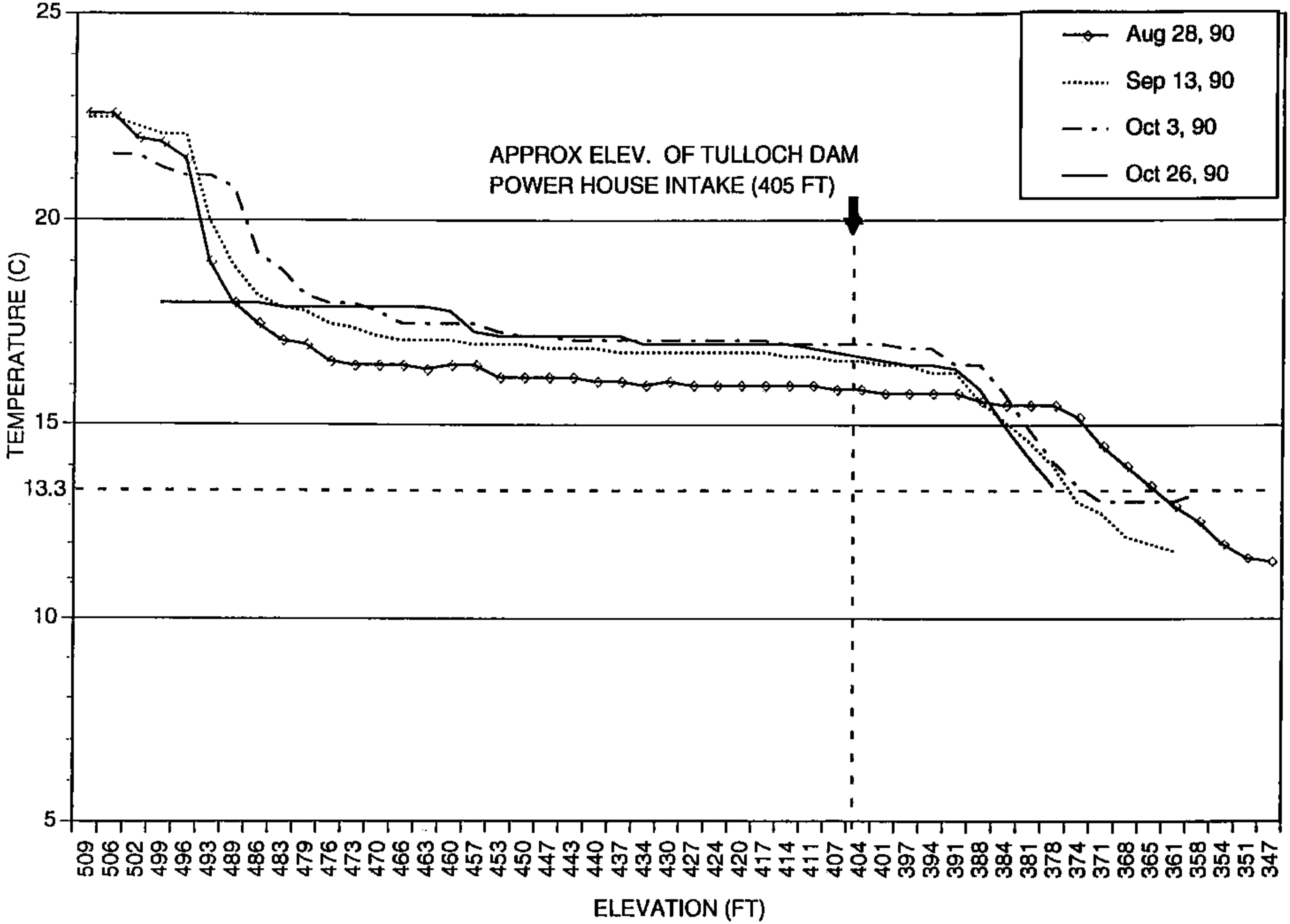


Figure 6 . Mean daily water temperatures in the Stanislaus River at Knights Ferry for 1990 and 1991.

