PREPARED FOR MAILLIARD RANCH

BY

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1994 SUMMER INSTREAM MONITORING REPORT
MAILLIARD RANCH

In a continuing effort to remain forerunners in land-stewardship the Mailliard Ranch initiated three stream monitoring stations on the ownership for 1994. This was accomplished in concurrence with Mike Howell, registered professional forester, and Charlotte Morrison, consulting wildlife biologist. These stations, located in central Mendocino County on the main stem Garcia, Mill Creek and Redwood Creek (Map 1), were established to address issues of beneficial water uses and fisheries concerns for areas under timber management.

Temperature, instream gravel composition and aquatic vertebrate abundance/distribution were evaluated. The most recent standardized monitoring protocols were used, whenever possible, to reduce sampling bias and acquire defensible, objective data. Stations were determined by proximity to forthcoming land management activities and access (See Appendix 1).

ACKNOWLEDGEMENTS

Appreciation is extended to Larry Mailliard, Mike Howell, Tim Motl, Sue Larson and Ted Wooster.

THERMAL REGIME OF THE MAIN STEM GARCIA
MILL CREEK AND REDWOOD CREEK
MILLIARD RANCH, SUMMER 1994

INTRODUCTION

Stream temperature is one of the most important environmental factors affecting fish. Summer instream temperatures have been identified as limiting factor for salmonids. In Mendocino County streams reach highest temperatures from mid- to late summer, the time of greatest solar incidence and ambient air temperature. Subsequently, design was to evaluate the thermal regime of freshwater refugia used by juvenile salmonids during the summer low flow period.

METHODOLOGY

Hobo-Temp Data Loggers were placed in pools in Redwood Creek, Mill Creek and the main stem Garcia (Map 2), to continuously record instream temperature at 2.4 hour intervals. This interval setting has been shown to insure representation of thermal peaks throughout the critical summer period (Jon Ambrose, Georgia-Pacific Biologist, pers. comm.). Temperatures in degrees Celsius (C) and Fahrenheit (F) were recorded between August 3, 1994 and October 19, 1994.

Hobo-Temps were anchored in pools, secured by 3/8" steel rebar. Instream and riparian measurements were taken at all Hobo-Temp sites (Please reference Hobo-Temp Data Forms in Appendix 2).

RESULTS

Results are graphed for each station on Tables 1, 2 and 3. Thermal regime of Station #1, Redwood Creek, ranged from 47.5 F to 62.7 F with a mean of 57.9 F. Mill Creek temperatures, Station #2, ranged from 45.3 F to 65.2 F with a mean of 56.7 F. Temperatures were highest on the main stem Garcia, Station #3, with a thermal regime from 46.1 F to 70.3 F. Thermal climate peaked at 70 F for a time interval of 2 hours on 4 August, 6 August and 7 August of 1994. Mean temperature for the main stem Garcia was 60.2 F.

Canopy closure for Redwood Creek, Mill Creek and the Garcia were estimate using a Spherical Concave Densiometer at 75%, 65% and 10%, respectfully. Instream and riparian measurements (Hobo-Temp data forms) and a hard copy of the collective instream recordings can be found in Appendix 2.

DISCUSSION

Distinct thermal requirements exist between salmonid species and their developmental stages. The upper lethal temperature for juvenile Coho salmon (*Oncorhynchus kisutch)* is 78 F, with maximum growth efficiency (MGE) between 53.6 to 57.2 F (Bell 1973). The upper lethal temperature for juvenile Steelhead (*Oncorhynchus mykiss)* is 82 F with MGE between 45 F and 68 F (Wendy Jones, CDF&G). Both species are stressed at temperatures over 68 F, but due to their thermoregulatory processes, studies have shown they can minimize body temperature fluctuations and acclimate, despite wide variation in thermal regimes (Bjornn and Reiser 1991; Coutant 1969). Hence, both species can withstand temperature above their MGE for short periods of time without harm (CDF&G Draft prepared to Board of Forestry, September 1994).

Of the three stations, the main stem Garcia (Station #3) reported the highest summer temperatures, although still below the thermal threshold for steelhead. Factors dictating stream thermal regime include: the influence of water surface area under solar exposure, rate of flow, type and density of vegetation within the riparian zone, ambient climate, channel morphology and topographic location. In 1994 extremely low flows, due to drought conditions, have influenced both stream temperature and salmonid populations (Valentine and Jameson 1994). Hence, stream temperatures are expected to decrease under a normal rainfall year. Furthermore, these data reflect observations which demonstrate a natural gradient of increasing temperature from headwaters to lower reaches (Hynes 1985).

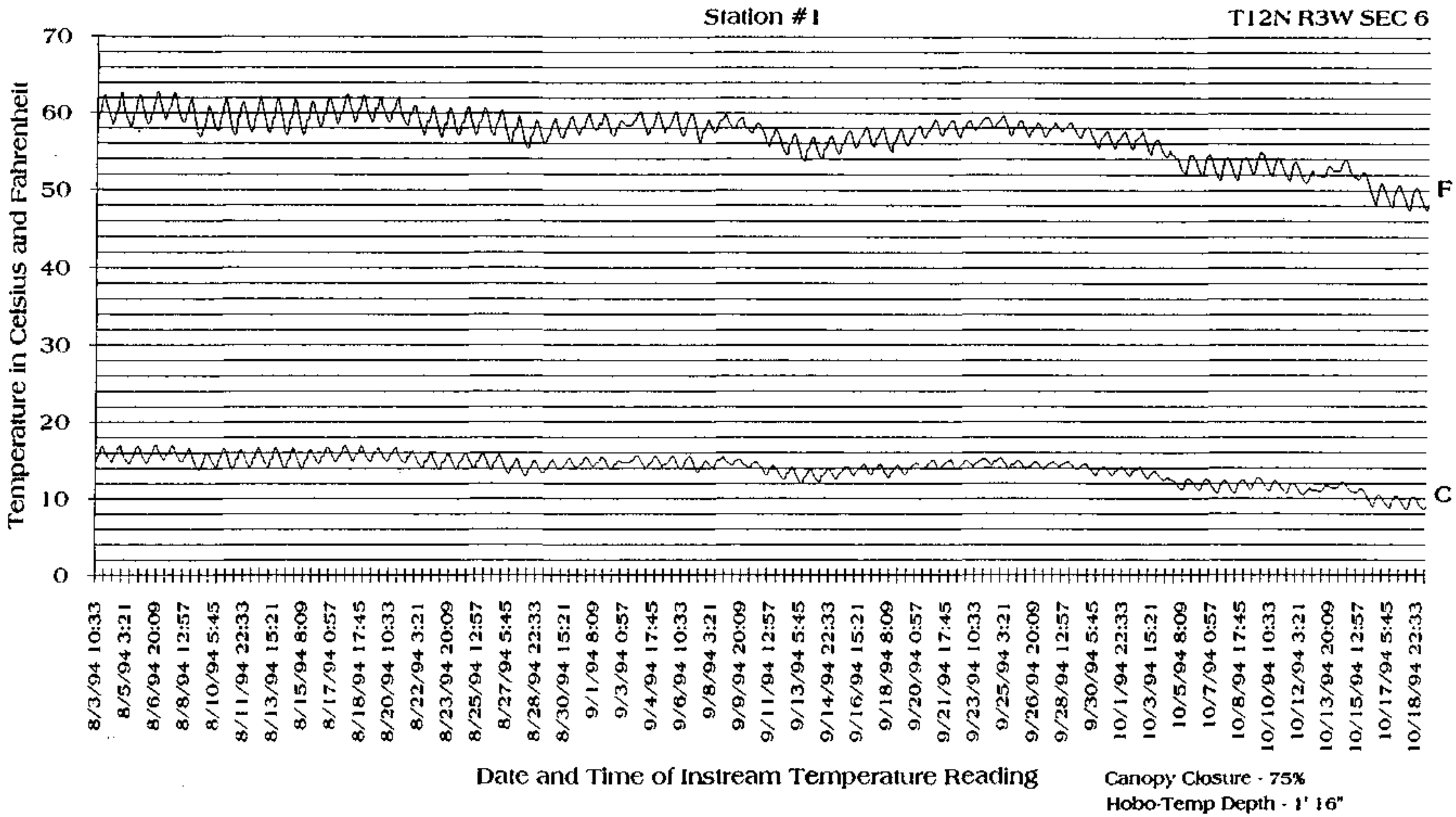
Stream reach proximity and low flows, resulting from drought, have influenced temperature conditions. Summer afternoon temperatures were of a relatively short interval and this site can provide habitat for many aquatic vertebrates. Electrofishing demonstrated a considerable steelhead population.

Additionally, Coho have been shown to ascend rivers to headwater reaches (Kondolf and Wolman 1993) with fry summering in deep pools and slow-flowing water. Steelhead are commonly located across *a* wide spectrum of stream reaches and habitat types. Although temperatures neighbor the MGE conditions for steelhead, this low reach area, due to location, temperature, channel broadness, low flows, lack of riparian vegetation and absence of pools is not presently considered over-summer habitat for juvenile coho.

