

The Relationship Between Streamflow, Opossum Shrimp
Habitat and Coho Salmon Growth and Survival in the
Lagunitas Creek Estuary, Marin County 1/

Introduction

The Marin Municipal Water District (MMWD) has submitted testimony to the State Water Resources Control Board (SWRCB) in conjunction with the Board's March, 1992 hearings regarding water diversions from Lagunitas Creek. MMWD proposes certain streamflow measures to protect the fishery and public trust resources of that stream and Tomales Bay and asserts that "these measures will provide substantial improvements to all habitat conditions within the control of MMWD and will sustain healthy salmonid populations." (page 26, MMWD's "Summary of Procedural History, Studies Completed and Recommendations", February, 1992").

We have reviewed the technical bases of MMWD's proposed fishery protection measures and we have concluded they will not be sufficient to sustain healthy salmonid populations in the Lagunitas Creek watershed. This rebuttal testimony provides both the technical basis for our disagreement with the District's position and a recommendation to the SWRCB for the protection of the fishery and public trust resources of the Lagunitas Creek estuary.

Background

In its 1982 decision concerning Marin Municipal Water District's (MMWD) request to increase its storage of Lagunitas

1/ REBUTTAL TESTIMONY of William M. Kier on behalf of the Save Tomales Bay Committee, presented at a hearing of the State Water Resources Control Board concerning Lagunitas Creek water use issues conducted in Sacramento on March 23, 24, 25 and 26, 1992.

Creek water at enlarged Kent Lake, the State Water Resources Control Board (SWRCB) ordered MMWD to evaluate the stream during a period of operation and study before final determination could be made regarding the quantity of water to be released for the protection of beneficial use resources. SWRCB specifically directed that the relationship of streamflow to aquatic nutrients be investigated in Lagunitas Creek "at or near the Tomales Bay headwater" (Condition 25, Decision 1582).

In response to SWRCB's directive, MMWD's consultant, D.W. Kelley & Associates, investigated the Lagunitas Creek estuary – the more than two and a half miles of tidal channel extending upstream from the head of Tomales Bay to Shoreline Highway – in the spring and summer of 1983 and 1984. These investigations included, among other things, the abundance of opossum shrimp (the crustacean Neomysis mercedis) and its importance as food for young coho salmon (Oncorhynchus kisutch) and steelhead (Oncorhynchus mykiss) out-migrating through the estuary. The results of these studies are presented in Kelley's 1984 and 1988 reports to MMWD, and Kelley and Entrix's February, 1992 habitat recommendations report, the basis for MMWD's abovereferenced recommendations to the SWRCB.

This testimony is based on a review of the Kelley report and draws, as well, upon my own professional training, experience and judgement as a certified fisheries scientist. The purpose of this testimony is to explain the relationship between streamflow and the habitat of opossum shrimp in the Lagunitas Creek estuary, on the one hand, and the importance of opossum shrimp to the growth and survival of coho salmon on the other hand. Although the information presented here is largely derived from the Kelley reports, its bearing on the conservation of coho salmon has been insufficiently introduced, in our view, into these proceedings by MMWD, given the SWRCB's clear interest in defining and providing

adequately for the legitimate needs of the fishery and public trust resources of Lagunitas Creek and the Tomales Bay estuary.

The importance of opossum shrimp to coho salmon in Lagunitas Cr.

Kelley's 1984 report explains (page 56) that the only useful food in the stomachs of young coho salmon and steelhead trout (Oncorhynchus mykiss) collected in the Lagunitas Creek estuary between May 19 and June 24, 1983 was planktonic organisms, and "all but a single one of the planktonic organisms were opossum shrimp". The report states (page 58) that "Analysis of the data to determine the influence of streamflows on the distribution and abundance of this important food source, and its availability to outmigrating coho salmon and steelhead trout is in progress."

Kelley's 1988 report notes (page 127) that "Emigration of salmon smolts from Lagunitas Creek generally began in early April and ended in the latter part of June.". The report makes clear therefore, that at the precise time young coho salmon are preparing to leave Lagunitas Creek for the rigors of Tomales Bay and the ocean, they depend upon the opossum shrimp for sustenance, growth and survival.

The importance of opossum shrimp as food for the juveniles of economically-important game- and commercial fish is widely recognized. The SWRCB conducted a lengthy review of the importance of opossum shrimp to the growth and survival of juvenile striped bass (Morone saxatilis) in the San Francisco Bay-Delta estuary and provided specific salinity standards for the protection of its habitat in its 1978 Delta water quality plan and water rights Decision (D. 1485).

Finally, with regard to the relationship between food availability and the growth and survival of salmonids, the

Department of Fish and Game correctly states (page 13, Stream Evaluation Report 86-2) that "Survival rate from smolting to spawning is directly related to smolt size at emigration, the larger the smolt at emigration, the greater its chances of survival. Thus, the more large fish habitat, the more large smolts, and consequently, the more adults returning to spawn.

