92-FR-12 (handwritten: FP)

Project Title: Monitoring of Out-migrant Juvenile Salmonids in Mill, Pine, Supply, and Tish Tang Creeks on the Hoopa Valley Reservation, 1992 through 1995

Hoopa Valley Tribal Department of Fisheries

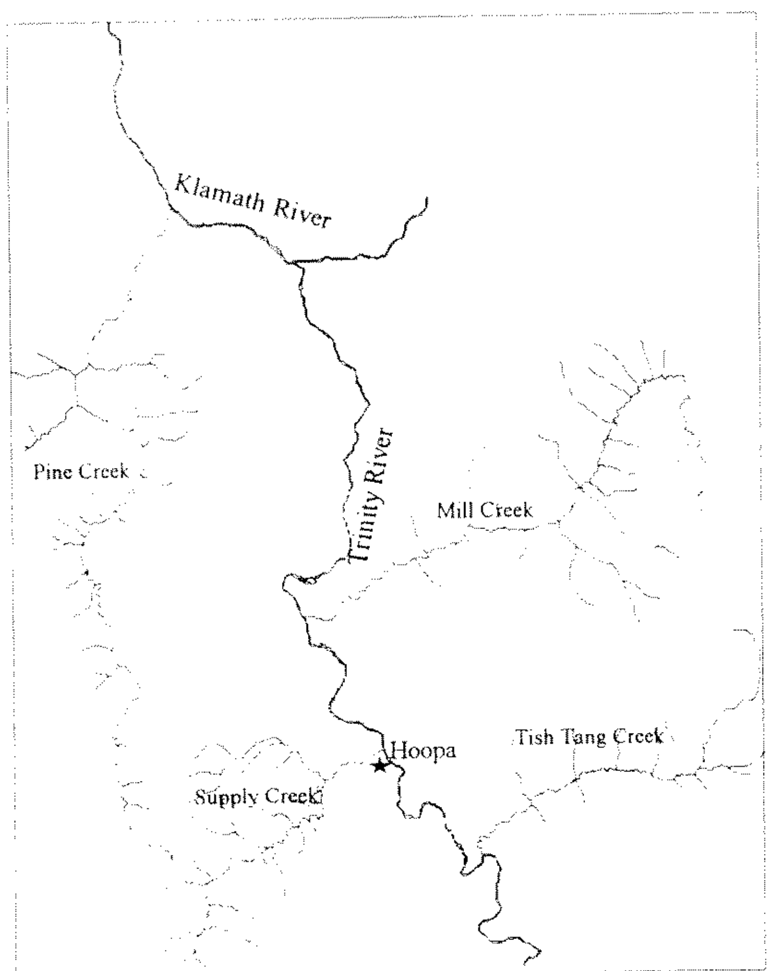
Abstract

Downstream migrating salmonid juveniles were sampled during periods from 1992 through 1995 using fyke nets placed in three tributaries of the Trinity River (Mill Creek, Supply Creek, and Tish-Tang Creek) and one tributary of the Klamath River (Pine Creek) on the Hoopa Valley Tribal Reservation. The study produced measures of relative abundance, timing of downstream migration, and growth of downstream migrant chinook salmon, coho salmon, age 0+ steelhead, and age 1+ and 2+ steelhead. Mill Creek, Tish-Tang Creek, Supply Creek, and Pine Creek produced 42%, 27%, 23%, and 8% respectively, of the total estimated number of juvenile salmonid out-migrants from all streams. Outmigrant abundance pooled across species and streams was greatest in 1992 and smallest in 1995. Relative abundance of the three salmonid species varied between streams. Chinook made up an average of 75 percent of all downstream migrants (range 43% to 95%) in all streams. Coho made up an average of 1 percent of all downstream migrants (range .22% to 1.6%) in all streams. Steelhead made up an average of 24 percent of all downstream migrants (range 4% to 57%) in all streams and peak years of abundance varied between streams and age groups. Timing of out-migration of juvenile salmonids varied greatly between years, streams, and species. Peaks in chinook and coho out-migration occurred mostly between the 15th and 30th week of the year. Timing of out-migration of steelhead was distinctly later in each season for age 0+ juveniles than for age 1+ and 2+ juveniles. Increases in average length through each trapping season were observed for all species groups. Steelhead showed distinct bi-modal length-frequency patterns. Significant proportions of seasonal out-migration occurred in weeks with mean temperatures ranging from 49 degrees to 65 degrees F. Very little occurred in weeks when mean temperatures were lower than 49 degrees F.

