COMMENTS ON THE

UNITED STATES FISH AND WILDLIFE SERVICE'S

PROPOSAL TO LIST THE

SACRAMENTO SPLITTAIL AS THREATENED

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APPENDIX 1

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Comments on the Status of the Sacramento Splittail Inhabiting the Sacramento-San Joaquin Bay-Delta

The U.S. Fish and Wildlife Service (USFWS) has compiled and evaluated available scientific information regarding the Sacramento splittail population inhabiting the Sacrament-San Joaquin Bay-Delta system. Based upon results of these analyses USFWS has concluded that the Sacramento splittail population has declined by approximately 62% since 1984 and has therefore proposed to list Sacramento splittail as a threatened species (Federal Register 59(4):862-868, dated January 6, 1994). The scientific data available to assess long-term trends in Sacramento splittail abundance are primarily from surveys performed by the California Department of Fish and Game (CDFandG), USFWS, University of California at Davis, and fish salvage at the State and Federal (SWP and CVP) Water Projects. Many of these fishery survey programs were originally designed to collect data primarily on striped bass (CDFandG summer tow net and fall mid-water trawl surveys) and juvenile chinook salmon (USFWS) Chipps Island and Sacramento River mid-water trawling and beach seining surveys with Sacramento splittail being collected incidentally as part of these surveys.

No long-term fisheries monitoring program has been designed or conducted (e.g., selection of sampling areas, sampling gear and collection methods, and seasonal sampling) specifically to collect information on the population abundance or dynamics of Sacramento splittail. The data that have been collected on Sacramento splittail, however, have shown a strong correlation between indices of abundance for juvenile splittail and freshwater outflow from the Delta as discussed below. The fisheries survey results also show a substantial decline in juvenile splittail abundance indices during the late 1980's and early 1990's which is not surprising given the juvenile abundance-outflow relationship and the extended drought conditions (and substantially reduced freshwater outflow) occurring during the late 1980's and early 1990's.

In evaluating the scientific basis for the proposed listing of Sacramento splittail as a threatened species, however, consideration needs to not only be given to observed recent declines in indices of juvenile abundance, but more importantly the population status of reproductively mature Sacramento splittail. It is the abundance and reproductive capacity of the adult population that determines the resiliency of the population in avoiding the threat of becoming an endangered species. In the absence of a strong stock-recruitment relationship, particularly for a long-lived species such as Sacramento splittail, an observed decline in juvenile indices of abundance cannot be used as direct evidence that a corresponding decline in the abundance of reproductively mature adult Sacramento splittail has also occurred or that the abundance of reproducing adults has declined to a population level where they are threatened. Evaluation of the population status for Sacramento splittail, within context of the proposed listing as a threatened species, requires consideration of scientific data and analyses for both juvenile and adult lifestages.

Life History Characteristics

Sacramento splittail are a relatively large (adult length exceeds 300 mm; 12 inches) native cyprinid inhabiting the Bay-Delta system. Splittail are reported to live five to seven years with a relatively high reproductive capacity (fecundity up to 100,000 eggs per female). Splittail become reproductively mature at age two, although some portion of the male population may begin spawning at age one. The geographic distribution of Sacramento splittail includes the Sacramento River and its tributaries (e.g., Feather and American rivers), the lower San Joaquin River and its tributaries, the Delta, Suisun Bay, Suisun Marsh, the Napa River, and the Petaluma River. Since splittail typically inhabit lower salinity areas their geographic distribution may vary seasonally and among years in response to variation in freshwater outflow and corresponding salinity conditions. Although splittail may occur throughout the water column, larger juveniles and adults are primarily epibenthic foragers inhabiting the lower portion of the water column. Both juvenile and adult splittail frequent shallow inshore waters, particularly within Suisun Bay,

however the relative distribution between inshore areas and deeper channel habitats is largely unknown.

Juvenile and Adult Population Abundance and Dynamics

Although the California Department of Fish and Game and others have conducted extensive fisheries monitoring programs within the Sacramento - San Joaquin Delta and San Francisco Bay system over an extended period of time, no quantitative estimate of population abundance for Sacramento splittail has been derived. The actual number of juvenile and adult Sacramento splittail inhabiting the Bay-Delta system, and changes in population abundance from one year to the next are unknown.

Very little information is available on the population dynamics of Sacramento splittail including population age structure, variation in growth and survival rates among years or for various geographic areas within their distribution range, diel movement and behavioral patterns, or behavioral response and physiological tolerance to various environmental factors including salinity and water temperature. In addition, the significance of various sources of incremental mortality and sublethal effects such as those associated with entrainment losses at the State and Federal water project diversions and other agricultural, industrial, and municipal diversions, exposure to toxicants and pollutants, and competition and predation on the population dynamics and abundance of splittail cannot be quantified using currently available information. As discussed below, information is available on relative changes in abundance indices and the correlation with freshwater outflow during the spring thought to be related to habitat availability and conditions within Suisun Bay and larval and juvenile dispersal.

Fishery Monitoring Data

Results of various fisheries monitoring programs including the CDFandG San Francisco Bay studies, CDFandG summer tow net surveys, CDFandG fall mid-water trawl surveys, USFWS mid-water trawling and beach seine surveys, Suisun Marsh fisheries monitoring, and fish salvage monitoring at the State and Federal (SWP and CVP) diversion facilities provide relative information which can be used in assessing general trends in the distribution and abundance of splittail. Results of these surveys, however, are subject to a number of constraints and limitations. Although results of these surveys provide a relative index for use in monitoring species status and trends, results of these surveys cannot be used to quantitatively assess actual population abundance.

Several of the available long-term fisheries monitoring datasets, such as those for Suisun Marsh and the State and Federal water project fish salvage operations, represent sampling within only a limited portion of the splittail geographic distribution. Variation in the population geographic distribution among seasons and years in response to environmental conditions influence results of these site-specific surveys in providing a reliable basis for assessing trends in the Bay-Delta splittail population.