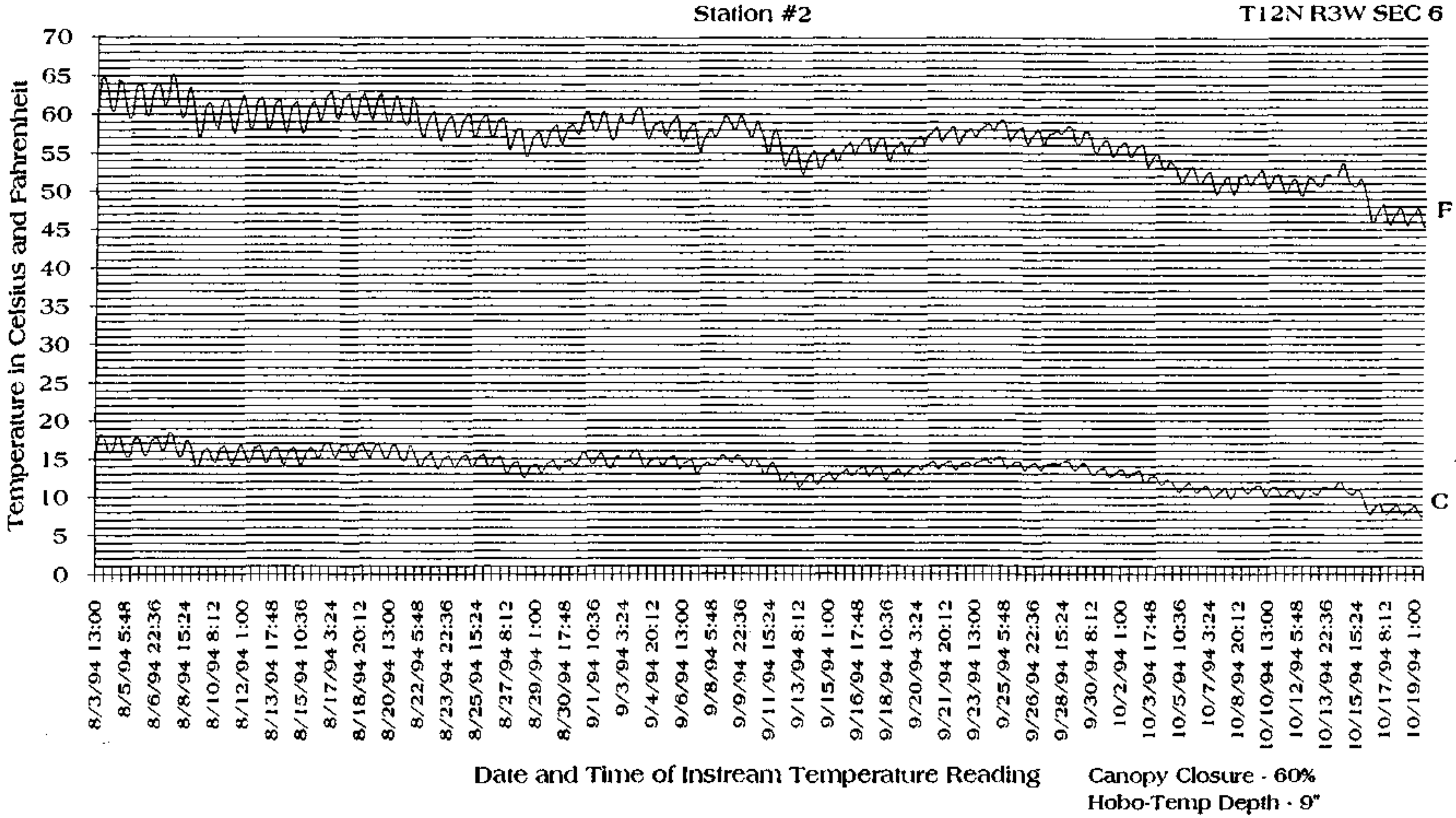
Cooler temperatures were recorded for Stations #1 and #2. Redwood Creek indicated the lowest temperatures of the three stations. This is the result, in part, to channel morphology, typical of higher order streams. Canopy closure measures were higher and channel width was more confined in Stations #1 and #2, likely reducing solar exposure within the stream and buffering temperatures. Additionally, channel width at, and upstream of, the site can significantly influence thermal regime of the stream. Wider channels maintain vegetation much further from the stream-zone creating a larger gap in canopy. Shade canopy on a slender stream channel can play a more insulative role: a premise for the low stream temperatures at Stations #1 and #2.

Stream temperatures are the cumulation of many factors which include seasonal changes in solar radiation, ambient air climate, fluvial geomorphology, riparian canopy and stream flow; hence, further study would be necessary to expound on these data. Nonetheless, temperatures associated with Stations #1 and #2 appear below the threshold for both steelhead and coho, indicating that summer thermal regimes are not limiting at these sites.

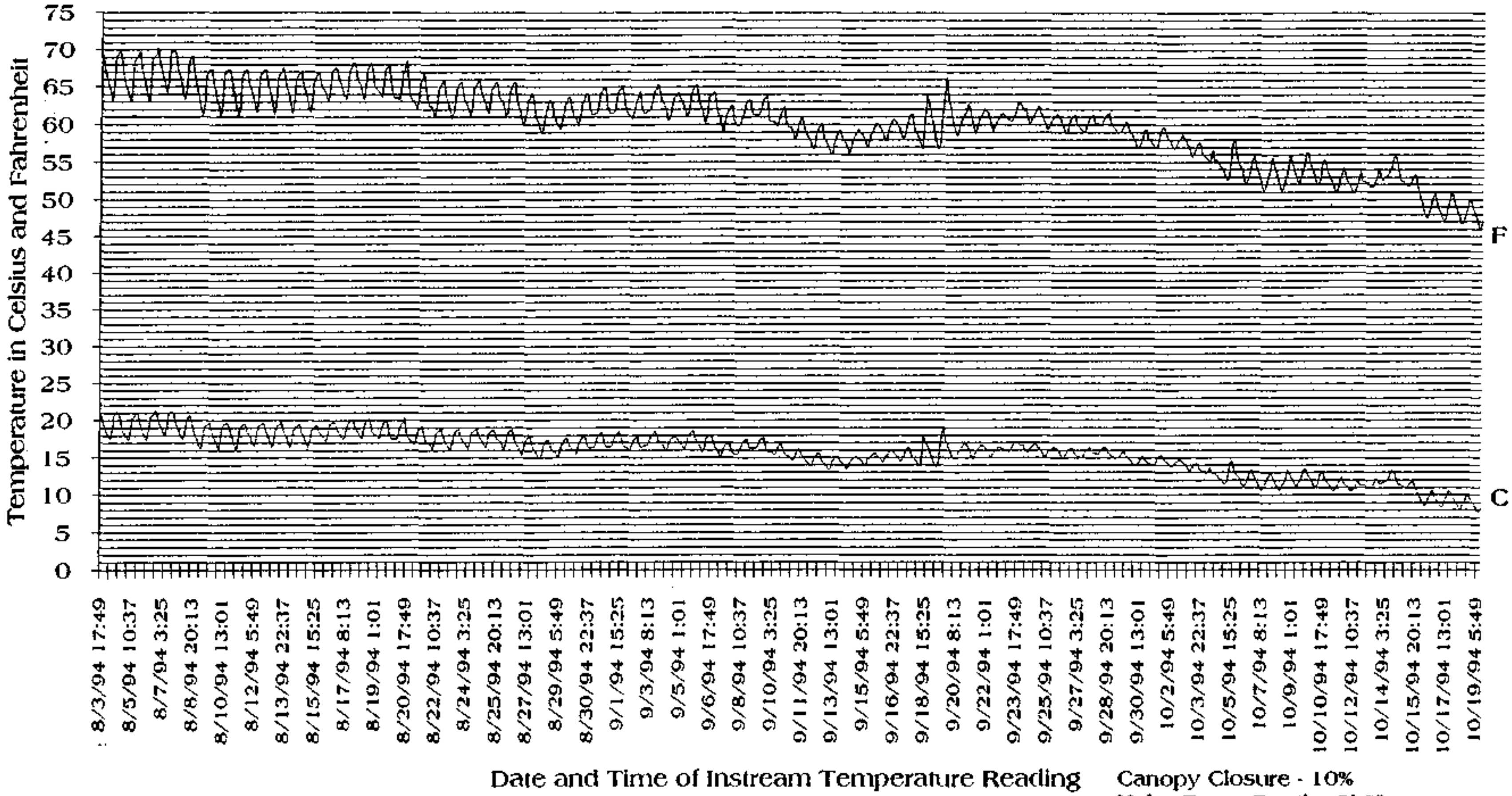
Temperature Regime for Redwood Creek, Garcia Drainage
Mailliard Ranch



Temperature Regime in Mill Creek, Garcia Drainage
Mailliard Ranch



Temperature Regime for Main Stem Garcia, 1.5 Mile Hollowtree
Mailliard Ranch
Station #3



Canopy Closure - 10%
Hobo-Temp Depth - 2' 5"

INSTREAM GRAVEL COMPOSITION OF REDWOOD CREEK

MAILLIARD RANCH, SUMMER 1994

INTRODUCTION

Stream substrate composition has been correlated to spawning success of salmonids (Tappel and Bjornn 1983; Platts et al. 1989). Although attempts are made to link the effects of land management on the streams' ecosystem (Stowell et al. 1983), due to inherent inconsistencies between, and within, certain studies (Chapman 1988; Young et al. 1990; Beschta 1982) conclusions regarding the effects of land use, and subsequent instream effects, still remain unresolved.

Anadromous fish exhume pits, called "redds", at the pool/riffle juncture of spawning streams, deposit their eggs and cover them with upstream substrate. Egg incubation period is approximately 2-6 months and following hatch, the young fry maneuver through the gravels to reach the water column. High levels of fine instream sediment (less than 0.85 mm) can reduce intergravel flow through the redd and, thus, restrict the availability of oxygenated water from reaching the eggs, resulting in low survivorship. Additionally, high sedimentation can create an impermeable layer within redds, preventing emerging fry from reaching the surface. Subsequently, stream gravels are often evaluated to estimate egg-to-fry survival to emergence (STE) and have been identified as a limiting factor for salmonids. To address these concerns, stream substrate was sampled utilizing the McNeil Sampler from two sites in Redwood Creek, within the Mailliard ownership, in the summer of 1994. McNeil samples, of all the current instream metrics, provide the best biological link between instream gravel composition, salmonid spawning and fry survivorship (Bill Trush, Humboldt, pers. comm.) The objective of this project was to obtain a "snap-shot" of general composition of instream gravels.