92-PR-12 FP

Monitoring of Out-migrant Juvenile Salmonids in Mill, Pine, Supply, and Tish Tang Creeks on the Hoopa Valley Reservation, 1992 through 1995

Hoopa Valley Tribal Department of Fisheries



April 1997

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Downstream migrating salmonid juveniles were sampled during periods from 1992 through 1995 using fyke nets placed in three tributaries of the Trinity River (Mill Creek, Supply Creek, and Tish- Tang Creek) and one tributary of the Klamath River (Pine Creek) on the Hoopa Valley Tribal Reservation. The study produced measures of relative abundance, timing of downstream migration, and growth of downstream migrant chinook salmon, coho salmon, age 0+ steelhead, and age 1+ and 2+ steelhead. Mill Creek, Tish-Tang Creek, Supply Creek, and Pine Creek produced 42%, 27%, 23%, and 8%, respectively, of the total estimated number of juvenile salmonid out-migrants from all streams. Outmigrant abundance pooled across species and streams was greatest in 1992 and smallest in 1995. Relative abundance of the three salmonid species varied between streams. Chinook made up an average of 75 percent of all downstream migrants (range 43% to 95%) in all streams. Coho made up an average of 1 percent of all downstream migrants (range .22% to 1.6%) in all streams. Steelhead made up an average of 24 percent of all downstream migrants (range 4% to 57%) in all streams and peak years of abundance varied between streams and age groups. Timing of out-migration of juvenile salmonids varied greatly between years, streams, and species. Peaks in chinook and coho out-migration occurred mostly between the 15th and 30th week of the year. Timing of out-migration of steelhead was distinctly later in each season for age 0+ juveniles than for age 1+ and 2+ juveniles. Increases in average length through each trapping season were observed for all species groups. Steelhead showed distinct bi-modal length-frequency patterns. Significant proportions of seasonal out-migration occurred in weeks with mean temperatures ranging from 49° to 65° F. Very little occurred in weeks when mean temperatures were lower than 49° F.

Introduction

This report documents monitoring of downstream migrant juvenile fish during the years 1992 through 1995 in Mill, Supply, and Tish Tang Creeks (Trinity River tributaries) and Pine Creek (a Klamath River tributary) on the Hoopa Valley Reservation. The study produced measures of relative abundance, timing of downstream migration, and growth of downstream migrant chinook salmon, coho salmon, age 0+ steelhead, and age 1+ or 2+ (resident juvenile) steelhead in the four streams during the study years. Reptiles, amphibians, and non-salmonid fish sampled in the study are not discussed in this paper.

Methods

Sampling methods were developed in during years 1991 and 1992. We tested pipe traps but found they did not sample adequate stream volume. A rotary screw trap was used in 1992 but was replaced by fyke nets, which were easier to maintain and gave more consistent results. The fyke net was adopted as the most reliable sampling device for use in all streams. We carried out mark and recapture experiments with downstream migrant fish, however, we were unable to develop repeatable capture efficiency calibration constants. Therefore, estimates of downstream migrant fish are based on proportion of total stream flow and time sampled.

We monitored downstream migrant juvenile salmonids in four study streams (Figure 1). Sampling commenced in late February and continued through August. One or two fyke traps were placed in each stream each year. Traps were located no more than one-half mile upstream from the confluences of Mill, Supply, and Tish Tang Creeks with the Trinity River and from the confluence of Pine Creek with the Klamath River. As weather permitted, traps operated on a four-day-per-week schedule. All fish were removed from traps daily, classified by species, and enumerated. Fork length (nearest mm) was recorded for juvenile chinook, coho, and steelhead. Fish were released downstream from respective trap sites after processing.

Fyke net sampling was limited by high stream flows. During high flows, fyke traps were removed from the stream or moved to portions of the stream channel with lower velocity.