Other fisheries surveys are also subject to limitations and constraints resulting from the collection methods and sampling gear used in these surveys. For example, results of summer tow net and fall mid-water trawl surveys reflect sampling within the mid- and upper portion of the water column and may not effectively collect Sacramento splittail which, as larger juveniles and adults, predominantly inhabit the lower portion of the water column. The actual abundance of splittail may be substantially underestimated by these collection techniques. In addition, many of the routine fisheries collections are performed during the daytime when Sacramento splittail may be closer to the bottom and not effectively sampled by mid-water or surface trawling techniques. Because of their relatively large size sub-adult and adult splittail may be able to effectively avoid capture in towed nets and trawls (gear avoidance). The ability to sample shallow in-shore areas

which may be used extensively by juvenile and adult Sacramento splittail is limited by (1) numerous snags that make routine trawling in shallow inshore waters difficult, and (2) the limited availability of suitable shoreline to allow for beach seining and other inshore collection techniques throughout much of the Bay-Delta system. As a consequence of these and other sampling issues, results of available fisheries monitoring programs can be used to only provide a relative index of population abundance for comparison of trends among years. Sampling selectivity and gear efficiency has the potential of substantially underestimating the abundance and distribution of larger sub-adult and adult splittail which are not effectively collected by conventional trawling survey methods.

Sampling shallow inshore habitats and sampling at night using collection techniques such as gill nets, which can be sized to effectively collect sub-adult and adult splittail which may otherwise avoid conventional trawls, has not been used as part of routine fisheries surveys in the Bay-Delta system. The use of gill nets has been limited, in large part, because of high mortality to almost all fish species collected using this technique. Alternative collection techniques such as the use of electrofishing on a routine basis has also been limited within the Bay-Delta system as a consequence of variable salinity conditions which affect the effectiveness of electrofishing, water depth, high turbidity, and currents which further confound electrofishing surveys resulting in very qualitative data on species composition and abundance.

Relative Indices of Abundance

Indices of Juvenile Splittail Abundance

Indices of juvenile splittail abundance are relatively consistent in showing reduced catches, particularly during the mid- to late-1980's and early 1990's. The reduction in juvenile splittail indices is apparent over a wide geographic range encompassed by various fisheries

monitoring surveys. Results of the San Francisco Bay studies (Figure 1), Chipps Island trawling (Figure 2), and Suisun Marsh studies (Figure 3) all show a pattern of declining juvenile abundance. Fall mid-water trawl surveys (Figure 4) and results of SWP and CVP fish salvage (Figure 5) also show a pattern of declining indices.

Results of fall mid-water trawl surveys also provide information on the proportion of the Sacramento splittail index contributed by collections within the Delta and from Suisun Bay (Figure 6). Results of these surveys have shown that, in most years, collections within Suisun Bay provide the major contribution to the fall index of abundance. The proportion of the fall index from Suisun Bay is not correlated, however, to freshwater outflow during the previous February-May period (Figure 7).

Indices of juvenile splittail abundance from various fisheries monitoring programs have shown a statistically significant positive correlation with the magnitude of freshwater outflow during the late winter and spring (February-May; Figure 8; Meng 1993). It has been hypothesized that increasing freshwater outflow during the late winter and spring contributes to (1) an increase in the transport and dispersal of larval and juvenile splittail downstream into Suisun Bay where susceptibility to entrainment losses at diversions within the Delta is reduced, and (2) an increase in the availability of suitable juvenile rearing habitat within Suisun Bay. Increased freshwater outflow also contributes to flooding and inundation of shoreline riparian vegetation thought to be used as spawning habitat by splittail thereby increasing reproductive success and subsequently juvenile abundance.

Based on the relatively strong correlation between indices of juvenile splittail abundance and outflow, the decline in juvenile abundance observed in a number of studies within the Bay-Delta system (Figures 1 to 5) is not unexpected given the period of the prolonged low-outflow conditions resulting from the extended drought during the late 1980's and early 1990's. The primary issue then is not whether juvenile abundance has declined in recent years, but rather (1) does the adult splittail population have the reproductive

capacity to recover and produce strong yearclasses when higher outflow conditions occur, and (2) has the adult population abundance declined to a level where the Sacramento splittail population is being threatened with becoming endangered.

Indices of Adult Splittail Abundance

Although the available surveys have shown a decline in juvenile production in recent years a significant questions exists as to whether or not the adult Sacramento splittail population has experienced a similar decline. With respect to evaluation of the population status of Sacramento splittail, within context of the Endangered Species Act, one of the principal issues to be addressed is whether or not the adult reproductive population of splittail has declined to a level where there exists a significant likelihood that the species will become endangered or extinct within the foreseeable future throughout all or a significant portion of its range. As discussed above, however, many of the sampling programs and techniques which have been utilized within the Bay-Delta system on a routine basis may substantially underestimate the abundance and status of the adult splittail population.

The trend in adult splittail abundance from surveys performed as part of the San Francisco Bay studies (Figure 1) show that adult indices have been variable among years with the highest levels during the survey period occurring during the early and mid-1980's. Adult abundance indices from these surveys have shown that adult splittail indices have not declined to the same degree as observed for juveniles. The San Francisco Bay studies use an otter trawl to sample fish populations near the bottom and examination of length-frequency data (Figure 9) from these surveys show that they sample both juvenile and adult splittail. Indices of adult abundance from the San Francisco Bay surveys do not, however, encompass the entire geographic distribution of the adult splittail population.