METHODOLOGY

Stream substrate was collected, using a McNeil Sampler (McNeil and Ahnell 1964), processed and analyzed according to guidelines provided by Brad Valentine (Ca. Dept. Forestry and Fire Protection, Perpetual Draft 1993) and the Timber-Fish-Wildlife Ambient Monitoring Program Manual (1994). Two sample sites along Redwood Creek were selected based on proximity to *a* proposed timber harvest plan and suitable access (Map 3). A total of eight substrate core samples were taken at two stations, four in each location, from areas that most closely emulated spawning sites (i.e. pool/riffle confluence of a streambed). Collection was conducted by Mike Howell and Tim Motl, registered professional foresters for the Mailliard Ranch, and Charlotte Morrison, consulting wildlife biologist. Sampling occurred on 4 October and 10 October of 1994 during low flow conditions. Earlier collections may cause unnecessary mortality of fry emergents while later collection can bias information due to high-flow problems; hence, collection should be conducted during the summer low flow period (late summer through early fall).

According to Valentine (1993) bulk samples were collected in the following manner:

> The sampling tube of the McNeil sampler is manually worked into the substrate until the bottom of sample basin contacts the channel. The contents of the sampling tube are removed by hand and placed in the basin. The water remaining in the tube contains suspended material and must be removed with the plunger. The cork is removed from the plunger, the water in the tube agitated with the hand, and the plunger pushed down to the metal stop-pins. The plunger is then tightened by turning the handle. The cork is replaced and the sampler removed from the streambed. The contents (including the water and fines) in the tube are transferred to a bucket pending sieve analysis.

Cores of instream substrate is sieved to obtain size distribution of each sample. Sieve sizes used were 31.5 mm, 16.0 mm, 8.0 mm, 4.0 mm, 2.0 mm, 1.0 mm and 0.85 mm according to Shirazi et al. (1981). The remaining substrate represents the finest material in the stream (< 0.85 mm) and is measured in Imhoff cones, allowed to settle for 10 minutes. Instream characteristics noted during collection were stream gradient and water temperature (Please reference Appendix 3, Sediment Sampling data forms).

Since no single statistic can serve as an effective indicator of gravel quality (Kondolf and Wolman 1993; Young et al. 1991; Chapman 1988; Beschta 1982), results of this project are expressed in three forms: 1) Percent finer graphed on Tables 4, 5 and 6; 2) Geometric mean diameter and 3) Fredle Index on Tables 7, 8, 9 and 10. Percent finer represents the percent of substrate collected within a particular sieve size, quantified by volume. Geometric mean diameter and the Fredle Index were used to describe potential suitability and composition of spawning gravels.

RESULTS

Percent fines were variable along Redwood Creek for 1994. Upper Redwood Creek fines averaged 32.2% (Table 4) with lower Redwood Creek fines averaging 19.4% (Table 5). The average percent fines of these two stations were 25.8% (Table 6). Presently, the accepted standard threshold of concern when evaluating gravels for salmonids is 20% fines, less than 0.85 mm, (Lisle and Eads 1991).

Average geometric mean diameter of Redwood Creek substrate ranged from 3.1 mm to 6.3 mm with an overall average of 4.6 mm and average predicted survival of eggs to emergence was 25% for coho and approximately 45% for steelhead. The Fredle Index ranged from 0.6 to 1.8 with an overall average of 1.3, predicting survival of eggs to emergence between 12% and 25% for coho and between 35% and 45% for steelhead.

Both the Fredle Index and the geometric mean diameter were notably different between Station #1 and Station #2. The geometric mean diameter of Upper Redwood Creek averaged 4.1 mm with a .9 average Fredle Index, corresponding survival-to-emergence values were 0% to 15% for coho and 20% to 40% for steelhead (Tables 7 and 8). The geometric mean diameter of Lower Redwood Creek averaged 5.1 with a 1.8 average Fredle Index, corresponding survival-to-emergence values were 25% to 45% for coho and 40% to 50% for steelhead (Tables 8 and 9). Table 8 was acquired from Valentine 1993. Individual data entries into the geometric mean diameter and the Fredle Index template is provided in Table 10.

These data indicate a "worst case" scenario (i.e. estimates of survival will be better than indicated). Late summer samples may be sensitive to sediment accumulation between fry emergence and sediment sampling. Spawning salmonids modify the size distribution of gravels by winnowing the fine sediment content (Kondolf et al. 1993). Additionally, water retention of the smaller gravels during processing can result in slightly higher measures. Hence, late summer sampling, water retention or the flushing action of spawning were not expressed in this report.

DISCUSSION

A decrease in percent fines from upper Redwood Creek to lower Redwood Creek was observed. Furthermore, percent survival to emergence was higher in lower Redwood Creek. This variation between samples can be explained, in part, by slope. Upper Redwood Creek, Station #1, is likely a depositional reach where the length and gradient of the stream channel are such that it cannot carry the normal sediment load from upstream under normal flow conditions. A low rainfall year can further exacerbate sediment accumulation, especially along gentle terrain. Lower Redwood Creek, Station #2, supported a slightly higher gradient than the upper station, possibly allowing the channel sufficient energy to transport stream substrate, reducing sediment.

Percent finer, geometric mean diameter and the Fredle Index have been used as a measure of streambed suitability and composition for spawning salmonids. While some studies suggest percent fine measures are unsatisfactory at predicting survival-to-emergence, others attempt to correlate it to historic alteration in stream composition due to land management (Young et al. 1991; Beschta 1982). Others (Duncan et al. 1985) indicate fines are associated with lithology and soils rather than forest management practices. Further speculation infers that sediments, deposited into redds, are more a function of gravel framework (Lisle and Eads 1991), positioning of the redd within the channel and/or sediment load regime following redd construction (Kondolf et al. 1993). Although professionals differ in their opinions regarding individual metrics, percent fines, geometric mean diameter and the Fredle Index continue to provide the best available biological data linking gravels to spawning success and emergence.