Estimates of stream discharge and stream volume passing through the traps were important for development of indices of out-migration. Staff gauges were installed near each fyke net. Gauge height (water depth) and water temperature was recorded on trapping days. Several (5 to 15) times each season, stream discharge and discharge through each fyke net were measured with a digital (Marsh-McBurney © model 'Flow-Mate') flow meter. The relationship of discharge to gauge height for each fyke net and each stream in each year was calculated by regression using natural-log transformed values (Figures 2 and 3). Estimates of stream discharge and discharge through the fyke net were then calculated for the days for which only staff gauge data existed. Small gaps in the series of staff gauge data were filled by interpolation between adjacent data. However, some larger gaps were beyond the range of existing data. These gaps were filled by calculating regressions of staff gauge measurements on flows (cfs) present in the Trinity River during the same periods (differences between flows at Hoopa and Burnt Ranch, to emphasize run-off in the Hoopa area). Flow data from the Trinity River were therefore used to calculate missing staff gauge data for the four Trinity River Tributaries.

The number of each juvenile salmonid species moving downstream was calculated using the following formula:

$$\textit{Total number of downstream migrants (by species)} = \frac{\textit{Number of fish caught x Estimated total flow}}{\textit{Proportion of flow through trap}}$$

The estimated daily total number of downstream migrants in a stream was calculated separately for each trap and then summed across all traps for the week. This number was expanded proportionally from the total hours operation of all traps up to 168 (7 x 24) total hours in the week. Estimates of weekly numbers of juvenile migrants of all species were used to create graphs showing changes in numbers of fish moving downstream at each study site.

Measurements of fish lengths by species were used to develop length-frequency histograms. From these data we were able to compare numbers of each age-class of migrating fish through time, both within and among streams.

Results

Downstream Migrant Juvenile Salmonids

Estimates of numbers of downstream migrants of the four salmonid groups in all streams are shown in Figure 4. Figures 5, 6, 7, and 8 show multi-year plots of cumulative weekly numbers of downstream migrant juvenile chinook, coho, age 0+ steelhead, and age 1+ and age 2+ (resident) steelhead for each stream.

Juvenile Chinook Numbers

In all streams except Tish Tang Creek, we estimated greater numbers of out-migrant juvenile chinook in 1992 than in 1993, 1994, or 1995 (Figure 4). The greatest estimated number of out-migrant juvenile chinook in Tish Tang Creek (18,700) was in 1993. In most streams, the minimum or near-minimum number of estimated downstream juvenile chinook migrants occurred in 1995. The minimum estimate for juvenile chinook in Pine Creek (220) occurred in 1994 (Figure 4). The minimum estimated annual numbers of juvenile chinook for Mill, Pine, Supply, and Tish Tang Creeks were 5.1%, 4.1%, 1.6%, and 23.5%, respectively, of the numbers estimated for the peak year in the same streams. The difference between peak year and other years was most extreme for Pine Creek, where the second and third ranked years were only 8.8% and 5.4% of the maximum. Otherwise, estimated juvenile chinook migrant numbers for the second and third ranked years were 82% and 68%, 49% and 25% , and, 51% and 39% of that for the maximum year for Mill, Supply, and Tish Tang creeks, respectively.

Timing of Juvenile Chinook Out-Migration

Timing of out-migration of juvenile chinook varied between years and streams (Figure 5). In 1992, early out-migration occurred in Pine Creek and Supply Creek, when observed numbers of juvenile chinook out-migrants increased rapidly beginning in week 12. 1992 out-migration was mostly over by week 18 in Supply Creek (Figures 5b, 5c). However, in most years and streams, peak juvenile chinook out-migration occurred later and was more protracted. Pine Creek 1992 peak out-migration lasted until week 22 (Figure 5b). Peak out-migration in Mill Creek occurred between weeks 18 and 25 in 1992, 1993, and

1994 (Figure 5a). Juvenile chinook out-migration in Tish Tang Creek began about week 16 in most years. Several peaks of migration in Tish Tang Creek occurred, lasting until as late as week 30 (Figure 5d). Minor peaks in migration occurred in several streams and years as late as week 31. Length-frequency graphs (Figure 13) also illustrate out-migration of different size categories of juvenile chinook.

Juvenile Coho Numbers

Coho salmon juveniles were much less abundant than chinook juveniles in all streams. The estimated number of coho averaged only 1.4% of the corresponding number of chinook for each year and stream (Figures 4a, 4b). Juvenile coho were trapped in all streams. Estimated total juvenile migrant coho numbers were lower in all streams in 1995 than in 1992 (Figure 6). The highest numbers of juvenile coho migrants in Supply Creek and Tish Tang Creek occurred in 1994 and 1993, respectively (Figures 6c, 6d). The highest 1995 juvenile migrant coho count in all streams was in Mill Creek, when the estimated total for juvenile coho migrants in 1995 was 66% of that for 1992 (Figure 6a). No juvenile migrant coho were trapped in Pine and Tish Tang creeks in 1995. The highest overall annual numbers of juvenile coho were observed in Mill Creek. The lowest were in Pine Creek.