Since adult splittail are relatively long-lived (approximately 5-7 years) and have high fecundity, annual fluctuations in adult abundance are substantially reduced and stabilized

despite reduced juvenile production of one or more years (e.g., Figure 1). In the absence of a fisheries sampling program which effectively monitors the population abundance of both adult and juvenile splittail seasonally throughout the geographic range of the population the necessary scientific data for determining the stock-recruitment relationship for splittail are unavailable. In the absence of a significant stock recruitment relationship, the relationship between annual indices of juvenile production and corresponding changes in either the age structure, abundance, or reproductive capacity of the adult population of Sacramento splittail remains unknown.

There exists considerable uncertainty regarding the ability of many of the routine fisheries surveys to effectively sample sub-adult and adult splittail and whether trends in adult abundance derived from these surveys are representative of actual population conditions. For example, results of a series of reconnaissance level fisheries collections performed within the lower American River by Hanson Environmental, Inc., Beak Consultants, and the California Department of Fish and Game, (Lower American River Fishery and Aquatic Resource Investigations: Results of Phase I Studies and Recommendations for Phase II Investigations, September 1991) showed that in a limited series of gill net collections (May 21, 1991) performed during nighttime, adult Sacramento splittail (193-345 mm; mean length 239 mm) were the second-most abundant fish species collected. In contrast, no Sacramento splittail were collected in the same area using beach seines during the daytime and splittail represented approximately 1% of the fish collected in electrofishing surveys. Results of these exploratory surveys, although not providing quantitative information on splittail, demonstrate the potential for substantially underestimating adult splittail abundance and geographic distribution as a consequence of gear avoidance and low collection efficiency of various fisheries sampling methods.

In a series of fisheries investigations conducted within Suisun Bay between July 1991 and June 1992 (PG&E 1992: Contra Costa and Pittsburg Power Plants Thermal Effects Assessment, 1991-1992 submitted to the Central Valley and San Francisco Regional Water Quality Control Boards and performed in cooperation with representatives of the

California Department of Fish and Game, National Marine Fisheries Service, and U.S. Fish and Wildlife Service) Sacramento splittail were the second-most abundant fish species collected (12%). Sacramento splittail were most commonly collected in bottom trawls, gill nets, and beach seines which is consistent with their general distribution in the lower portion of the water column and within inshore habitats. In contrast, very few Sacramento splittail were collected in either surface trawls or fyke nets. Sacramento splittail were the fifth-most abundant species collected during fisheries surveys in the lower San Joaquin River in the vicinity of Antioch (PG&E 1992). Results of these surveys, although not providing quantitative information to compare splittail abundance among years are consistent in showing the significance of collection methods and locations on the resulting numbers of juvenile and adult Sacramento splittail collected (and on resulting indices of abundance for both juveniles and adults).

Similar fisheries studies were conducted by PG&E within both Suisun Bay and the lower San Joaquin rivers during the period from August 1978 through July 1979 (gill nets, bottom trawls, beach seines, etc.) and July 1991 through June 1992. Results of these two series of fisheries surveys, based on the percentage of Sacramento splittail within the composite catches, are summarized below:

	Sacramento Splittail			
	1978-79[1]		1991-92[2]	
	Percent Composition	Rank	Percent Composition	Rank
Suisun Bay	14	2	12	2
Lower San Joaquin River	3	6	4	5

[1]Source: Ecological Analysts 1981 a and b

[2]Source: PG&E 1992

The percentage composition of the fisheries community represented by splittail during surveys conducted in 1978-79 and 1991-92, was similar. The similarity in the percent composition of the fisheries community sampled in the survey does not, provide information on the absolute abundance of Sacramento splittail between the two surveys, but does indicate that further surveys and investigations, particularly on the status of splittail within shallow inshore waters and for the adult population, which may not be effectively sampled using routine trawling methods, is warranted before an accurate assessment of the potential changes in the population abundance and contribution of the splittail population to the Bay-Delta fisheries community can be completed.

Conclusions

Based upon a review of the available scientific information on the status of the Sacramento splittail population it has been concluded that:

- Data from a variety of fisheries surveys are consistent in showing a substantial decline in indices of abundance (primarily juveniles) during the late 1980's and early 1990's;

- A strong correlation exists between indices of juvenile splittail abundance and freshwater outflow during the late winter and spring (February-May) which accounts, in part, for the observed decline in juvenile production during the recent period of extended drought;

- A strong stock-recruitment relationship has not been established and therefore the relationship between the observed decline in annual indices of juvenile production and the abundance, age structure, reproductive capacity, and population dynamics for the adult splittail population is unknown;

- The majority of long-term fisheries monitoring programs conducted within the Bay-Delta have historically collected relatively few Sacramento splittail and results of many surveys do not effectively sample the adult splittail population (primarily because of the locations and depth within the water column sampled and gear avoidance by larger fish) over the geographic distribution of the population;

- The available scientific data have been used for determining relative trends in indices of splittail abundance, but do not provide a sufficient basis for estimating absolute population abundance for either juvenile or adult splittail;

- Although indices of juvenile abundance have declined the available scientific data are insufficient for determining whether or not the reproductive population of adult splittail has declined to a level where the population is threatened with becoming endangered or extinct throughout all or a significant portion of its range.

Based upon these conclusions it is recommended that current fisheries monitoring programs be modified or a new survey program initiated which is specifically designed to provide quantitative information on geographic distribution, abundance, age structure, and population dynamics (e.g., influence of various environmental factors on growth and survival, significance of incremental mortality such as that associated with entrainment losses on population abundance, stock-recruitment relationships, and behavioral and physiological response of various lifestages to environmental factors and conditions). The survey program should be designed to provide specific information on the seasonal and geographic distribution of spawning, the significance of inundated vegetation and shallow-water habitat as spawning sites, egg incubation and larval development, and juvenile rearing. The survey should also evaluate the effects of such environmental factors as freshwater flow within various areas of the Bay-Delta system in influencing habitat availability and suitability, transport, and dispersal of early lifestages. The survey program should provide information on the geographic distribution, abundance, and importance of

various habitat areas on growth and survival of sub-adult and adult Sacramento splittail. The data from these surveys will provide the necessary basis for evaluating Sacramento splittail population status and evaluating the effectiveness of various alternative protective measures for improving conditions for splittail.