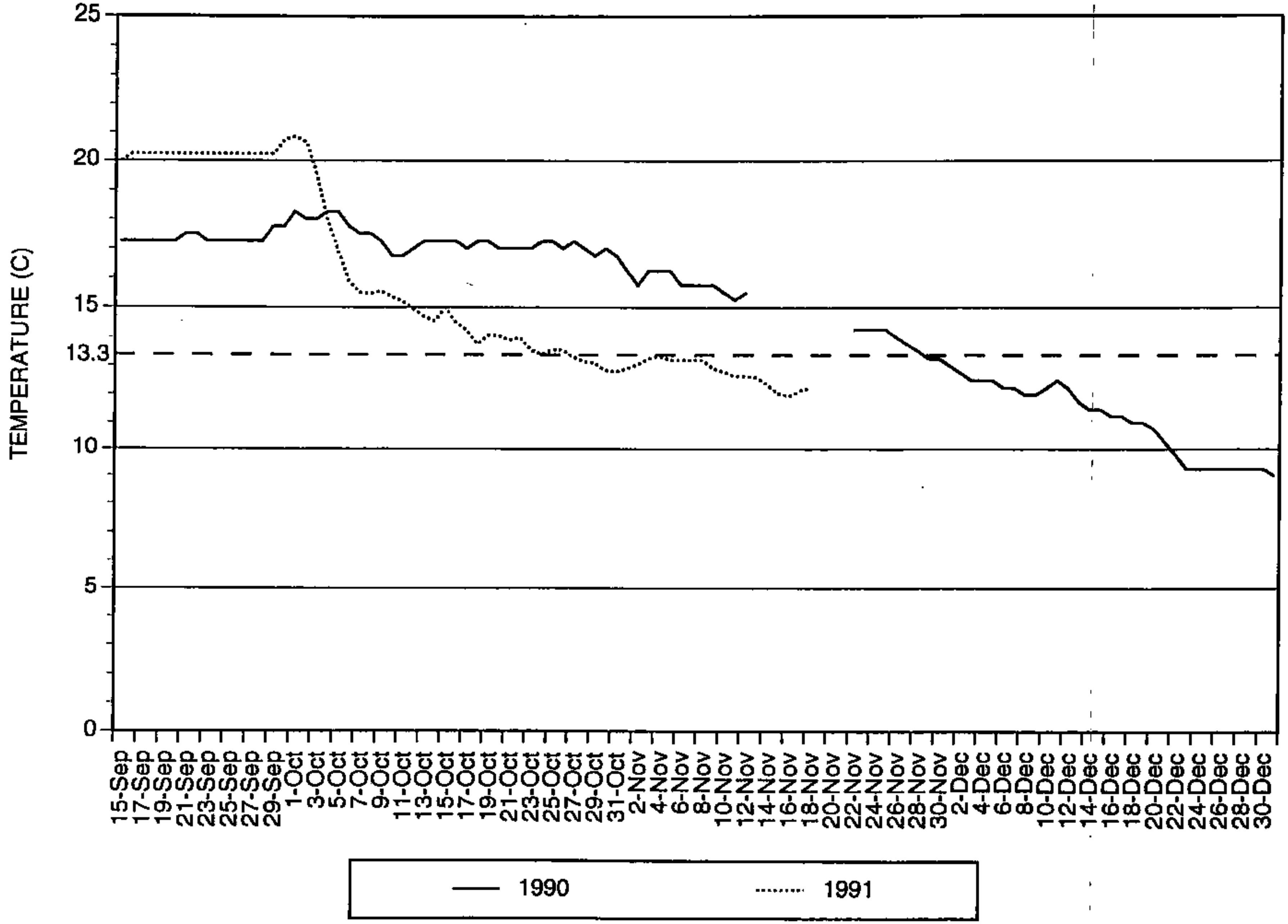
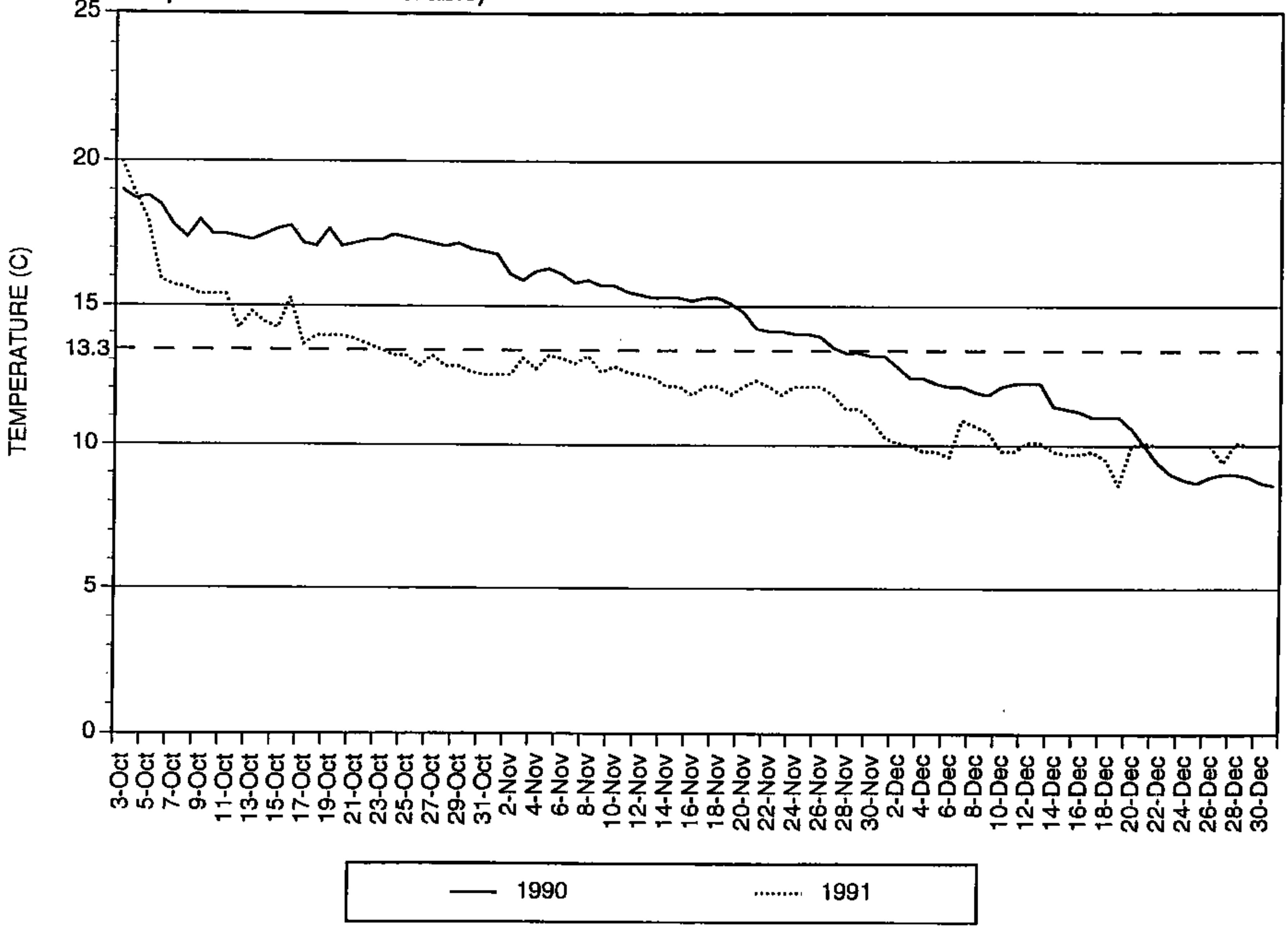