Timing of Juvenile Coho Out-Migration

Captures of downstream migrant juvenile coho were rare and sporadic. Therefore, patterns of downstream migration cannot be characterized for individual streams. Generally, captures occurred between week 12 and week 32, with the highest peaks occurring after week 20. Relatively large peaks of out-migration occurred as late as week 32 in some streams and years (Figure 6). Figure 15 shows length-frequency of juvenile coho salmon trapped in Mill Creek during 1992. Maximum numbers of out-migrant coho were trapped in the month of May (weeks 17 - 20).

Juvenile Steelhead

Downstream migrant steelhead juveniles were classified either as young-of-the-year (age 0+) or older (age 1+ or 2+), based on length. Age-class upper size limits were derived from analysis of length frequency data. The upper size limit for age 0+ steelhead varied from 35 mm before April to 100 mm in September. The upper size limit for age 1+ steelhead began at 130 mm before April, and increased to 210 mm in September. Occurrence of juvenile steelhead larger than the age 1+ upper limit was rare and sporadic. Juvenile steelhead of the larger classes are referred to here as 'residents' because of their delayed age of migration. Within any stream and year, estimated numbers of downstream migrant age 0+ steelhead were usually greater than corresponding combined numbers for age 1+ and 2+ (resident) juvenile steelhead (Figure 4). Across all streams and years, the ratio of estimated annual age 0+ steelhead migrants to resident juvenile steelhead migrants ranged from .90 to 3.1, and averaged 2.3.

Juvenile Steelhead Numbers

Juvenile steelhead were proportionately less abundant than juvenile chinook in most streams and years of the study (32% on average). The greatest (peak) estimated number of combined age 0+ and resident juvenile steelhead out-migrants in any stream and year was about 9000. The average was approximately 2900. The greatest number of age 0+ downstream migrant juvenile steelhead occurred during 1992 in two of the four streams (Figure 4c). Also, the greatest number of resident juveniles occurred during 1992 in three of the four streams (Figure 4d). 1993 was the peak year for age 0+ steelhead juvenile migrants in two of the four streams. In only one stream was 1992 the peak year for both age 0+ and resident downstream migrant juvenile steelhead (Figures 4c, 4d). Within streams, the ratio of the smallest estimated annual total of age 0+ juvenile downstream migrant steelhead to the largest estimated annual total ranged from 4.8% to 24%, averaging 18%. For resident juvenile steelhead the corresponding range was from 3.6% to 28%, averaging 9.4%.

Timing of Steelhead Out-migration

Graphs of cumulative annual downstream migrants (Figures 7, 8) and length-frequency graphs demonstrate that the pattern of out-migration differs markedly between the two size categories of juvenile steelhead. Length-frequency graphs for Mill Creek 1992 are presented for illustration (Figure 14). The general pattern of juvenile steelhead out-migration, as inferred from length-frequency data, may be stated as follows. In March, a number of juvenile steelhead appear (are trapped) which have lengths of about 60 mm - 100 mm.

A scattering of juvenile steelhead with lengths up to 200 mm are also present. By the end of May, the modal length of the smaller of these two size-groups of fish appears to have increased, and the numbers of both have declined sharply. In May, a number of juvenile steelhead with lengths from 20 mm to 40 mm is seen. The total number and modal length of this group increases through most of the summer. Smaller numbers of distinctly larger fish may or may not be present. Numbers of all categories decline toward the end of the season. This general pattern suggests that many of the larger, older juvenile steelhead, which must have been produced by spawning one or more years before, migrate out of the stream early in the season. After that, numbers of smaller juveniles, which must be young-of-the-year, migrate out of the stream. Timing and magnitude of the pattern, as well as relative abundance of the different size categories of juvenile steelhead, differ between streams and years. It is possible to infer the approximate age of at least the smaller category of juvenile steelhead.