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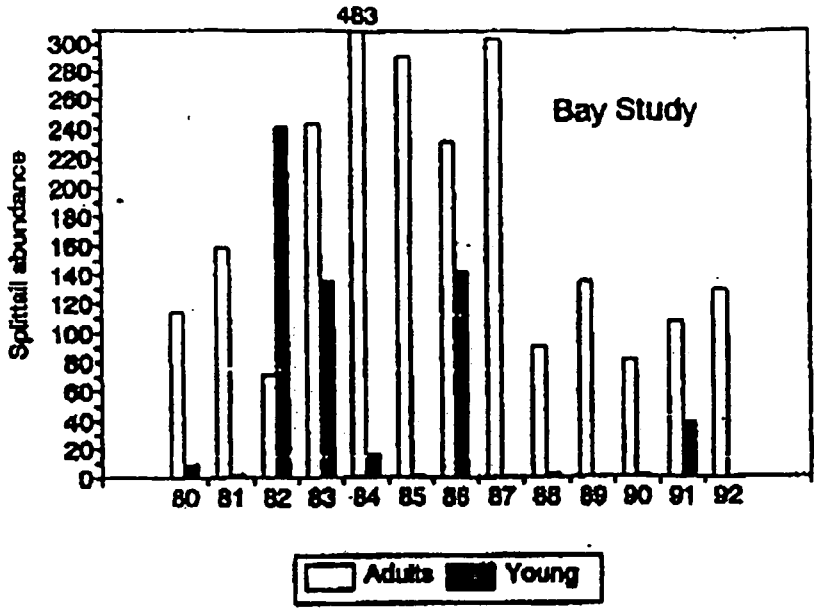


Figure 1. **Indices of juvenile and adult Sacramento splittail abundance from the CDFandG San Francisco Bay fisheries studies, 1980-1992 (Source: Meng 1993).**

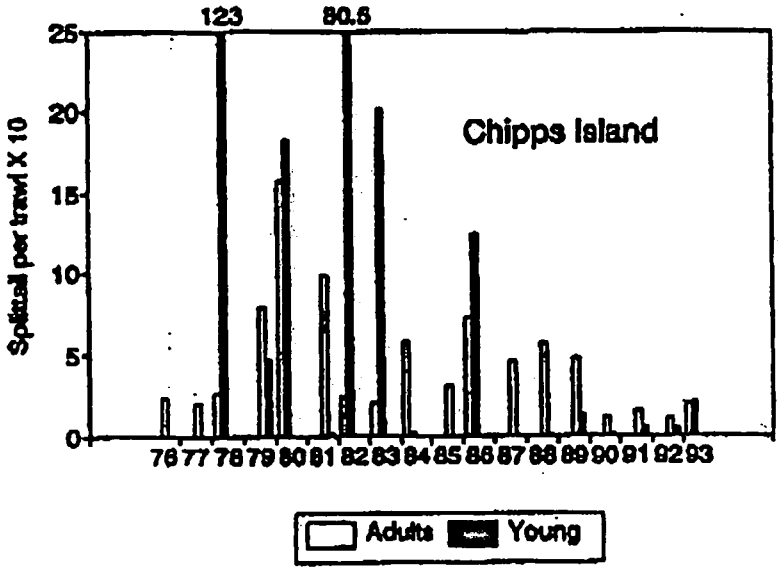


Figure 2. **Indices of juvenile and adult Sacramento splittail abundance in USFWS Chipps Island trawl surveys, 1976-1991 (Source: Meng 1993).**

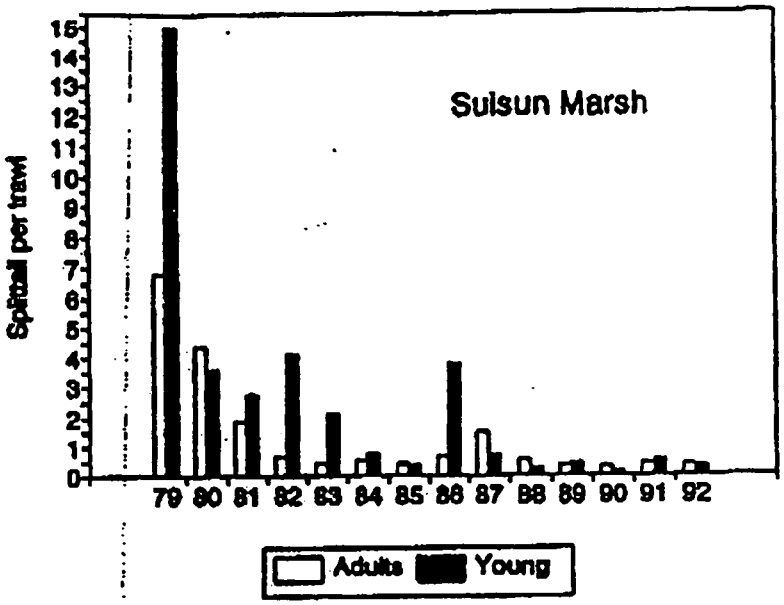


Figure 3. **Indices of juvenile and adult Sacramento splittail abundance in Suisun Marsh studies performed by the University of California, Davis, 1979-1992 (Source: Meng 1993).**