Figure 7. Maximum daily water temperatures in the Stanislaus River at Two-Mile Bar for 1990 and 1991. (Note-Temperature recording device malfunction rendered minimum temperature values unreliable)



8). Mean daily water temperature at this location did not remain below 13.3°C until mid November. No temperature data are available after 21 November 1991 from USGS.

The Yahi Archery Range near Riverbank represents the downstream end of the salmon spawning reach in the Stanislaus defined in Fish & Game Code Section 1505. Water temperature at this location also declined after Tulloch began refilling, but to a slightly lesser extent. A decrease of about 4°C (from 22°C to 18°C) was observed initially, however, mean daily temperatures did not remain below 13.3°C until mid November (Figure 9). Mean daily water temperature near the mouth of the Stanislaus River declined from a high of 26°C in early September to about 8°C near the end of December. A 3°C decrease (from 23°C to 20 °C) was observed shortly after the refilling of Tulloch began. Water temperature at this location remained below 13.3°C after mid November (Figure 10). No temperature information is available for this location for 1990.

The reservoir operation conducted in the fall of 1991 dramatically reduced the warm water stored in Tulloch Reservoir. River water temperatures at all locations were generally reduced as a result of the operation and were an improvement over the preceding year. Improved river temperatures resulted in 1991 even though less water was released from Goodwin Dam compared to 1990. Still, temperatures needed to provide protection under the 1991 flow and ambient air temperature conditions were not observed until about late November; approximately the same time as the preceding year when no temperature protection plan was in place.

The effects of the reservoir operation were less apparent the further downstream the location. In the one to two river miles below Goodwin Dam, suitable temperatures for spawning were maintained from mid October on. However, in the area from Knights Ferry to Riverbank where the majority of the natural spawning has occurred for the past 5 years (Table 1), temperatures exceeded 13.3 °C for another thirty days.

Table 1. Percent spawning by survey reach determined by weekly surveys conducted each year by CDFG crews.

Survey Reach	1986	1987	1988	1989	1990
Goodwin Dam vicinity	6.3	0.9	1.3	1.5	----
Two-Mile Bar	14.6	5.8	3.5	5.0	2.2
Knights Ferry to Orange Blossom Br	62.3	90.1	85.4	60.0	21.2
Orange Blossom Br to Oakdale Rec	----	----	9.8	27.0	58.0
Oakdale Rec to Riverbank	16.8	4.2	N/S	6.5	18.6

N/S= not surveyed

Ambient air temperatures appeared to have a greater influence on river water temperatures than did the reservoir operation (Figure 11). Water temperatures at nearly all locations responded

Figure 8. Mean daily water temperatures in the Stanislaus River at Oakdale for 1990 and 1991.