Figure 7 shows inter-annual comparisons of timing of out-migration and cumulative estimated numbers of age 0+ steelhead out-migrants in Mill Creek, Pine Creek, Supply Creek, and Tish Tang Creek. Timing of out-migration varied considerably between streams and years. In Mill Creek, increased out-migration in most years began between weeks 18 and 21, and lasted through week 28. Mill Creek out-migration in 1993 was later, lasting through week 35 (Figure 7a). Timing of out-migration of age 0+ steelhead in Pine Creek was more variable than that of Mill Creek. Also, migration during the peak year In Pine Creek was earlier than it was for the peak year in Mill Creek (Figure 7b). Supply Creek also had early or late migration in two years, although the most rapid out-migration in two years occurred in week 20 and week 23, similarly to Mill Creek and Pine Creek (Figure 7c). Age 0+ steelhead out-migration in Tish Tang Creek was much greater and also later in 1993 than in the other years. Relatively small peaks of out-migration occurred in weeks 20 and 26 and earlier in some years (Figure 7d).

Figure 8 shows inter-annual comparisons of cumulative estimated numbers and timing of out-migration of resident steelhead out-migrants in the four study streams. Large differences between out-migration numbers in various streams and years are evident. The greatest numbers of resident juvenile steelhead were observed between weeks 9 and 20 in most streams. In some years, out-migration of resident juvenile steelhead in Tish Tang Creek continued until as late as week 24 (Figure 8d).

Length-at-age data

Enumeration and measurement of all trapped juvenile salmonids during four trapping seasons in four streams produced a large quantity of length data. Length-frequency graphs covering two-week periods were created to track changes in size and abundance of the fish in each stream, species group, and year. Multi-year graphs of bi-weekly mean length of each species in each stream were created to summarize these trends in a very condensed form (Figures 9, 10, 11, and 12). These graphs included only bi-weekly mean lengths derived from at least four measurements, and did not include any measure of dispersion of the measurements. Change in mean length through the season is most evident in the graphs for juvenile chinook (Figure 9) and age 0+ steelhead (Figure 10). Numbers of coho trapped were not adequate to show seasonal change in average length (Figure 12). Data were not sufficient to clearly show growth trends of age 1+ steelhead except for the year 1992 (Figure 11). As examples of dispersion of the length measurements, graphs are included which show length-frequencies for juvenile chinook, steelhead, and coho trapped during 1992 in Mill Creek (Figures 13, 14, and 15). Sample number, mean length, and standard deviation of length are included on each graph. For juvenile steelhead, these statistics are given for both age 0+ juvenile steelhead and resident (age 1+ and 2+) juvenile steelhead. Maximum and minimum length for each group of fish are expected to be about 2 standard deviations above and below the mean length.

Stream Temperature and Out-migration

Pages 1 through 4 of Appendix A show weekly mean temperature (F°) and estimated weekly juvenile out-migrant numbers for chinook, coho, age 0+ steelhead, and age 1+ steelhead in all four streams and years. The graphs show a general trend of rising stream temperatures during the period of out-migration. Appendix A page 5 shows weekly proportion of season total out-migrants graphed against week mean temperature, for juvenile chinook in all streams and years. The graph shows that relatively small proportions of season out-migration of juvenile chinook occurred during weeks with mean temperatures 48 F° and lower. Relatively large proportions of season out-migration occurred in a few weeks with mean temperatures above 48 F°, with the two largest recorded season out-migrant proportion occurring at temperatures of 53° and 49°. In most cases, however, there was no single temperature at which a large proportion of juvenile chinook migrated out of the stream. Occurrences of out-migration of 20% or more of the estimated season total for the stream occurred in weeks with mean water temperatures from 49 F° to 65 F°.

Discussion

Large differences between estimated numbers in peak years for each species group compared to other years indicates that there were high inter-annual variabilities in production of juvenile salmonids in the four streams. In individual streams, years that were peak years for one species were usually not peak years for other species. Forty percent of the total out-migration of all juvenile salmonid out-migrants for all streams and years occurred in 1992. The following years; 1993, 1994, and 1995, produced 29%, 23%, and 7%, respectively, of all juvenile salmonid out-migration during the study period. Comparing total juvenile salmonid out-migration between streams for all years, the ranking from highest to lowest was, Mill, Tish Tang, Supply, and Pine Creeks, with 42%, 27%, 23%, and 8%, respectively, of the grand total number. However, high inter-annual variability within individual streams could change these rankings in the future. Individual species groups had much higher inter-annual variability.