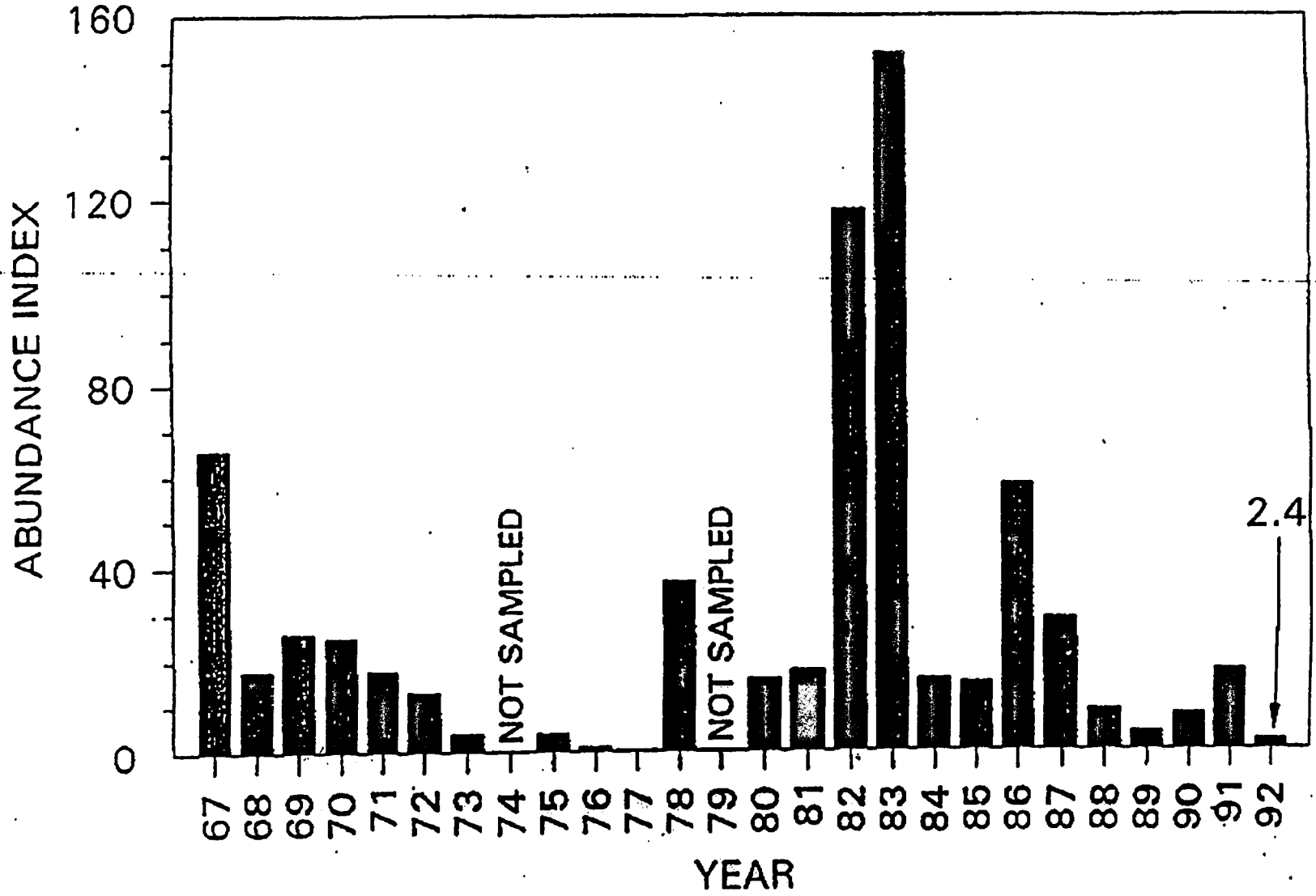


Figure 4. **Sacramento splittail abundance indices from the CDFandG fall mid-water trawl surveys, 1967-1992 (Source: Meng 1993).**