Unfortunately, none of Kelley's Lagunitas Creek reports, including the February 13, 1992 Kelley/Entrix report of habitat recommendations, provides the results of the analysis "to determine the influence of streamflows on the distribution and abundance of this important food source, and its availability to outmigrating coho salmon and steelhead trout" reportedly "in progress" on January, 1984.

The relationship of streamflow and salinity to opossum shrimp habitat

The investigation performed by Kelley & Associates for MMWD in 1983 and 1984 included frequent measurements of the stream's salinity and the identification of planktonic organisms, including opossum shrimp, collected at intervals along the 12,000- to 14,000 foot length of the Lagunitas Creek estuary. (Natural circulation is interrupted in the upper 2,000 feet of the estuary by the construction of the Giacomini dam, typically in May or June, each year.)

Kelley reports in 1988 (page 177) that "Very few Neomysis were collected where salinity concentrations exceeded 13 ppt." (parts per thousand) and notes that "The population of Neomysis moved upstream as flows declined. By late June nearly all Neomysis were captured immediately below Giacomini's Dam."

The SWRCB found in its 1978 evaluation of striped bass food

in the San Francisco Bay-Delta estuary (page 111-56, SWRCB, 1978) that the greatest concentrations of opossum shrimp occurred there in salinities of 4 ppt.

Using a habitat criterion of 5 ppt salinity and data points derived from the Kelley's 1984 report (page 49), we describe in Figure 1 how reductions in Lagunitas Creek's streamflow reduced opossum shrimp habitat along the length of the estuary in 1983. All but approximately 2,000 feet of the estuary was suitable for opossum shrimp at flows above 25 cubic feet per second (c.f.s.). As flows decreased below 25 c.f.s., however, opossum shrimp habitat decreased rapidly.

As Kelley notes (1988, page 177), by late June, with streamflow reduced to less than 10 c.f.s., the shrimp had been driven upstream to the base of Giacomini's dam, at which point essentially no opossum shrimp habitat remained in the Lagunitas Creek estuary.

Conclusions

The Kelley report makes clear that juvenile coho salmon depend upon opossum shrimp, almost exclusively, for sustenance during the period that they are gathering strength in the Lagunitas Creek estuary before entering Tomales Bay and the ocean. The report generally confirms the SWRCB's 1978 findings concerning the relationship of salinity to opossum shrimp habitat: that these crustaceans prefer brackish water of 4 or 5 ppt salinity and are unlikely to be found in salinities of 13 ppt or higher.

The report makes clear that a majority of the potential Lagunitas Creek estuary opossum shrimp habitat was lost during the April-June, 1983 coho salmon out-migration period through the

reduction of the stream's freshwater flows to less than 10 c.f.s, MMWD's failure to recognize the April-June streamflow needs of the Lagunitas Creek estuary makes clear that their habitat recommendations to the SWRCB will not "provide substantial improvements to all habitat conditions within the control of the MMWD". Absent measures to maintain substantial opossum shrimp habitat in the estuary, MMWD's recommendations will clearly not "sustain healthy salmonid populations."

Recommendations

Considering the importance the SWRCB, MMWD, the California Department of Fish and Game and the Marin County community have attached to the conservation and restoration of Lagunitas Creek's coho salmon resource it is imperative to provide adequately for each of the fish's critical life stages. Given the importance of opossum shrimp to the growth and survival of juvenile coho, it is recommended that streamflows be provided during the April-June out-migration period sufficient to protect much, if not all, of the stream's estuarine mysid shrimp habitat.

As Figure 1 demonstrates, Lagunitas Creek's opossum shrimp habitat is plentiful at 25 c.f.s. and deteriorates rapidly at flows below that level. Streamflows in the Lagunitas Creek estuary should, therefore, be maintained at 25 c.f.s. through the coho salmon emigration period, that is, until the end of June.