Overall proportional abundance of juveniles of the three salmonid species (chinook, coho, and steelhead) was calculated for all streams and years lumped. On average, chinook made up 75% of all downstream migrant juvenile salmonids. Steelhead made up 24% of the grand total, and coho, 1%. These ratios varied between streams. Pine Creek, for example, had a higher average proportion of steelhead (57% of total) than of chinook (43%). In contrast, steelhead juveniles made up only 4% of all salmonid juveniles in Supply Creek, while chinook made up 95%. Coho percentages ranged from .22% of all juvenile salmonids in Mill Creek, up to 1.6% in Tish Tang Creek. Based on species proportions observed during this study, there probably exist long-term differences between the streams in the physical or ecological conditions most affecting each salmonid species. From the standpoint of relative species balance in downstream migrant juvenile numbers, Supply Creek could be characterized as the most chinook dominated stream, Pine Creek as the most steelhead dominated, and Tish Tang Creek as the most coho dominated. Mill Creek, which produced the most juvenile salmonids in the four year study period, had close to the long term species ratios of the entire study (although Mill Creek data was a major determinant of those ratios). Within individual years, these rankings vary.

Species proportions and numbers of juvenile salmonids out-migrants are probably also being affected by chance survival and spawning of adult chinook, coho, and steelhead. If very few adults return to a stream to spawn, then the return of an additional few to a stream may greatly increase the number of juveniles migrating down the stream the following summer. Returns of low numbers of adults to a stream would produce much year-to-year variability of juvenile out-migrants, due to the chancy nature of survival. Characterization of individual streams as better chinook habitat or better coho habitat would then have little meaning. Species proportions could change greatly from year to year. This phenomenon is almost certainly occurring to some degree within the streams being monitored, especially with regard to coho. No coho juveniles were trapped in Pine and Tish Tang creeks in 1995. Fyke nets sample only part of the stream flow, so absence of juvenile coho in the samples does not prove there were no coho out-migrants in those years , but is clear evidence that numbers were very low. This may be more of a cause of concern for coho than for other species. Large variation in juvenile chinook and steelhead out-migrant numbers was also observed. However, lack of chinook or steelhead out-migrants in a stream during a season would not necessarily signify extinction of part of the stock. Variable age of spawning (in chinook and steelhead) and variable age of out-migration (in steelhead) could lead to re-establishment of the missing component of the run in future years. Coho females, on the other hand, spawn only as three-year-olds. Low or absent numbers of juvenile coho downstream migrants during any year in the study streams is therefore a matter of concern.