TABLE 4
1994 AVERAGE McNEIL STREAM SUBSTRATE SAMPLES FOR UPPER REDWOOD CREEK
STATION #1

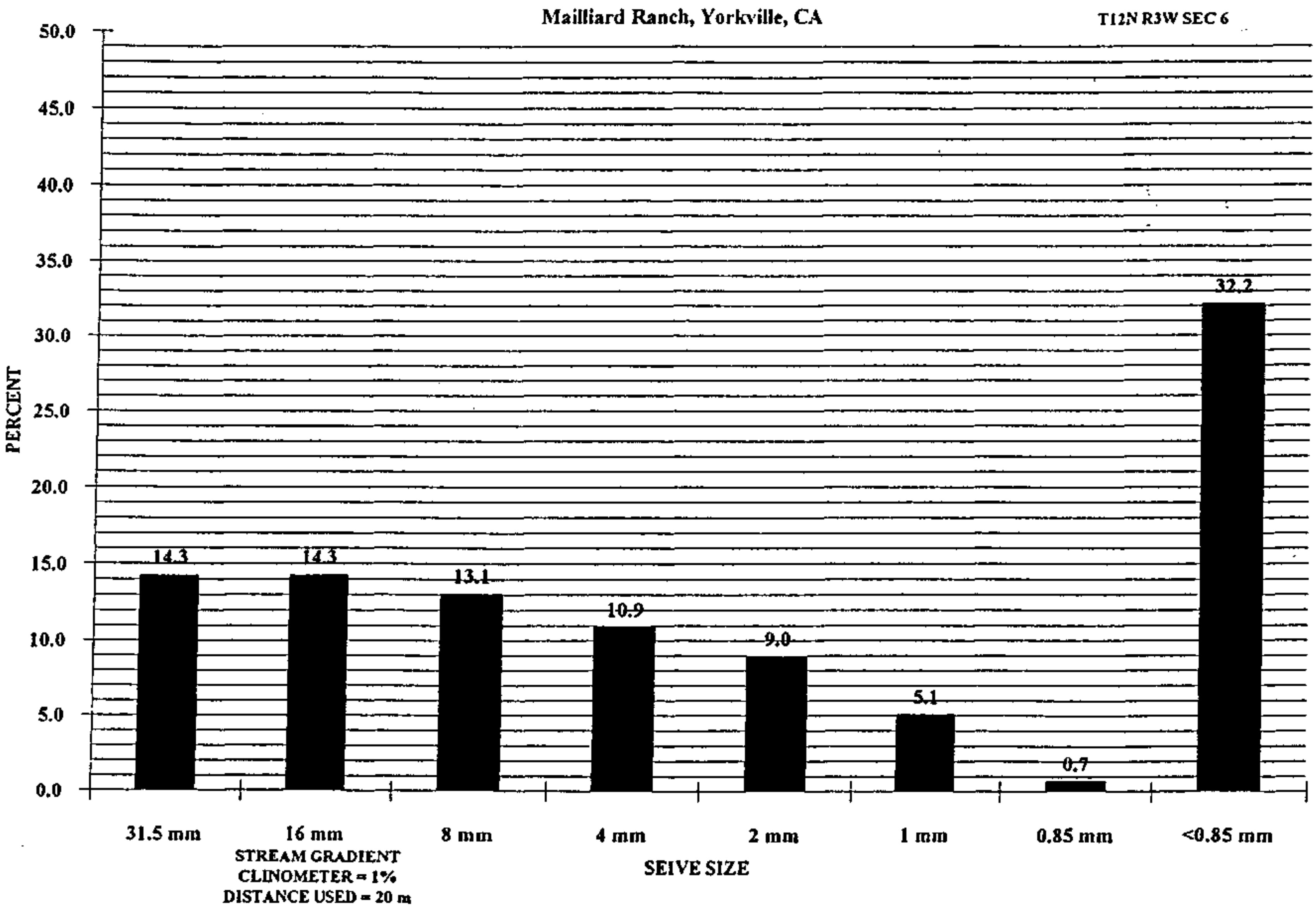
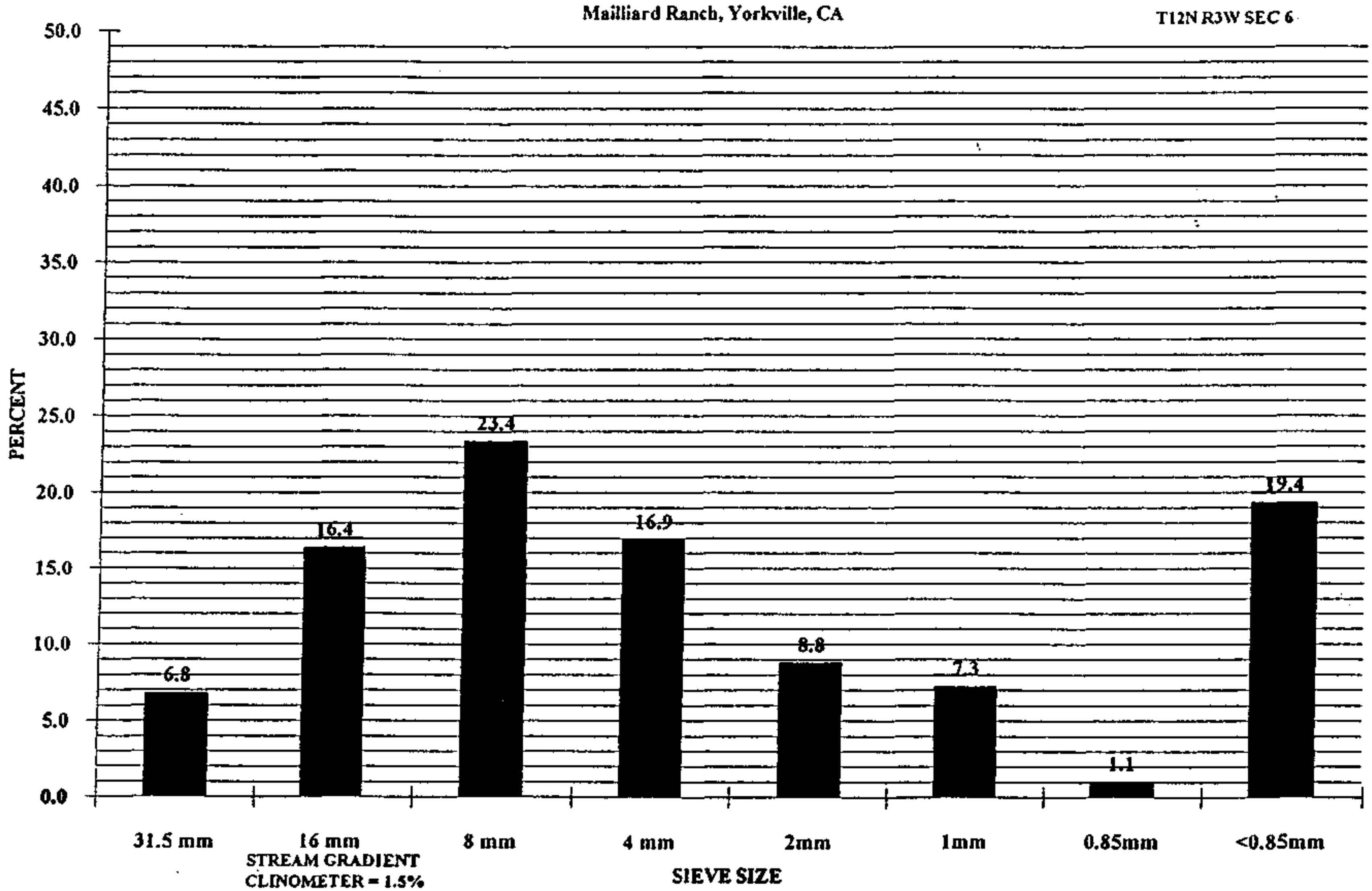


TABLE 5
1994 AVERAGE McNEIL STREAM SUBSTRATE SAMPLES FOR LOWER REDWOOD CREEK
STATION #2



STREAM GRADIENT
CLINOMETER = 1.5%
DISTANCE USED = 40 m

TABLE 6

1994 AVERAGE McNEIL STREAM SUBSTRATE SAMPLES FOR REDWOOD CREEK

Mailliard Ranch, Yorkville, CA

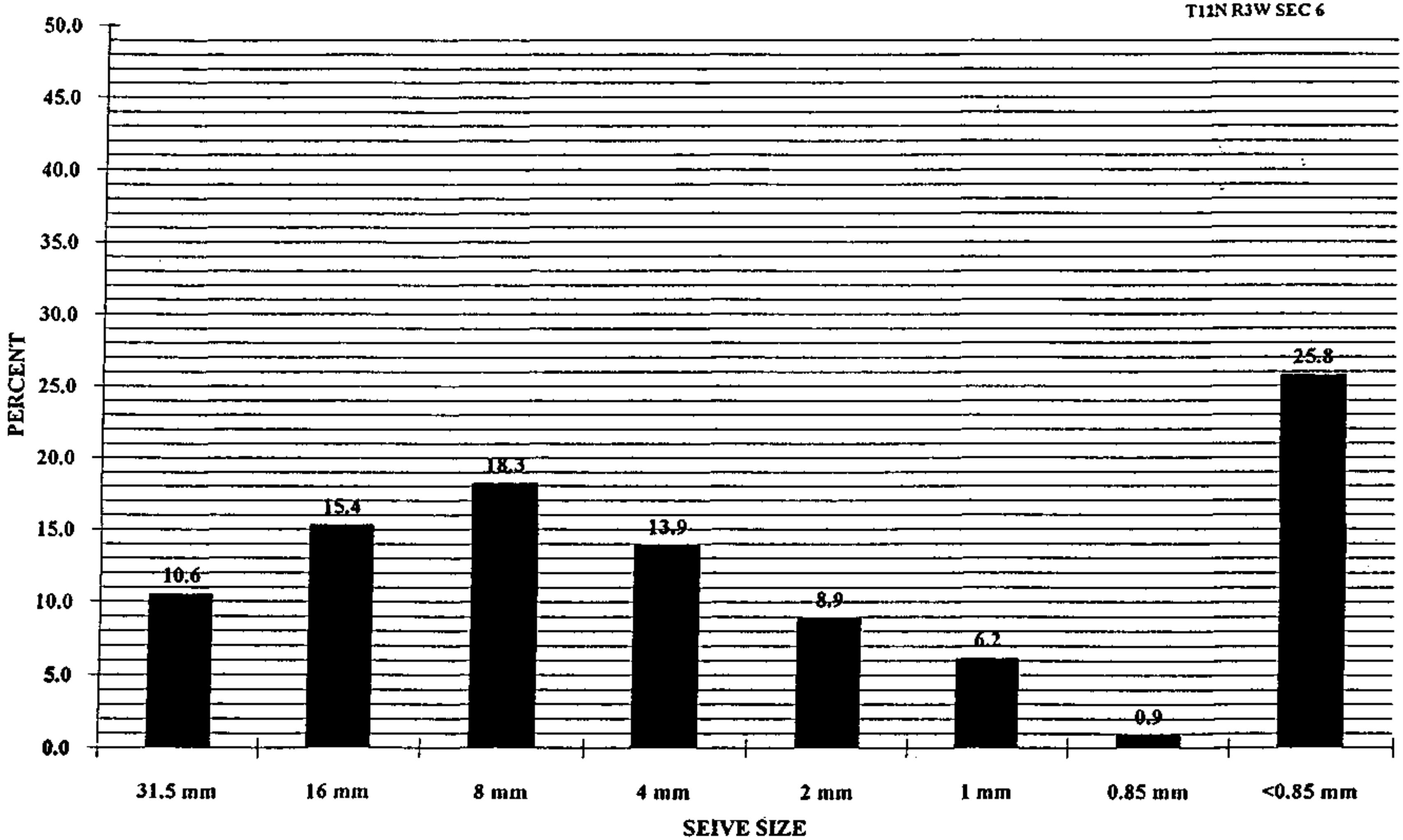


TABLE 7
AVERAGE OF UPPER REDWOOD CREEK
PERCENT SURVIVAL TO EMERGENCE FOR COHO AND STEELHEAD AGAINST THE FREDLE INDEX,
SITE FIGURES PLOTTED ON THE CURVES.