REFERENCES

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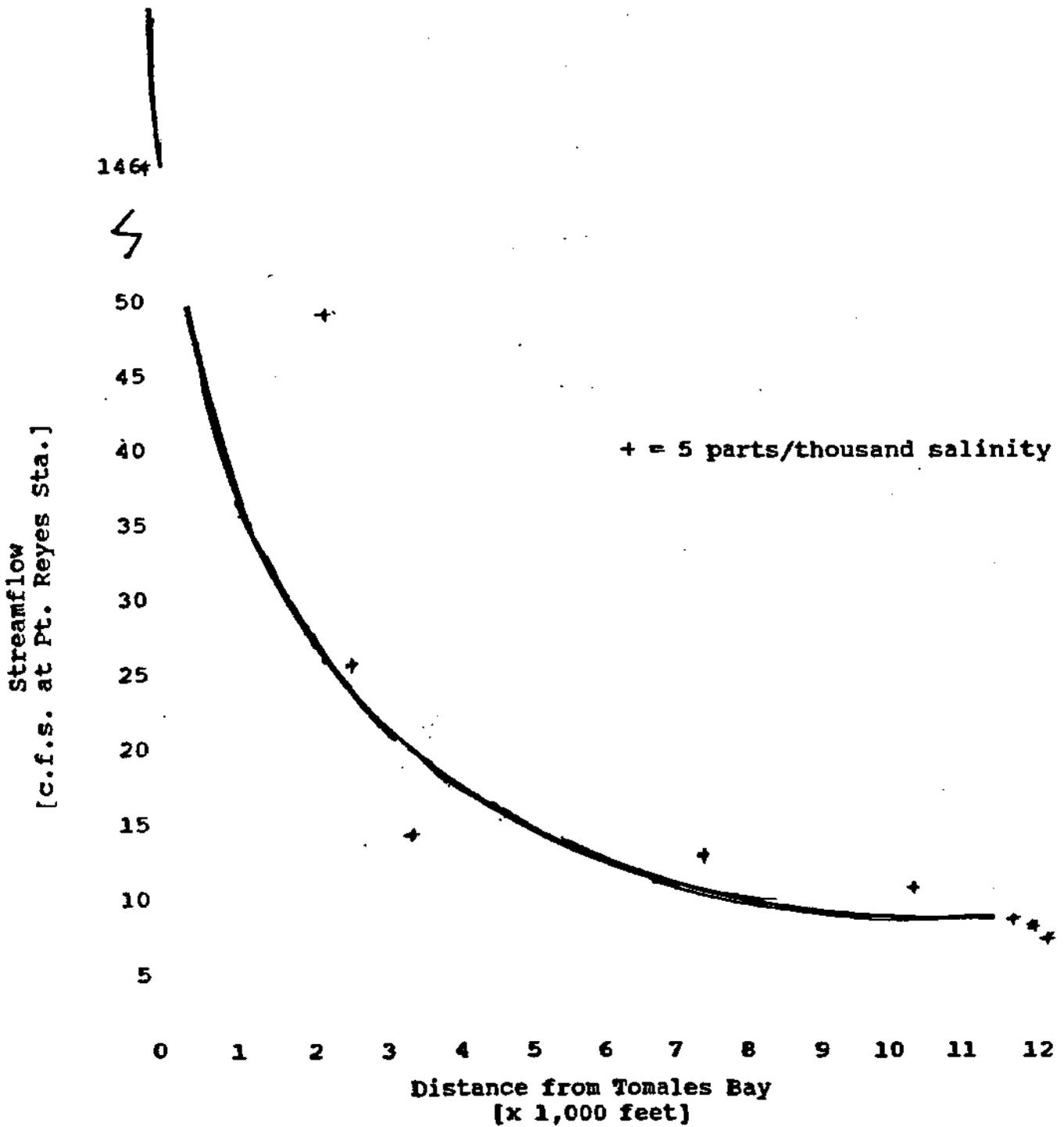


Figure 1. Approximate relationship between extent of opossum shrimp habitat and streamflow in Lagunitas Creek, April-June, 1983 [derived from Bratovich and Kelley, 1988].

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SPECIAL SKILLS AND EXPERTISE

Freshwater fisheries biology, aquatic and anadromous salmonid ecology, instream flow studies, water development impact assessments, sampling and statistical design, habitat analysis, expert testimony, and water resources management.

EDUCATION

A. B. Zoology, Sacramento State University, 1958, Graduate studies in ecology, sampling and statistical design, Sacramento State University, 1958-1959.

EXPERIENCE

Project Management and Coordination. As a certified fisheries scientist with William M. Kier Associates: Project manager and principal investigator in charge of statewide and major river basin fish resource assessments and conservation plans involving aquatic ecology, fisheries and instream flow assessments.

Research Director, Environmental Specialist. Principal environmental specialist and director, California State Senate, Office of Research. Conducted and supervised the conduct of investigations into the performance of laws, regulations and programs of state government concerned, among other things, with the protection of fish, wildlife, water, and other public resources.

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Fisheries Biologist. Conducted field investigations for the California Department of Fish and Game and the California Department of Water Resources into the streamflow and temperature requirements of both resident and migratory fish populations. Developed, and assisted the development, of field methods for determining the streamflow and related requirements of salmon, steelhead and trout populations. Participated in research related to the life history requirements of striped bass, shad and sturgeon.

Research Chemist. Studied fate of industrial pollutants in ground and surface waters, assisted a major Sacramento Valley manufacturer and the Central Valley Regional Water Quality Control Board to develop a program of water quality monitoring and assessment.

SPECIAL TRAINING

Methods of determining the streamflow requirements of fish populations. California Department of Fish and Game (student and trainer).

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