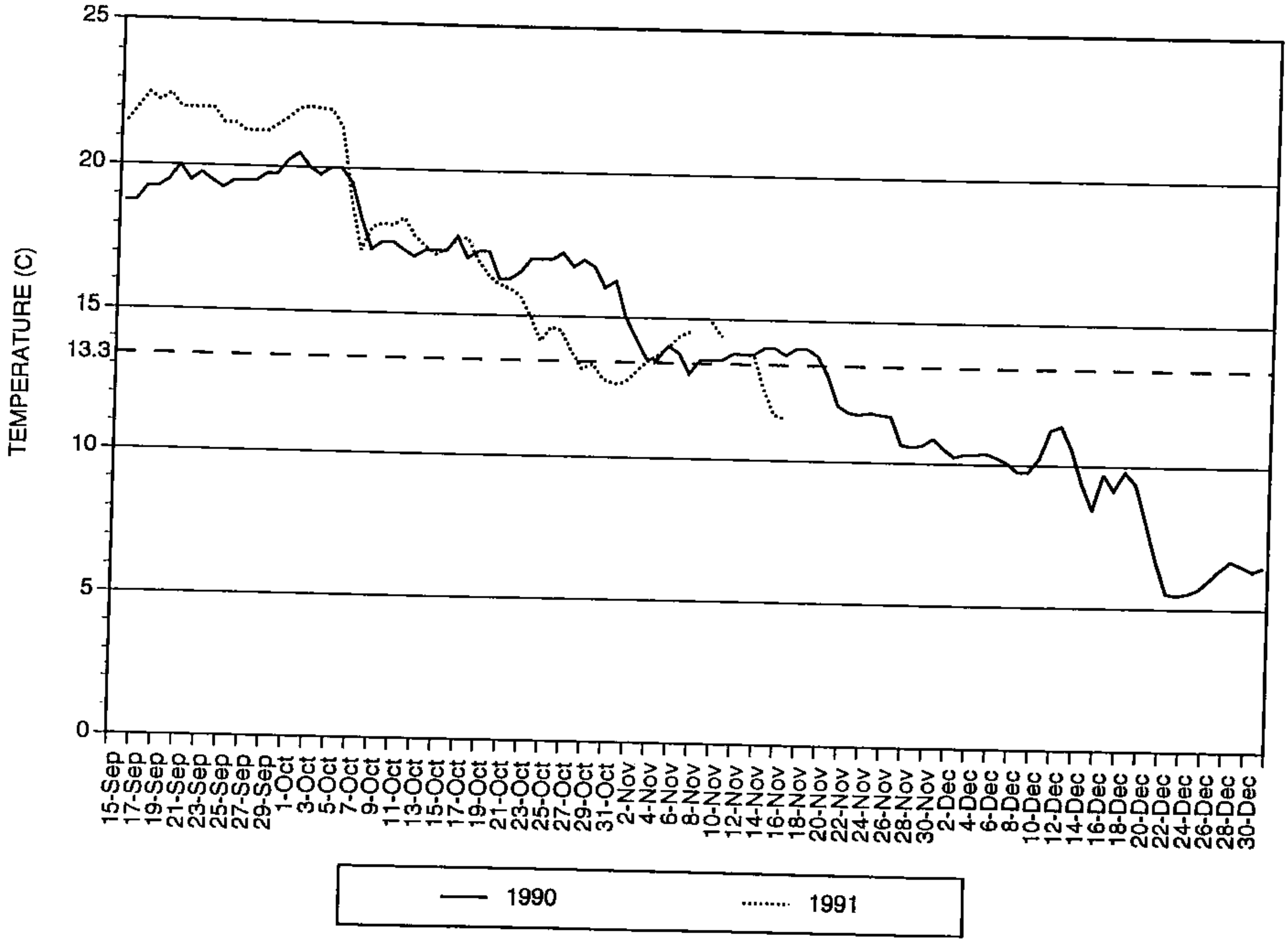


Figure 9. Mean daily water temperatures in the Stanislaus River at the Yahi Archery Range near Riverbank for 1990 and 1991.

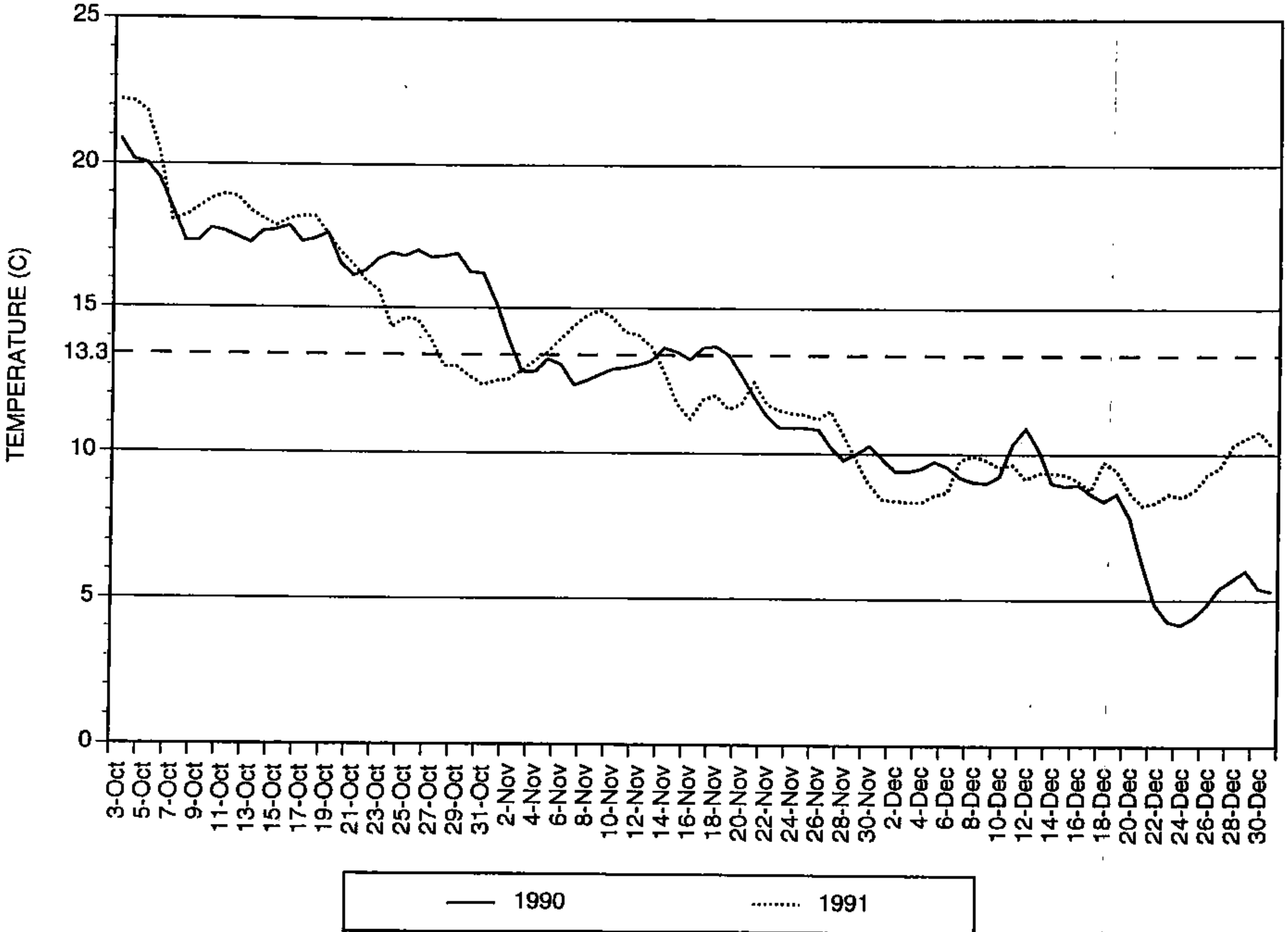


Figure 10. Mean daily water temperatures in the Stanislaus River near the confluence of the San Joaquin River for 1991.