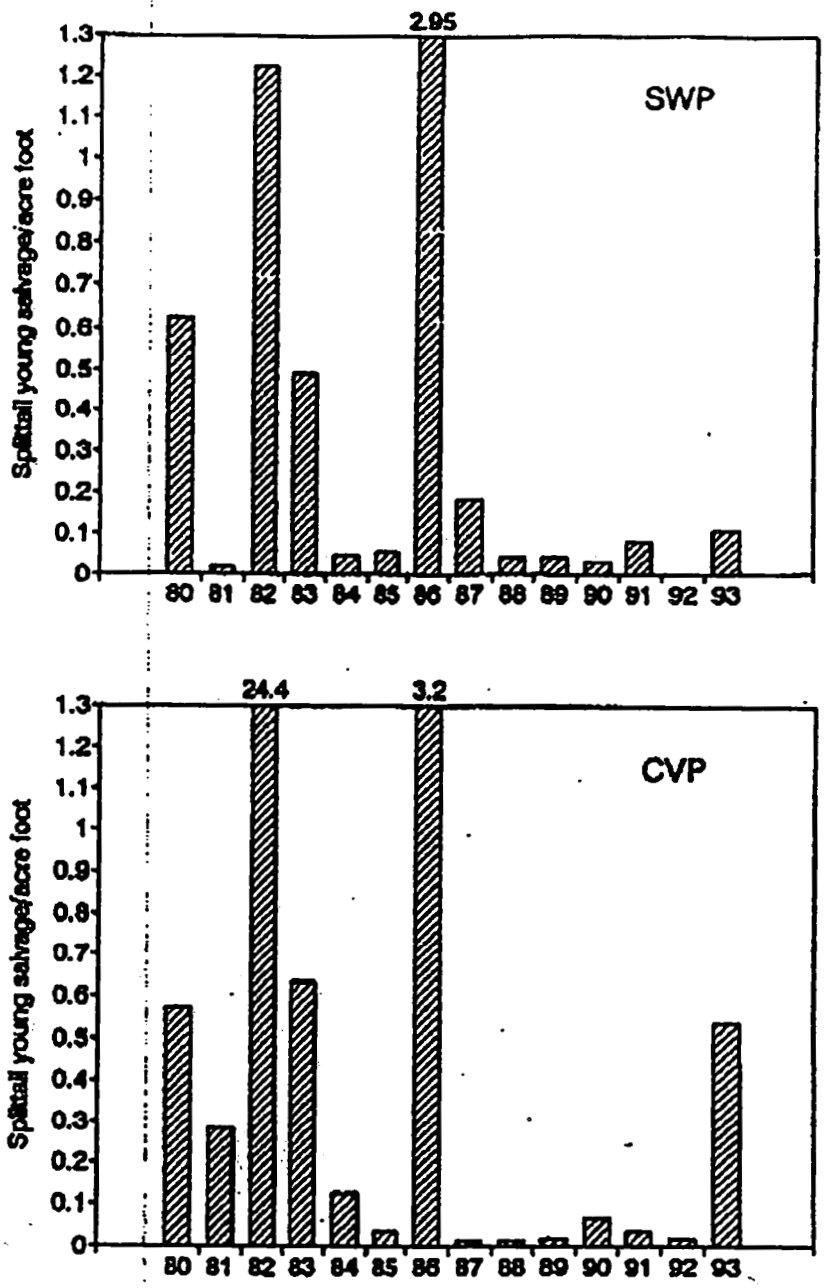


Figure 5. Juvenile Sacramento splittail salvage per acre foot diverted at the State and Federal (SWP and CVP) fish salvage facilities, 1980-1993. (Source: Meng 1993).

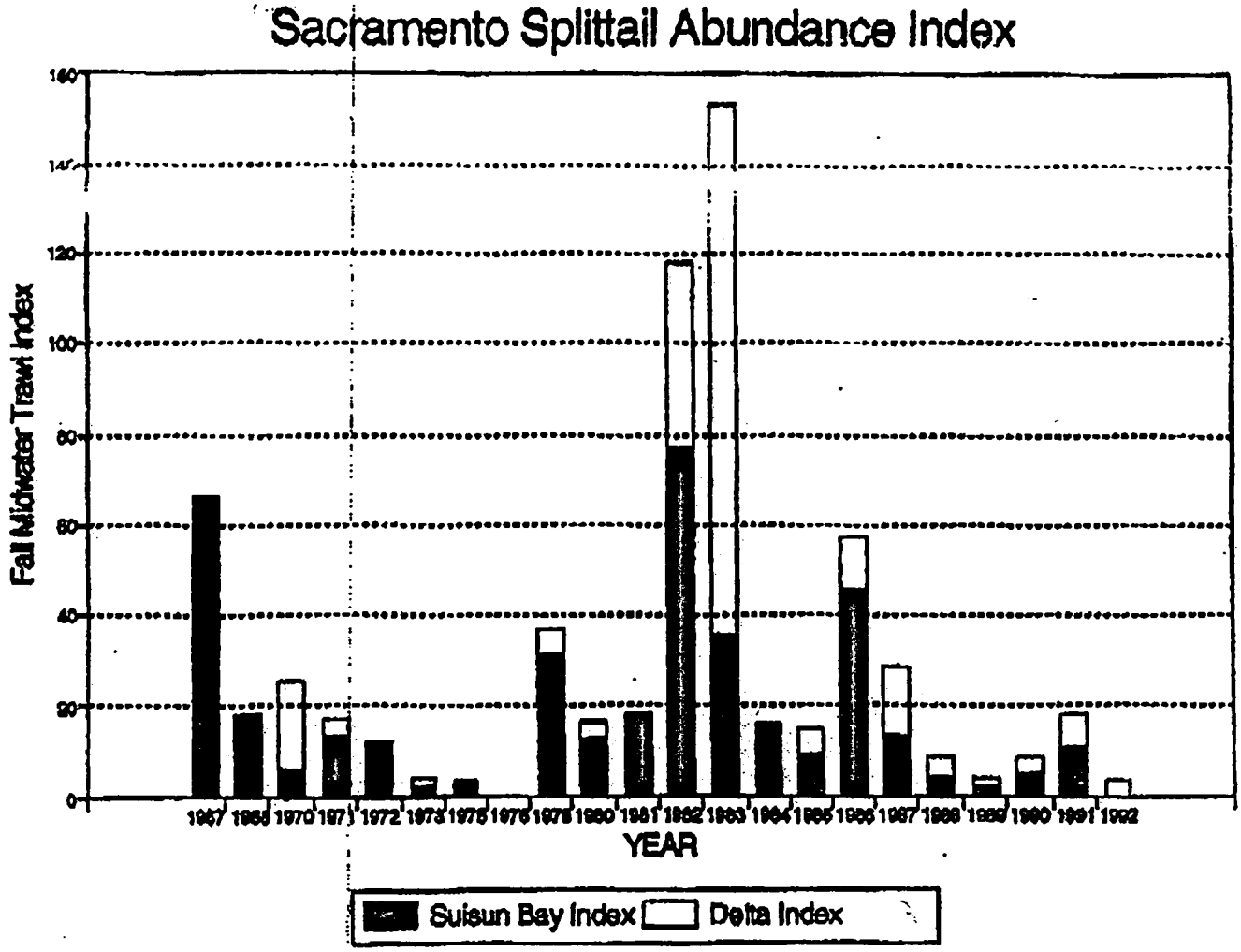


Figure 6. **Contribution of Sacramento splittail collected within Suisun Bay and the Delta to the annual CDFandG fall mid-water trawl abundance index (Source: CDFandG unpublished data).**