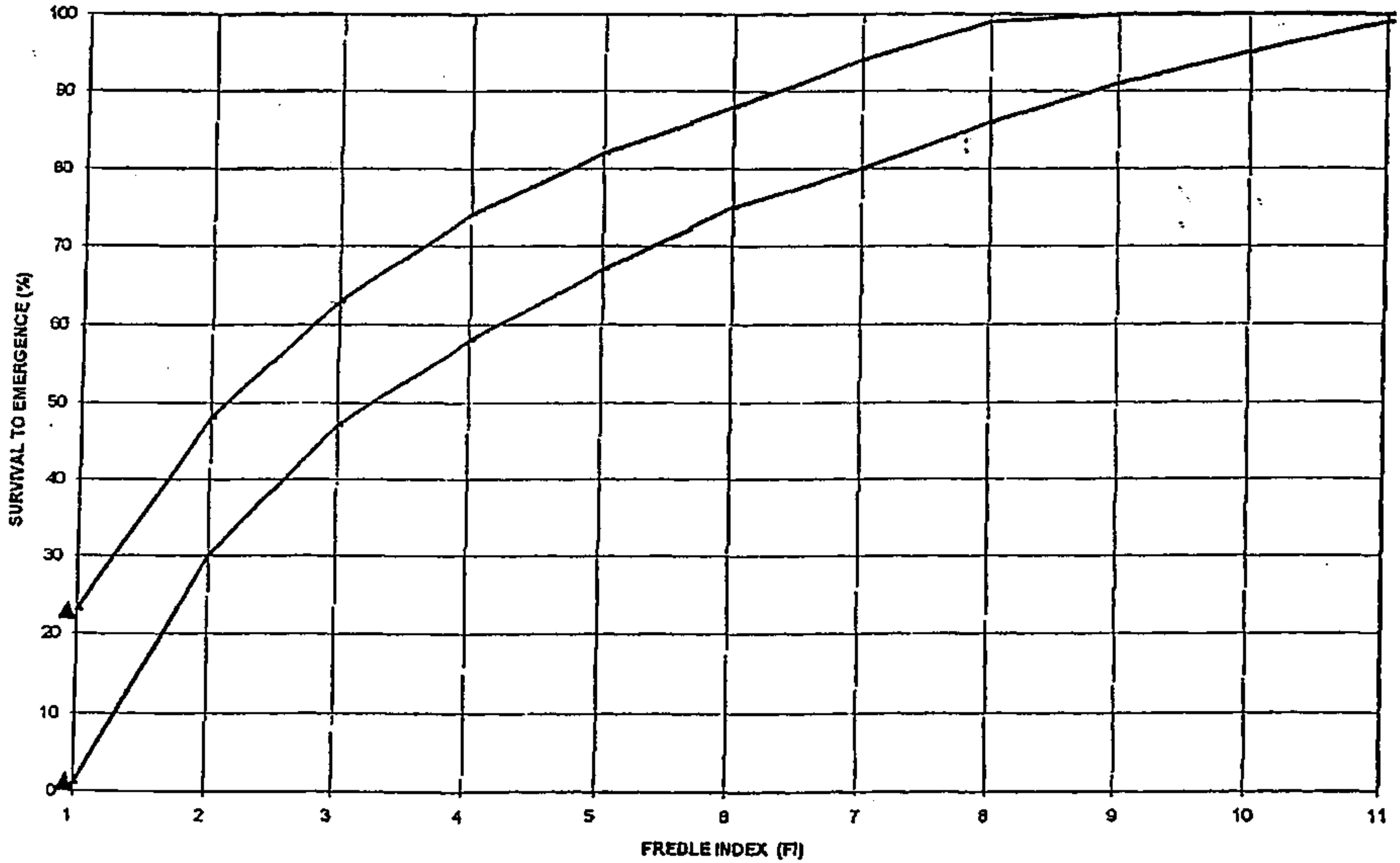
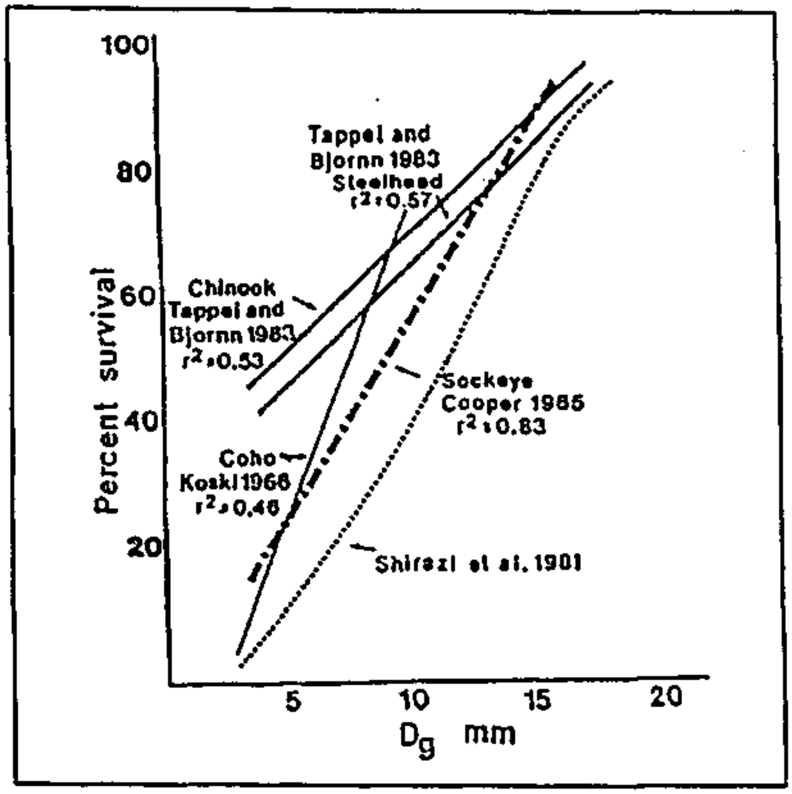


TABLE 8



←A

Fig 3. Survival of eggs to emergence based on substrate composition for several salmonid species. "A" is based on the substrate's geometric mean diameter, "B" is based on the Fredle Index. From Chapman (1988).

B
↓

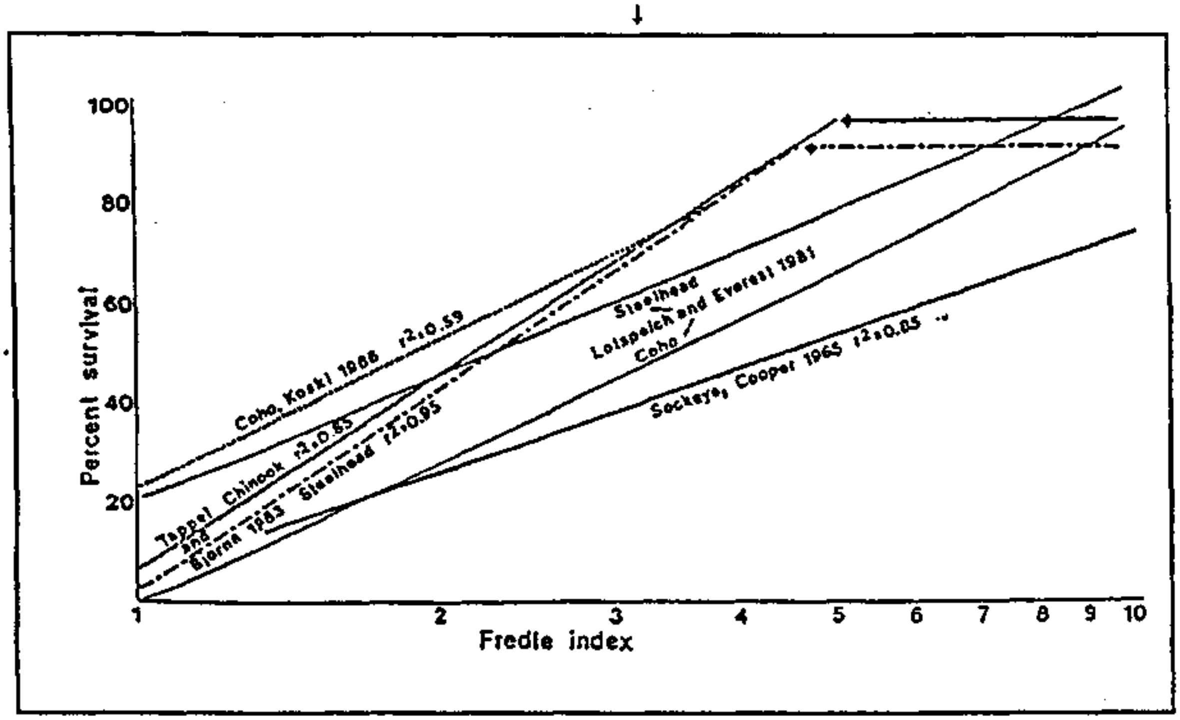


TABLE 9

AVERAGE OF LOWER REDWOOD CREEK

PERCENT SURVIVAL TO EMERGENCE FOR COHO AND STEELHEAD AGAINST THE FREDLE INDEX, SITE FIGURES PLOTTED ON THE CURVES.