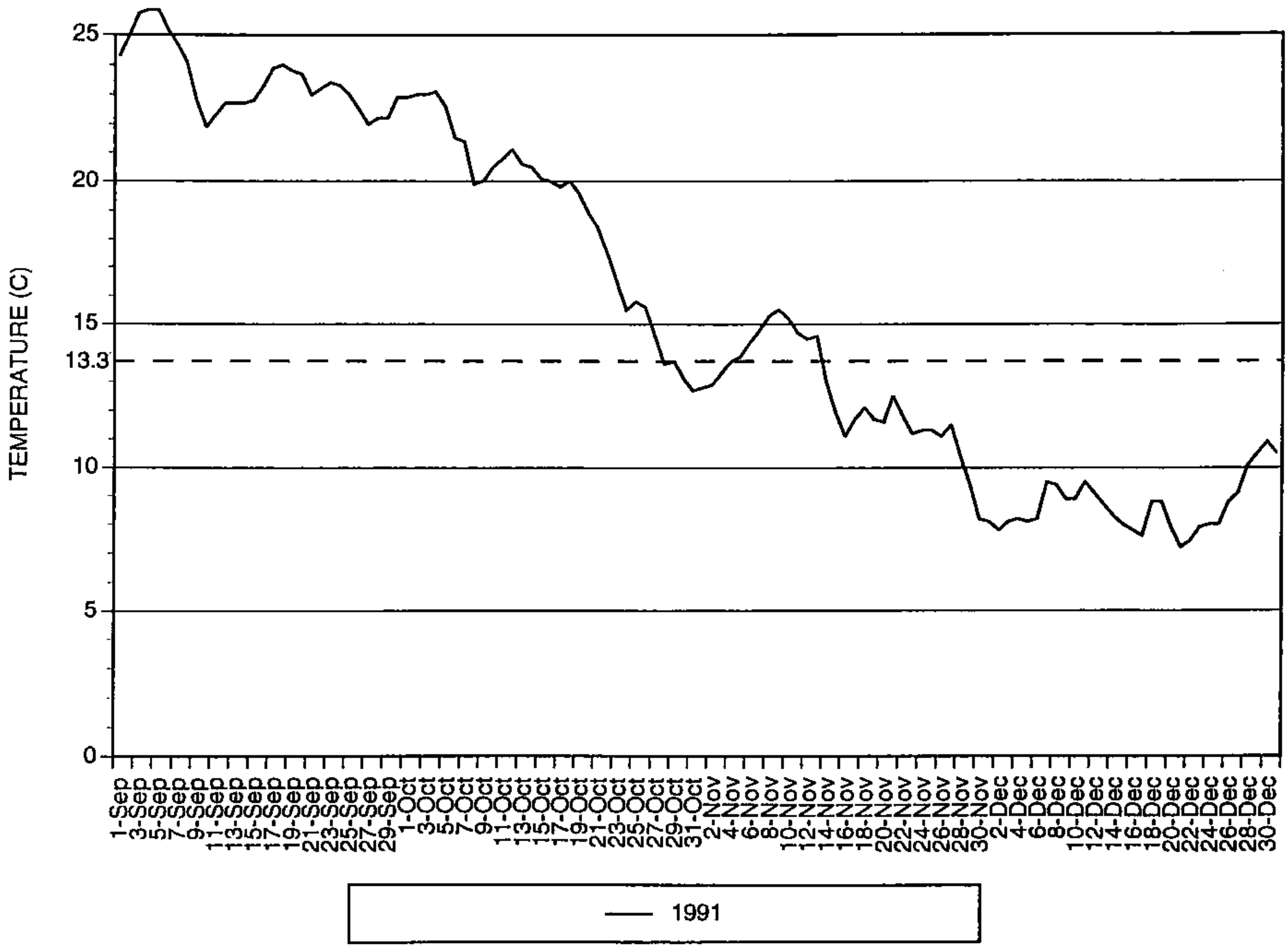


Figure 11. Mean daily water temperatures observed in the Stanislaus River during the fall of 1991 (Maximum daily temperatures from Two-Mile Bar ommitted) and ambient air temperatures from Modesto.