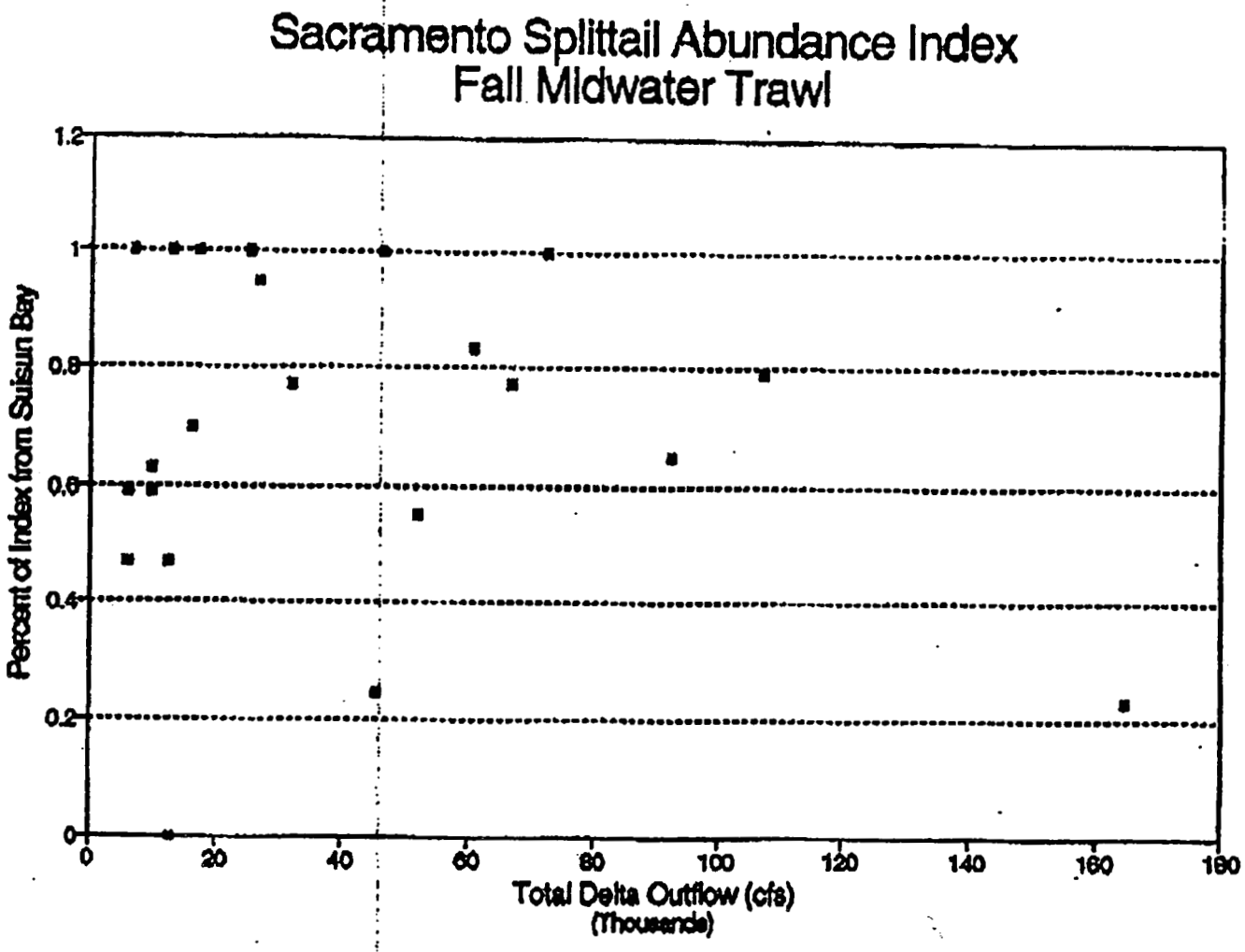
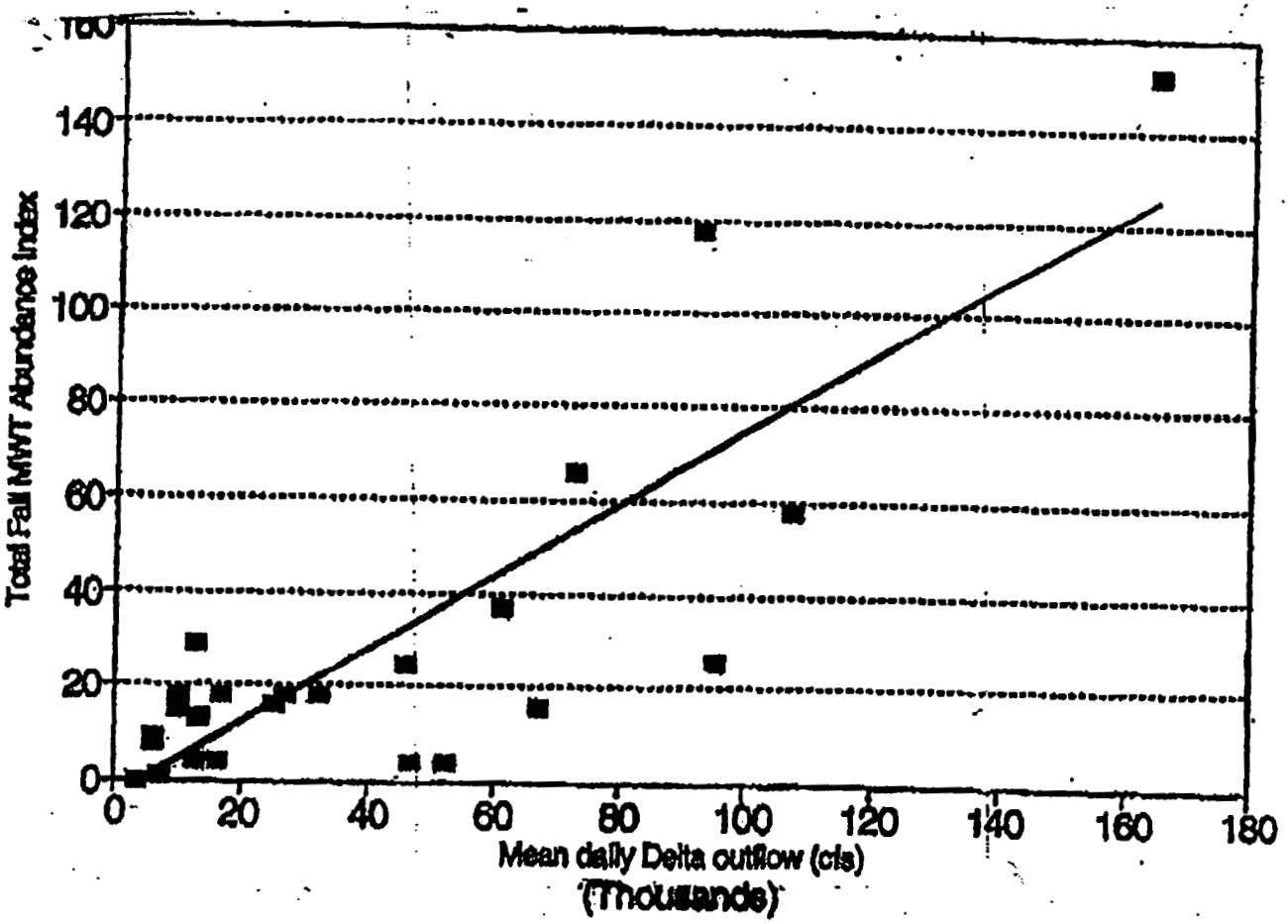