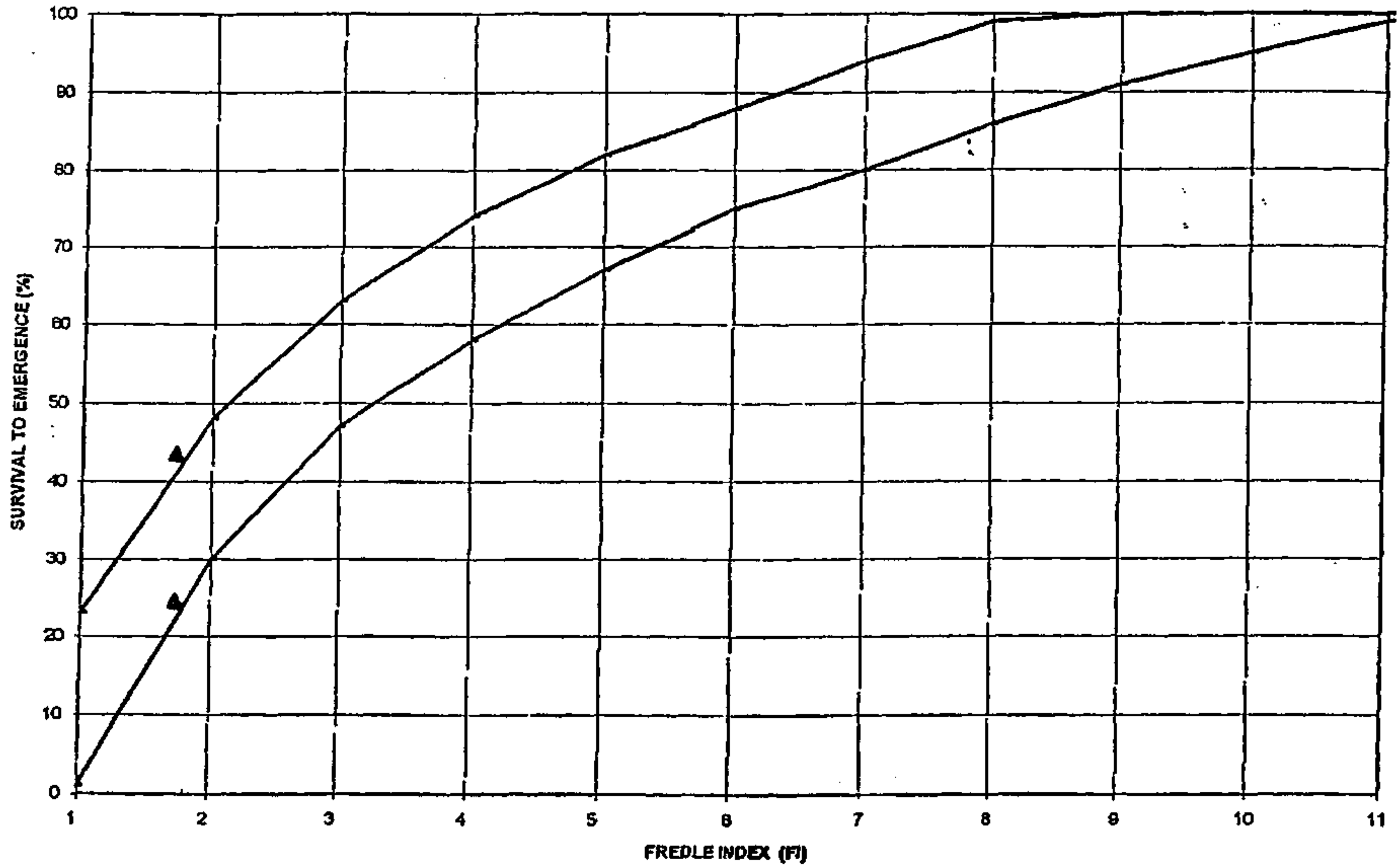


TABLE 10

GEOMETRIC MEAN DIAMETER AND FREDLE INDEX
REDWOOD CREEK, MAILLIARD RANCH, 1994

Percent of sample passing through various sieve sizes: Input data in yellow cells								
	Station # 1 samples				Station #2 samples			
Sieve size (mm)	1	2	3	4	1	2	3	4.
31.5	21.1	13.4	20.5	2.3	0.0	7.4	6.3	13.5
16	15.1	11.2	16.4	14.4	13.9	14.5	15.9	21.4
8	10.8	11.2	15.4	15.0	27.9	24.7	23.8	17.2
4	8.6	10.6	10.6	13.8	20.9	16.3	16.7	13.7
2	5.9	8.4	12.5	9.2	7.0	10.4	9.4	8.4
1	4.0	6.2	2.5	7.8	8.0	6.5	8.6	5.9
0.85	0.0	1.3	0.0	1.6	1.0	1.6	0.0	1.6
<0.85	33.5	37.7	21.6	35.9	21.2	18.7	19.4	18.2
Geometric mean	4.5	3.1	6.3	2.7	4.2	5.1	5.0	6.2
Fredle Index	0.7	0.6	1.7	0.6	1.4	1.7	1.7	1.8
Percent < 3.3 mm	49.0	60.5	43.5	63.5	50.8	47.8	48.3	43.0

SAMPLING OF AQUATIC VERTEBRATES ON
REDWOOD CREEK AND MAIN STEM GARCIA
MILLIARD RANCH, SUMMER 1994

INTRODUCTION

Electrofishing has become a widely recognized method of estimating aquatic vertebrate populations. Watersheds, and their relative importance to salmonids, has gained new attention with agencies, land managers and the public. The historic fluctuations of species diversity during anadromy, and in some cases the continuing steady decline in migrating salmonid populations, has raised concern regarding the overall health of our fisheries.

METHODOLOGY

On September 6, 1994 two sites, Redwood Creek and the main stem Garcia, were electrofished by Ted Wooster, Environmental Specialist from the Department of Fish and Game, with the assistance of Charlotte Morrison, consulting wildlife biologist, utilizing a Smith-Root Model 12 backpack electrofisher. Station length was 15 m with a total sampled surface area of 45 square meters. The multiple-pass depletion method was implemented and nets were placed at each end of the station to prevent emigration or immigration of aquatic vertebrates. Normally captures are weighed; however, Gutreuter and Krzoska (1994) recommended eliminating this in situ measurement since length alone can provide sufficient information. Hence, individuals collected were counted and measured, using fork length for fish and snout-vent length for amphibians, before being returned to the stream. Site measurements included date and time, canopy closure, air and water temperature, station length, station widths, cross-sectional depths and a visual estimation of substrate (Appendix 4, Electrofishing data forms).

RESULTS

Results are graphed on Tables 11 and 12. A total of 17 steelhead *(Oncorhynchus mykiss)*, 3 yellow-legged frogs *(Rana boylei)*, 2 Pacific giant salamanders *(Dicamptodon tenebrosus)* and 2 rough-skinned newts *(Taricha granules)* were collected in Redwood Creek at 1451 hours on September 9, 1994. Station length was 33 m.

On the Garcia 48 steelhead, 1 rough-skinned newt, 1 yellow-legged frog and 1 lamprey (Lampreta[sic], spp) were collected along a 15 m station at 1152 hours on September 9, 1994. Raw data sheets are provided in Appendix 5.

DISCUSSION

A moderate number of individuals were collected in Redwood Creek, which exhibited the best habitat between the two stations: cool temperatures, moderate riparian canopy, large woody debris, deep pools and slow moving water. A slightly higher number of individuals were collected in the main stem Garcia where temperatures were high and habitat appeared more simplified, lacking instream and riparian components such as deep pools, large woody debris and vegetative canopy.

Population estimates are not provided due to unavailability of the Microfish 3.0 software program. Seasonal timing, natural fluctuations of fish populations and differences in the stream reaches are dynamic and complex factors interacting with fish movement, distribution and abundance; therefore, general comparisons between stations cannot not be made. Fish presence and distribution has been used as an indicator of stream health. While "snapshots" can indicate presence or absence of certain species, only a comparative analysis of annual trends should be used to extrapolate stream fitness or fish health.