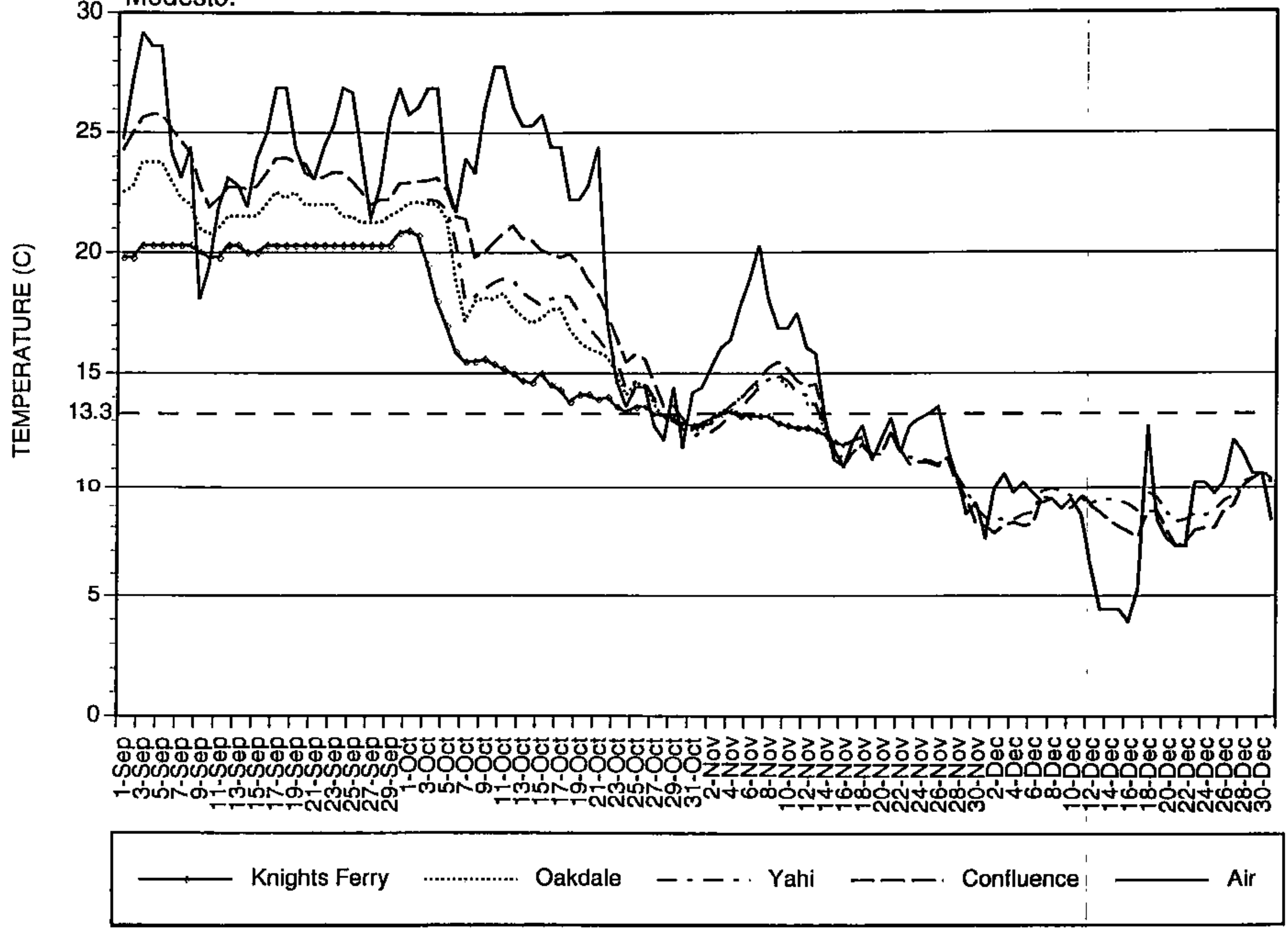
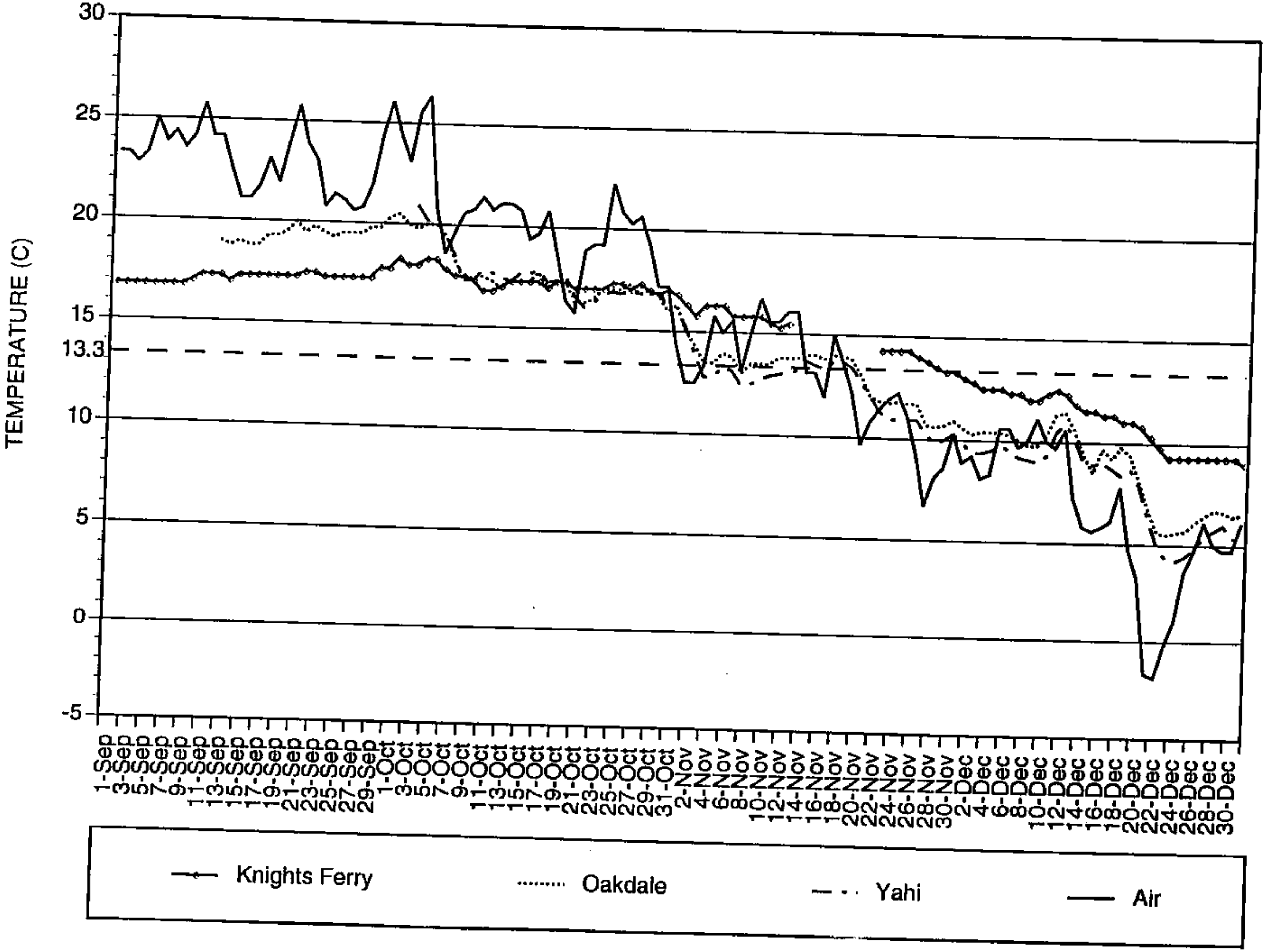