Stream Temperature and Out-migration

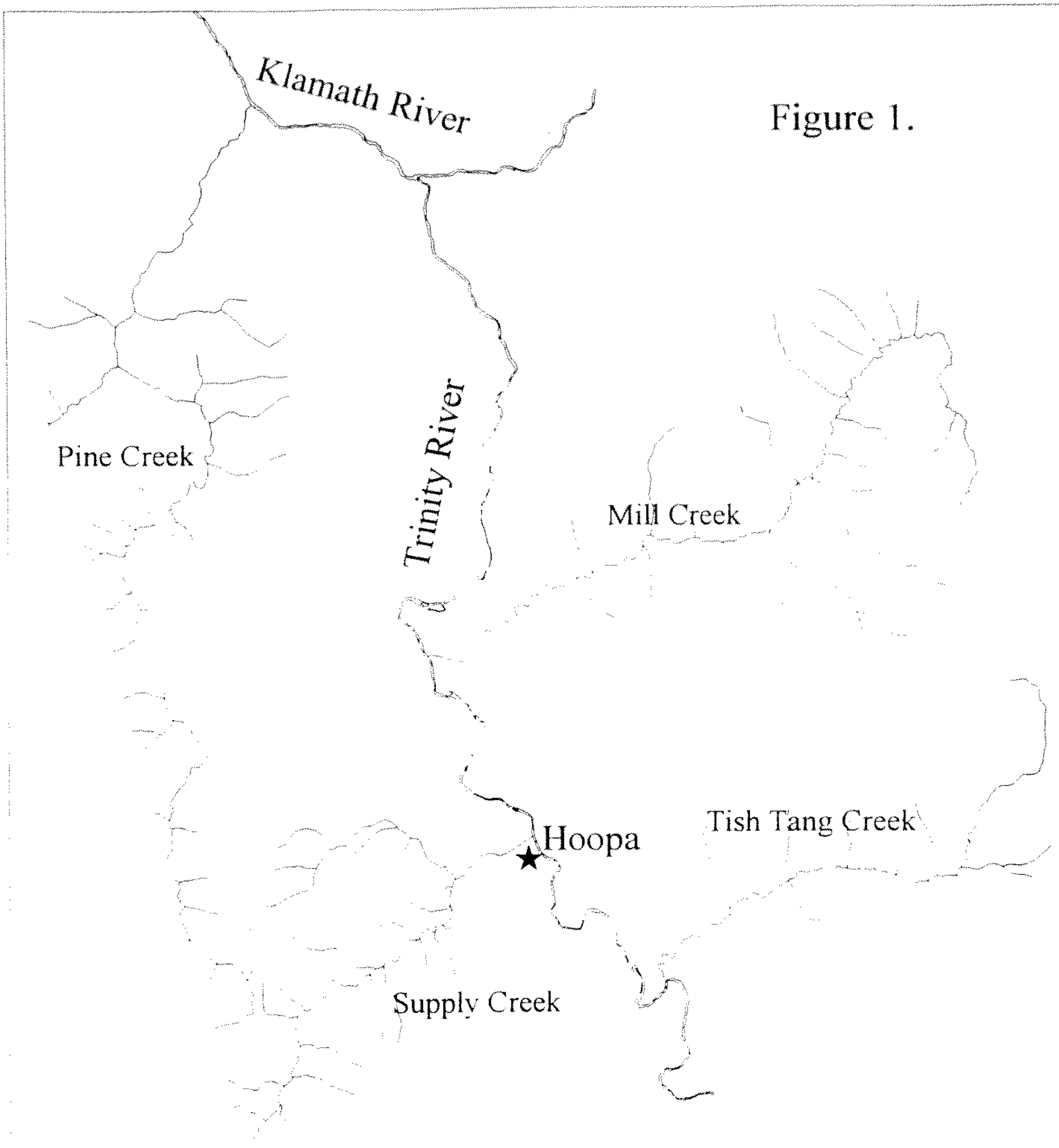
Appendix A page 5 shows that relatively small proportions of season out-migration of juvenile chinook occurred during weeks with mean temperatures below 49 F°, while larger proportions occurred in many weeks with mean temperatures of 49 F° or greater. This suggests that occurrence of water temperatures near 49 F° may have acted as a stimulus for some juvenile chinook to begin out-migration. Sampling of increasingly larger juvenile chinook at higher water temperatures as the season progressed may have resulted partly from the varying lengths of time required by juveniles to migrate down the tributary after occurrence of the critical minimum temperature for migration. However, stream flow levels and juvenile state of maturity may also have influenced timing of juvenile chinook out-migration.

Length Data

Interpretation of length-frequency or mean-length-at-age graphs is not straight-forward. Individual fish presumably are measured only once, and then continue their movement downstream. Measurements obtained at different times are influenced by growth of fish in the stream and by the pattern of out-migration. If timing of out-migration were random for all sizes of juveniles, or if all juveniles were being carried passively with the stream current, then measurements at any specific time might be representative of all fish remaining in the stream. However, age or size may be related to timing of out-migration for some fish. Consider the length-frequency graph for steelhead in Mill Creek during 1992 (Figure 14). Many larger (age 1+ or 2+) steelhead juveniles migrate out of the stream earlier each season than smaller young-of-the year juveniles. Some of the young-of-the-year steelhead remain in the stream for a year or more, and are not measured as part of the age 0+ group. If juveniles always migrated upon attaining a certain size, and never before, then graphs of average length-at-age might be relatively flat, suggesting no growth, because fish would be trapped after they reached the size required to migrate. No such phenomenon has been observed. There appears to be much variation in the lengths at which juvenile salmonids of all species migrate downstream. This suggests that other influences, such as season of the year, water temperature, flow, and genetic differences between individual fish, have an effect on timing of out-migration of juvenile salmonids.

To what extent can mean length-at-age be compared between years or creeks? Because of the wide spread in measurements of a species of juvenile salmonids at any time and location, and possible variation in timing of out-migration between streams and years, mean length-at-age probably cannot be used for comparison of growth of juvenile salmonids between locations.