TABLE 11

1994 ESTIMATED FISH AND AMPHIBIAN SPECIES POPULATION DENSITIES FOR REDWOOD CREEK,

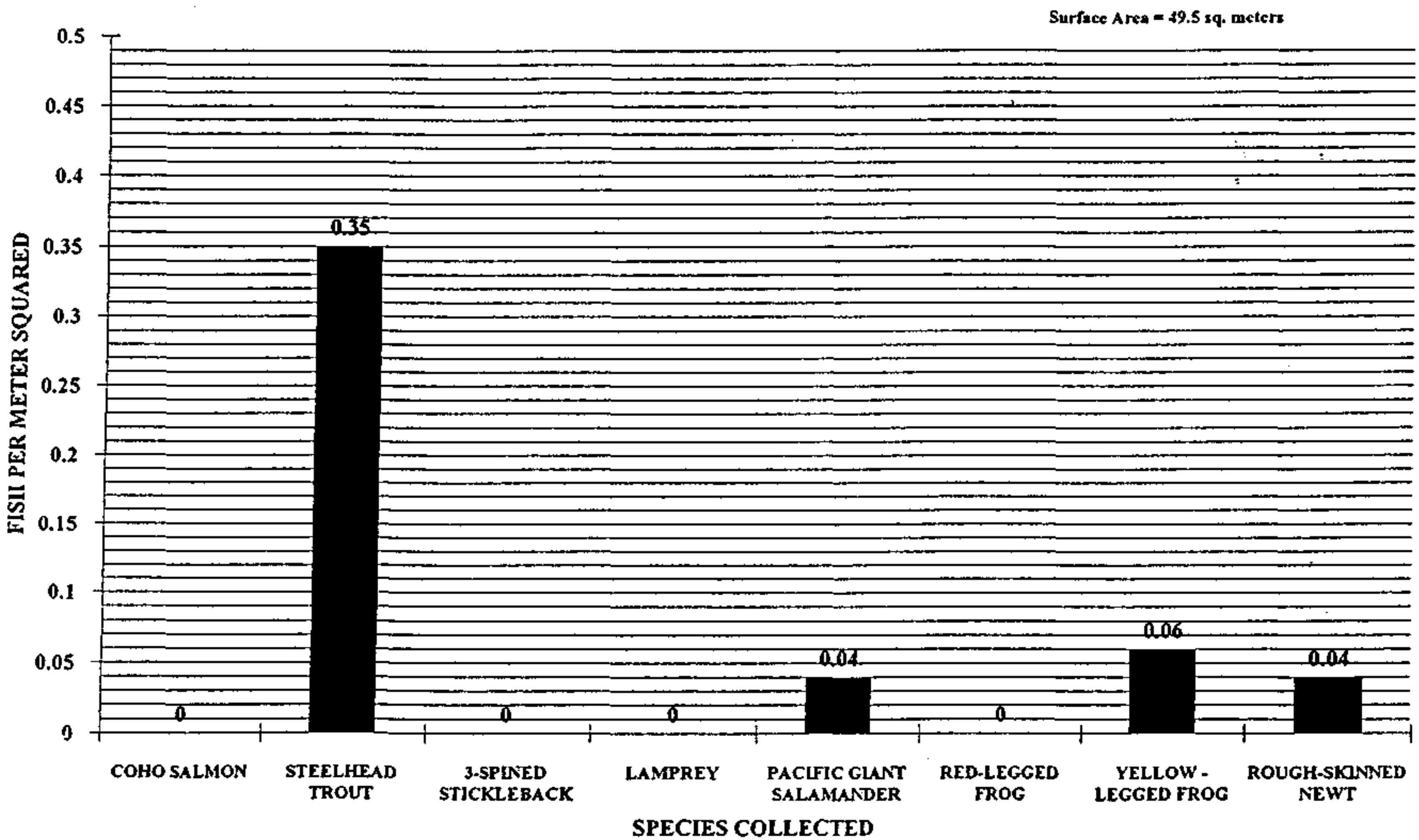
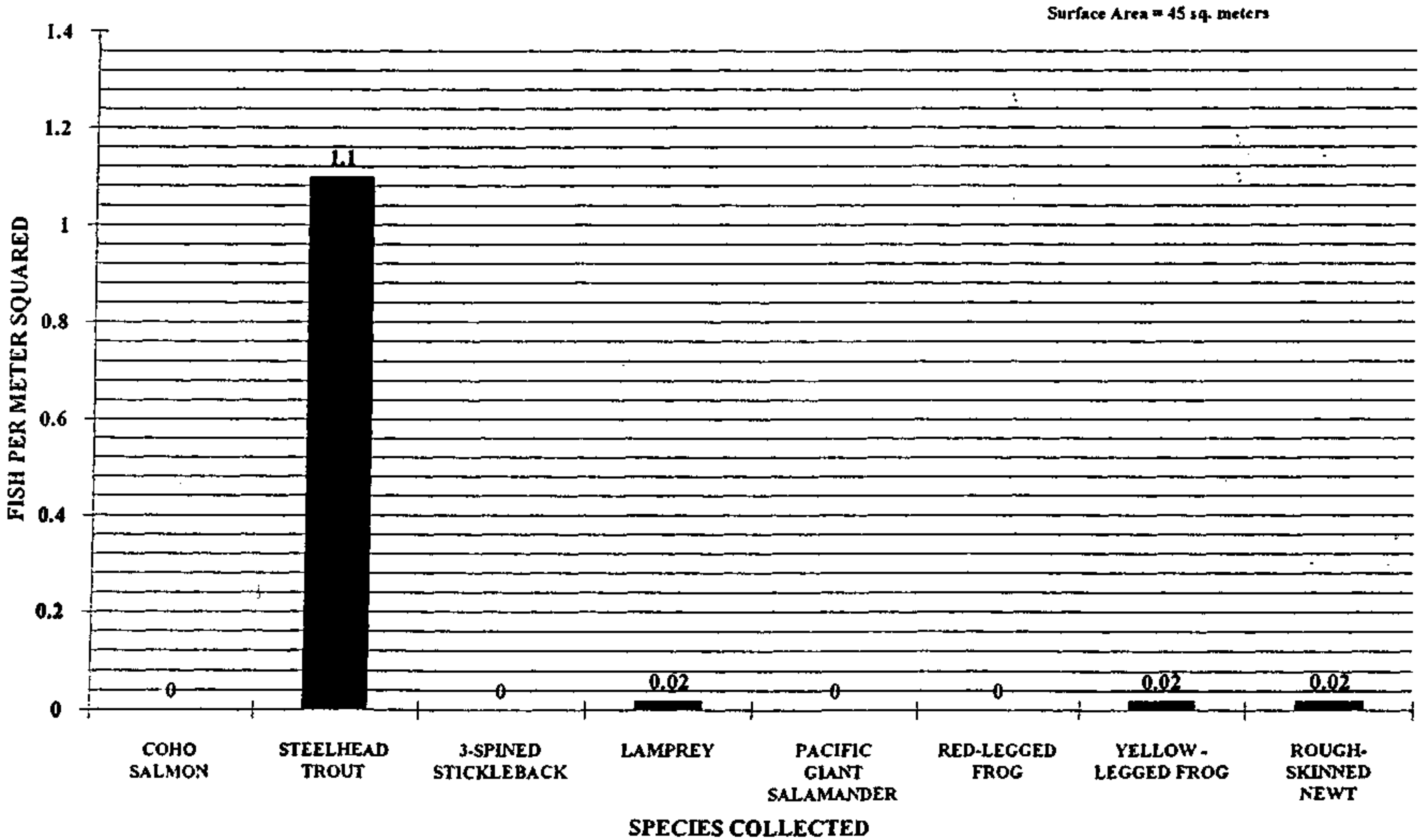


TABLE 12

1994 ESTIMATED FISH AND AMPHIBIAN SPECIES POPULATION DENSITIES FOR MAIN STEM GARCIA, MAILLIARD RANCH, YORKVILLE, CA



1994 INSTREAM MONITORING CONCLUSIONS

Each stream reach is distinct relative to its functional use for aquatic vertebrates; consequently, analysis should account for these differences. Transport reaches, spawning sites, over-summer and over-winter habitats should be analyzed within the context of species life histories, far beyond the scope of this project. Consequently, these results provide site-specific information for 1994 only and may not reflect representative condition of each reach.

This monitoring effort establishes critical baseline data which can be used in timber harvest plans to address fisheries issues and cumulative effects. Under the condition further monitoring is performed within the Mailliard ownership, data collection should coincide with these sampling locations and dates. This will allow comparison between samples and alleviate any biases due to seasonal fluctuations. These data, when compared over-time to future efforts, can provide valuable information on trends. Until then, broad-based conclusions cannot be made.

With the likely listing of the Coho salmon, under the Federal Endangered Species Act, areas within the historic range of this species will undoubtedly be scrutinized by regulatory agencies. Five watershed processes have been identified as significant to the survival and reproduction of Coho. These are: temperature, large woody debris, canopy cover, stream flow and nutrient input. Restrictive measures will focus on key coho areas, relative to the five watershed processes. Agencies will operate from two principle caveats: 1) to protect existing habitat from further degradation and 2) to ensure that recovery rate of this species is not impeded.

For persons involved with forest practice, efforts directed to address the five limiting factors may be successful at deflecting the regulatory onslaught. Benefit can be gained from identifying areas which maintain either some, or all, suitable habitat components for Coho. For example, relative to Redwood Creek, temperatures from 1994 would not be considered limiting for Coho or Steelhead. Therefore, land managers could eliminate that issue from concern when addressing forest management activities.

REFERENCES

Armour, Carl L. 1991. Guidance for evaluating and recommending temperature regimes to protect fish. U.S. Fish and Wildlife Service, National Ecology Research Center, Fort Collins, CO.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps. of Engineers. Portland, OR. Contract No. 57-68-C-0086. 425pp.

Beschta, R. L. 1982. Comment on "Stream system evaluation with emphasis on spawning habitat of salmonids" by M.A. Shirazi and W.K. Seim. Water Resources Research 18: 1292-1295.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in:* J. Morris ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Spec. Pub. 19, Amer. Fish. Soc., 101:1-16.

Burns, J. W. 1972. Some effects of logging and associated road construction on Northern California streams. Trans. Am. Fish. Soc., 101 1-16.

California Dept. of Fish and Game. September 1994. Coho salmon habitat impacts: Qualitative Assessment Techniques (Draft #1). Prepared for the Board of Forestry.

Cederholm, C.J., L.M. Reid, and E.O. Salo. 1981. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. In Proc. Conf. Salmon-Spawning Gravel: A renewable resource in the Pacific Northwest. Water Res. Center, Washington State University.

Chapman, D. W. 1988. Critical review of variables used to define effect of fines in redds of large salmonids. Trans. Am. Fish. Soc., 117(1): 1-21.

Coutant, C. C. 1969. Behavior of a sonic-tagged Chinook salmon and steelhead trout migrating past Hanford thermal discharges. Page 74 *in* EPA, 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. U.S. Environmental Protection Agency, Center for Streamside Studies, EPA/910/9-91-001. Seattle, WA.

Duncan, S.H., and J.W. Ward. 1985. The influence of watershed geology and forest roads on the composition of salmon spawning gravel. Northwest Science, Vol. 59, 3:204-212.

Flosi, G., and F. L. Reynolds. 1991. California salmonid stream habitat restoration manual. California Department of Fish and Game, Inland Fisheries Division.

Gutreuter, S., and D.J. Krzoska. 1994. Quantifying precision of in situ length and weight measurements of fish. North Amer. Jour. Fish. Manag. 14:318-322.

Hynes, H. B. 1972. The ecology of running waters. University of Toronto Press, Canada. 555 pp.

Kondolf, G.M. and M.G. Wolman. June 1993. The sizes of salmonid spawning gravels. Water Res. Res. Vol. 29(7):2275-2285.

Kondolf, G. M. and M. G. Wolman. July 1993. Modification of fluvial gravel size by spawning salmonids. Water Res. Res. Vol. 29(7):2265-2274.

Lisle, T.E., R.E. Eads. 1991. Methods to measure sedimentation of spawning gravels. USDA For. Serv. Res. Note PSW-411. 7pp.

Lotspeich, F.B., and F.H. Everest. 1981. A new method for reporting and interpreting textural composition of spawning gravel. U.S. Forest Service Research Note PNW-369.

McNeil, W.J., and W.H. Ahnell. 1964. Success of Pink Salmon spawning relative to size of spawning bed materials. U.S. Fish & Wildlife Service Spec. Sci. Rep. Fish. #469. 15pp.

Pacific Salmon Life Histories. 1991. C. Groot and L. Margolis eds. Department of Fisheries and Oceans, Biological Sciences Branch, Pacific Biological Station, Nanaimo, British Columbia, Canada.

Platts, W.S., M.A. Shirazi, and D. H. Lewis. 1979. Sediment particle sizes used by salmon for spawning with methods for evaluation. U.S. Envir. Prot. Agen., EPA-600/3-79-043, Corvalis, Oregon.

Platts, W.S., R.J. Torquemada, M. L. McHenry, and C. K. Graham. 1989. Changes in salmon spawning and rearing habitat from increased delivery of fine sediment to the South Fork Salmon River, Idaho. Trans. Amer. Fish. Soc. 118:274-283.