Figure 12. Mean daily water temperatures observed in the Stanislaus River during the fall of 1990 and mean daily ambient air temperatures from Modesto.



positively to changes in ambient air temperatures except for a brief period after Tulloch began refilling. From 1 October to about 7 October water temperatures declined even though air temperatures were increasing. Cool water releases from Tulloch and a one day pulsed flow (525 cfs) which occurred on 5 October may have helped sustain the lower temperatures observed. If the temperature protection plan had not been implemented, it is likely that river temperatures would have remained relatively high and may have even increased several degrees during the first two weeks of October.

In 1990, ambient air temperature appeared to positively influence river temperatures after mid October (Figure 12). Fairly stable water temperatures at Knights Ferry and Oakdale in September and early October resulted from substantially higher flow releases from Goodwin Dam even though air temperatures varied.

In an effort to help bolster future run sizes in the drainage, DFG installed and operated a temporary salmon trapping facility in the Stanislaus River near Orange Blossom Bridge (OBB) in both 1990 and 1991. The trap was installed in mid October and removed in mid December each year. Eggs collected from the trapped fish were taken to the Merced River Fish Facility where egg to fry survival will be optimized. Flow release from Goodwin Dam into the Stanislaus River was held constant at about 175 cfs. Relatively stable flow at the trap site was required for safe operation. An additional 200 cfs was routed through the South San Joaquin Irrigation District (SSJID) conveyance system and returned to the river near the town of Riverbank (below the spawning reach). This flow arrangement was implemented to attract as many spawners as possible up the Stanislaus River and ultimately into the trap. In both of these years, one day pulsed flow releases were made in early October (prior to trap installation) to assist salmon in their migration.

The high river water temperatures observed from mid October through mid Novemeber in 1991 may have been attenuated had the water routed through the SSJID system been released below Goodwin Dam instead. However, flows in the 350 to 400 cfs range would have precluded safe trap operation.

RECOMMENDATIONS

1. Increasing the amount of water released to the river in September, October and early November in combination with a reservoir water exchange may help overcome the influence of ambient air temperatures and provide cooler water temperatures for salmon. Another reservoir operation similar to the one described above should be implemented. Flows below Goodwin Dam should be increased to offset the affects of high ambient air temperatures. Flows should be elevated to the extent needed to provide 13.3°C throughout the salmon spawning reach defined in Fish and Game Code 1505.

2. One additional Ryan TempMentor should be deployed in the

vicinity of the Orange Blossom Bridge to help describe the effects of future reservoir operations.

3. A temperature model for the Stanislaus River system capable of incorporating reservoir changes (both New Melones and Tulloch) should be developed and documented.

4. Adult salmon trapping operations in the Stanislaus River should be suspended on an interim basis. The additional water previously diverted through the SSJID conveyance system should be released at Goodwin Dam. Flows during late December through mid March should be sufficient to prevent dewatering of incubating salmon eggs deposited during relatively higher fall flows.

5. Young salmon for the yearling program, smolt survival studies and other on-going evaluations should be collected from the Stanislaus River at the emergence life stage by fyke netting. Fyke netting is labor intensive and would require additional equipment and personnel.

6. For the purposes of future temperature protection efforts, daily maximum temperatures should be used. Mean daily temperatures would allow daily water temperatures to exceed 13.3°C particularly during low flow and high ambient air conditions.

cc S. Baumgartner
B. Loudermilk
A. Low
T. Mills, IFD
S. Shiba
J. Staley

Appendix 7. Numerical Summary of Information in Figures 9 and 10

	STAN AF	TUOL AF	MER AF	SJR AF	TOTAL AF	15% STAN CFS	35% TUOL CFS	35% MER CFS	15% SJR CFS
10000	41643	97167	41643	97167	277620	1500	3500	1500	3500
8000	33314	77734	33314	77734	222096	1200	2800	1200	2800
6000	24986	58300	24986	58300	166572	900	2100	900	2100
4000	16657	38867	16657	38867	111048	600	1400	600	1400
2000	8329	19433	8329	19433	55524	300	700	300	700

	STAN AF	TUOL AF	MER AF	SJR AF	TOTAL AF	STAN CFS	TUOL CFS	MER CFS	SJR CFS
10000	83286	194334	83286	194334	555240	1500	3500	1500	3500
8000	66629	155467	66629	155467	444192	1200	2800	1200	2800
6000	49972	116600	49972	116600	333144	900	2100	900	2100
4000	33314	77734	33314	77734	222096	600	1400	600	1400
2000	16657	38867	16657	38867	111048	300	700	300	700