Figure 7. **Correlation between the proportion of the fall mid-water trawl index from Suisun Bay and freshwater outflow during the previous February-May (Source: CDFandG fall mid-water trawl index and DWR dayflow).**



n=23

Figure 8. **Correlation between the CDFandG fall mid-water trawl index of Splittail abundance and freshwater outflow between February and May (Source: CDFandG fall mid-water trawl abundance indices and DWR dayflow).**

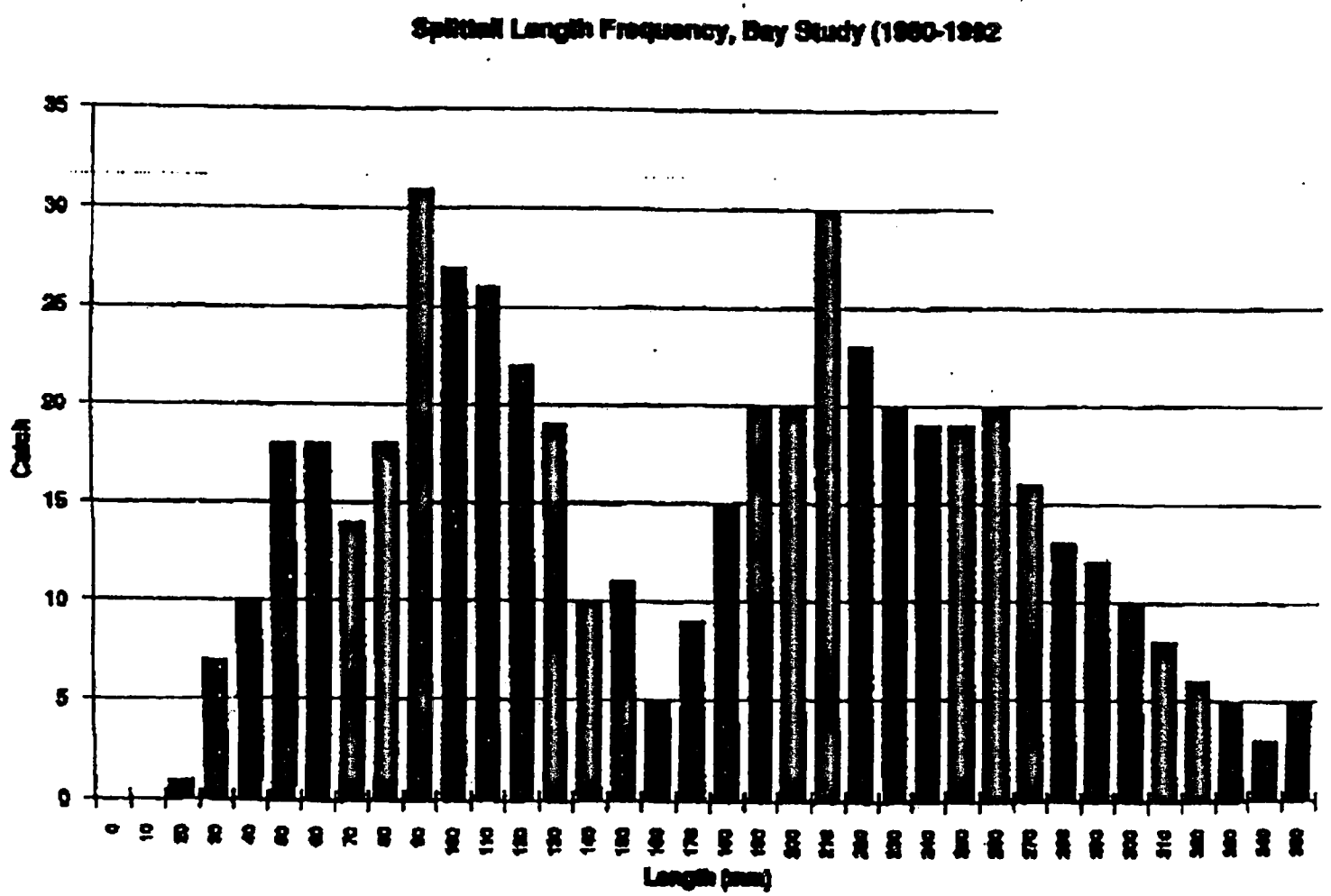


Figure 9. Length-frequency distribution for Sacramento splittail collected in CDFandG Bay Studies (Source: CDFandG unpubl. data).