Shirazi, M. A. and W. K. Seim. June 1981. A streams systems evaluation - An emphasis on spawning habitat for salmonids. Water Res. Res. Vol 17(3):592-594. Stowell, R., A. Espinosa, T. C. Bjornn, W. S. Platts, D. C. Burns, and J.S. Irving. 1983. Guide for predicting salmonid response to sediment yields in Idaho batholith watersheds. U.S. Forest Service, Northern and Intermountain Regions, Ogden, Utah.

Tappel, P.D., and T.C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North Amer. Jour. Fish. Manag. 3:123-135.

Timber-Fish-Wildlife Ambient Monitoring Program Manual. August 1994. D. Schuett-Hames, A. Pleus, L. Bullchild, and S. Hall eds. Northwest Indian Fisheries Commission. Olympia, WA.

Valentine, B. E. 1993. Stream substrate quality for salmonids: Guidelines for sampling, processing and analysis. Perpetual Draft - October 13, 1993. California Department of Forestry and Fire Protection, Region 1. Santa Rosa, CA.

Valentine, B. E. and Jameson, Marc. 1994. Little North Fork Noyo Fisheries Study, 1992. California Department of Forestry and Fire Protection, Coast Cascade Region, Santa Rosa, CA.

Young, M.K., W.A. Hubert, and T.A. Wesche. 1991. Selection of measures of substrate composition to estimate survival to emergence of salmonids and to detect changes in stream substrates. North Amer. Jour. Fish. Manag. 11:339-346.

APPENDIX 1

HOBO-TEMP DATA FORM
PROFESSIONAL FORESTRY INCORPORATED * UKIAH, CA

Date 8/3/94 Station# 1 Stream Redwood Creek

Purpose Install ✓ Check____ Remove____

Surveyors Mike Howell - Charlotte Morrison 9:15AM

Legal Location T 12 N R 3 W ____ ____ ____ Sec 6

Quadrangle ORRBAUN County MENDO

Hobo-Temp# 6328 Interval setting: 2.4 hours

****

Pool length 23' 8" meters Pool width 16' 8" (feet) meters

Pool depth: Left 7" Right 1'-10" Upper 12" Lower 2"

Deepest pool depth: 3'6" Hobo-Temp depth 1'-6" 457 Time 9:35AM

% Slope: 8% 48 feet Total canopy: 75 % Deciduous: 10 % Coniferous: 65 %

****

Water temperature: 56°F Water clarity: Clear

Air temperature: 64°F Weather: Clear

% swd (d<12") 35% Composition: DEBRIS

% lwd (d>12") 65% Composition: 100% RW

% aquatic vegetation 20 % whitewater 0 % boulders 15%

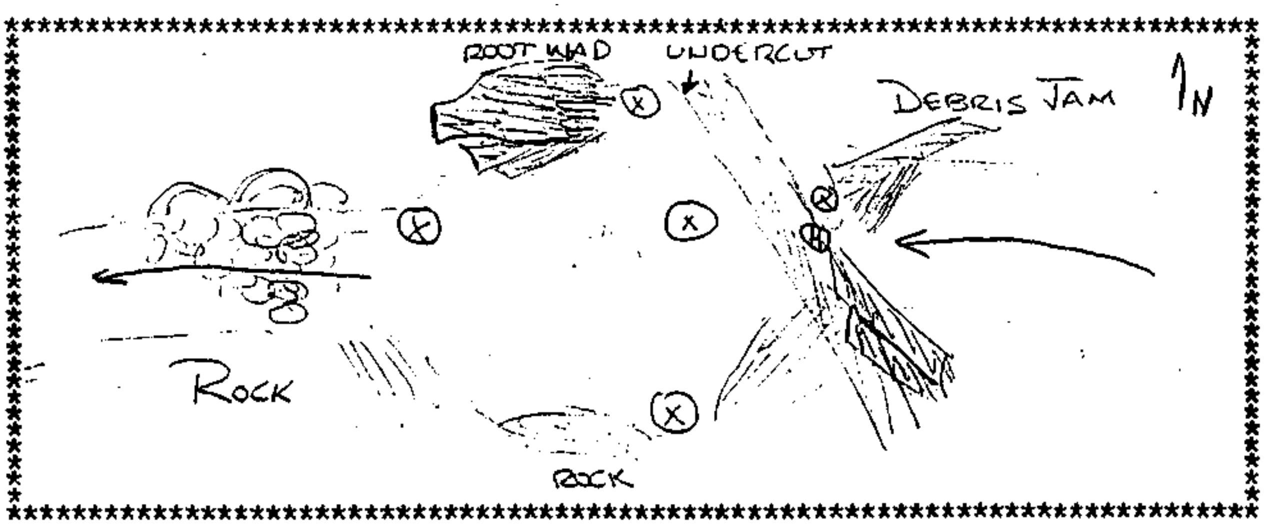
% undercut banks 5 % slope right______ left______ (facing upstream)

General structure & composition of riparian zone LARGE WOODY DEBRIS, GOOD CANOPY ABOVE HOBO; >REDWOOD(<DF) CANOPY

****

Species Observed: yellow legged Frog, FISH

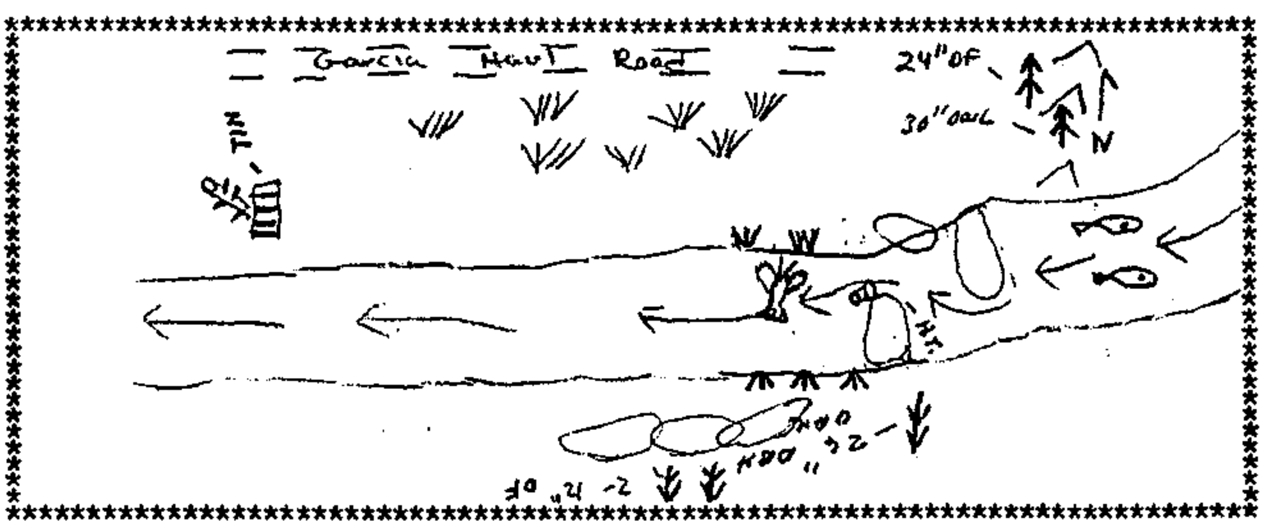
DIAGRAM OF AREA
INDICATE NORTH AND STREAM FLOW



HOBO-TEMP DATA FORM
PROFESSIONAL FORESTRY INCORPORATED * UKIAH, CA

Date 8/3/94 Station# 3 Stream North Fork Garcia @ 1.5 MILE HOLLOWTREE
Purpose Install___ Check___ Remove___
Surveyors Charlotte Morrison - Mike Howell
Legal Location T 12 N R 3 W ____ ____ ____ Sec 12
Quadrangle ORNBAUN VALLEY County MENDO
Hobo-Temp# 6330 Interval setting: 2.4 hours
****
Pool length 29' meters Pool width 14'-8" meters
Pool depth: Left 2" Right 1' Upper 1'-6" Lower 1'-7"
Deepest pool depth: 3' Hobo-Temp depth 2'-5" Time 12:08 PM
% Slope: 5% 65 feet Total canopy: 10 % Deciduous: 90 % Coniferous: 10 %
****
Water temperature: 68°F Water clarity: Clear
Air temperature: 80°F Weather: Clear
% swd (d<12") 6 Composition: ____
% lwd (d>12") 6 Composition: ____
% aquatic vegetation 20 % whitewater 10 % boulders 2
% undercut banks — % slope right 85 left 55 (facing upstream)
General structure & composition of riparian zone SEDGES & RIPARIAN GRASSES; VERY LITTLE LWD OR SHADE CANOPY; SOME YOUNG REPRODUCTION
****
Species Observed: FISH & CRAYFISH

DIAGRAM OF AREA
INDICATE NORTH AND STREAM FLOW



APPENDIX 4

ELECTROFISHING SHEET

Area: MAILLIARD Station: MAIN GARCIA (1.5 MILE HOLLOWTREE)

Date: 9/6/94 % Canopy Closure: 10% LIVE OAK & BAY T 12 R R 3 W Sec 6

Station Length: 50 FT (15M) Ft/M Who: WOOSTER & MORRISON

Air Temp: 80° F Water Temp: 63° F TIME: 1152 HRS.

% Bottom Type VISUAL OBSERVATION

%Silt 5 %Sand 10 %Gravel 10 %Pebble 5 %Bldr 65 %Bdrk —

%Gradient 0 %Area Riffle ___ Pool 100% Run ___

	Width	Cross-sectional Depths Left	Middle	Right
3m	7'	5"	10"	4"
6m	13'	8"	14"	10"
9m	13'	24"	27"	19"
12m	12'	18"	24"	19"
15m	4'	3"	5"	2"
18m				
21m				
24m				
27m				
30m				

SURFACE AREA: 45 M²
AVERAGE WIDTH: 3 M (10')
AVERAGE LENGTH: 15 M (50')

ELECTROSHOCKING TIME: 41 SEC.