	14-DAY	28-DAY
10000	277620	555240
8000	222096	444192
6000	166572	333144
4000	111048	222096
2000	55524	111048

	VERNALIS					
	14-DAYS	55524	111048	166572	222096	277620
1987	68453	-12929	42595	98119	153643	209167
1988	67045	-11521	44003	99527	155051	210575
1989	67719	-12195	43329	98853	154377	209901
1990	38371	17153	72677	128201	183725	239249
1991	39485	16039	71563	127087	182611	238135
	28-DAYS	111048	222096	333144	444192	555240
1987	125345	-14297	96751	207799	318847	429895
1988	124671	-13623	97425	208473	319521	430569
1989	121935	-10887	100161	211209	322257	433305
1990	75215	35833	146881	257929	368977	480025
1991	60866	50182	161230	272278	383326	494374

ERRATA SHEET FOR WRINT-DFG EXHIBIT 25. "INTERIM ACTION TO REASONABLY PROTECT SAN JOAQUIN FALL-RUN CHINOOK SALMON

The following minor changes are needed to improve the accuracy and utility of all single-sided copies of WRINT-DFG Exhibit 25:

1. Replace the existing Table Of Contents in all single-sided copies of WRINT-DFG Exhibit 25 with the Table Of Contents attached. This one is paginated, allowing you to paginate the remainder of the document for ease of reference.

2. Paginate WRINT-DFG Exhibit 25 beginning with "III INTRODUCTION."

3. Replace Figure 3 in all single-sided copies of WRINT-DFG Exhibit 25 with the Figure 3 attached. The bar graphs for the Merced and Stanislaus rivers were inadvertently reversed on all single-sided copies.

4. After paginating the document using the attached Table Of Contents as a guide, change the "D" to and "E" on page 22, and Change the "E" to an "F" on page 23. Refer to the Table Of Contents attached to make sure you've made the proper changes.

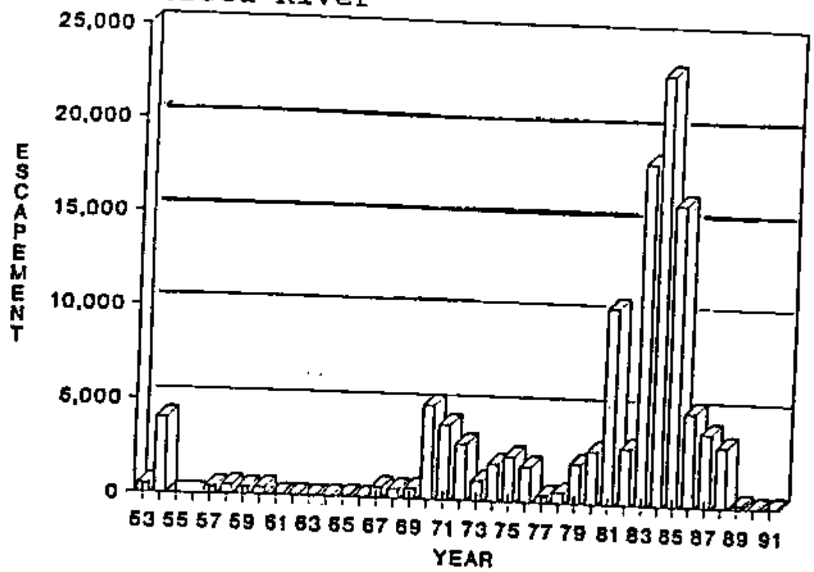
5. Minor word omissions and insignificant misspellings may exist but do not warrant changing.

Please accept my apology for any inconvenience these errors may have caused.

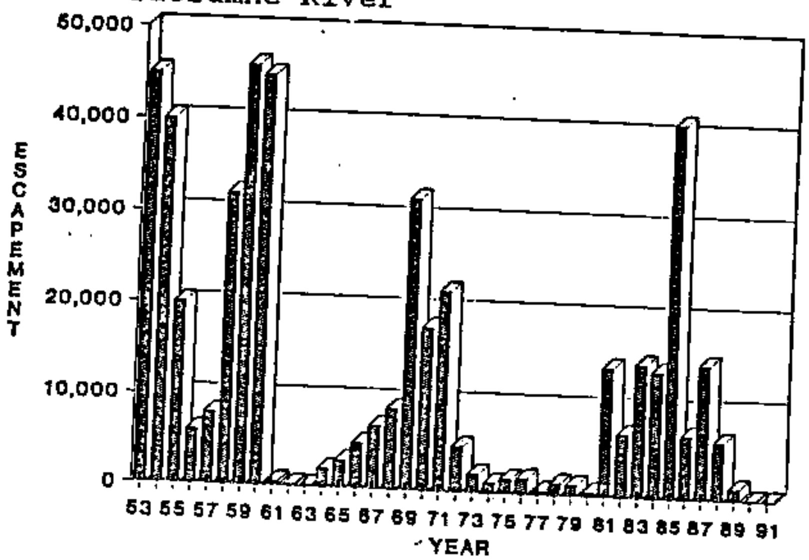
William E. Loudermilk
Environmental Specialist IV

II. TABLE OF CONTENTS

Figure 3. (A) Recent Fall-Run Chinook Salmon Escapements in the Merced River



(B) Recent Fall-Run Chinook Salmon Escapements in the Tuolumne River



(C) Recent Fall-Run Chinook Salmon Escapements in the Stanislaus River