Length-at-age graphs do suggest that within streams, specific lengths are attained later in some years that others. However, this phenomenon could be associated with possible size-dependent out-migration.



Study Area

Monitoring of Downstream Migrant Juvenile Salmonids
in Mill, Pine, Supply and Tish Tang Creeks
by Hoopa Valley Tribal Department of Fisheries
1992 - 1995

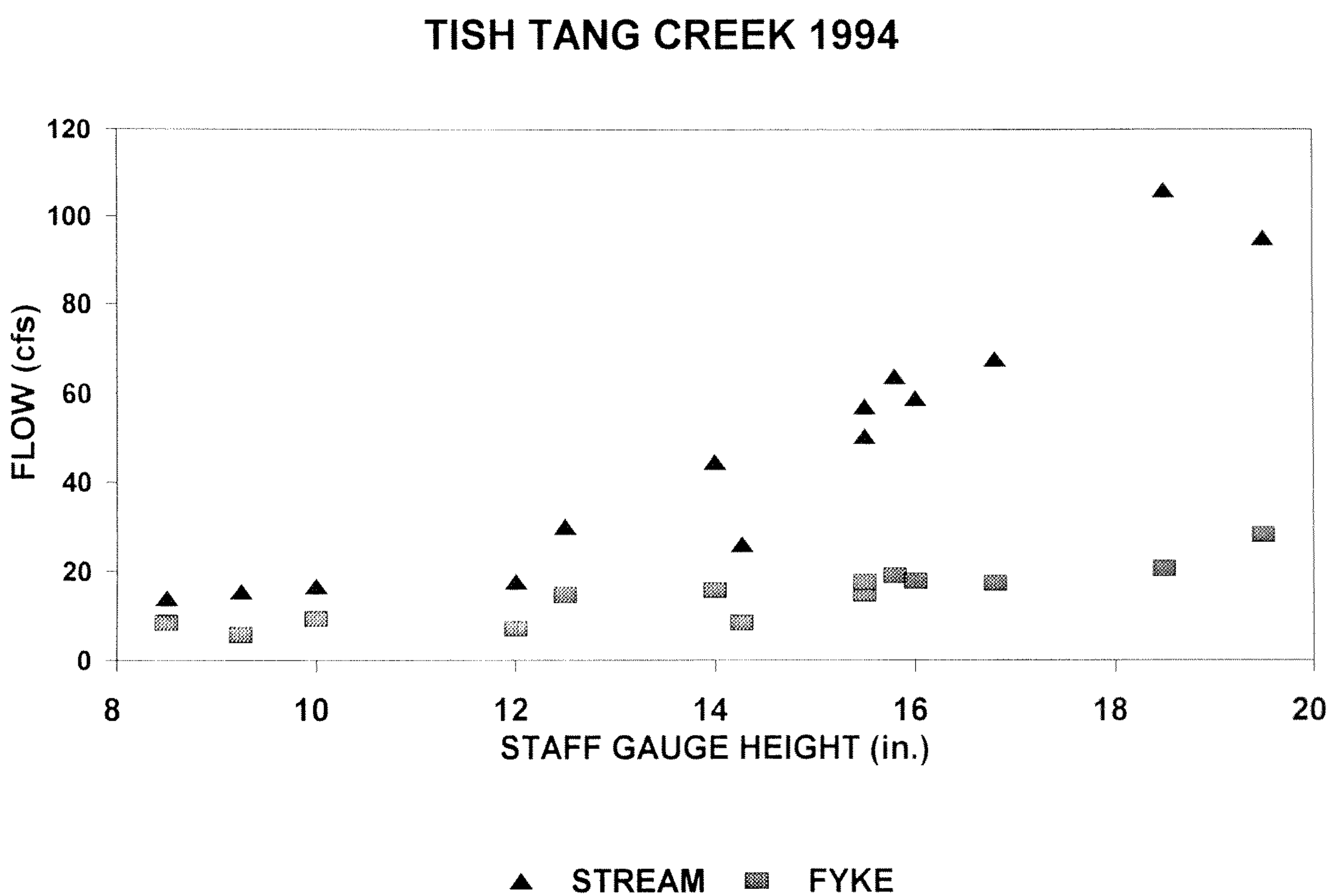


Figure 2. Tish Tang Creek 1994: Relation of staff gauge reading to stream flow and flow through fyke.

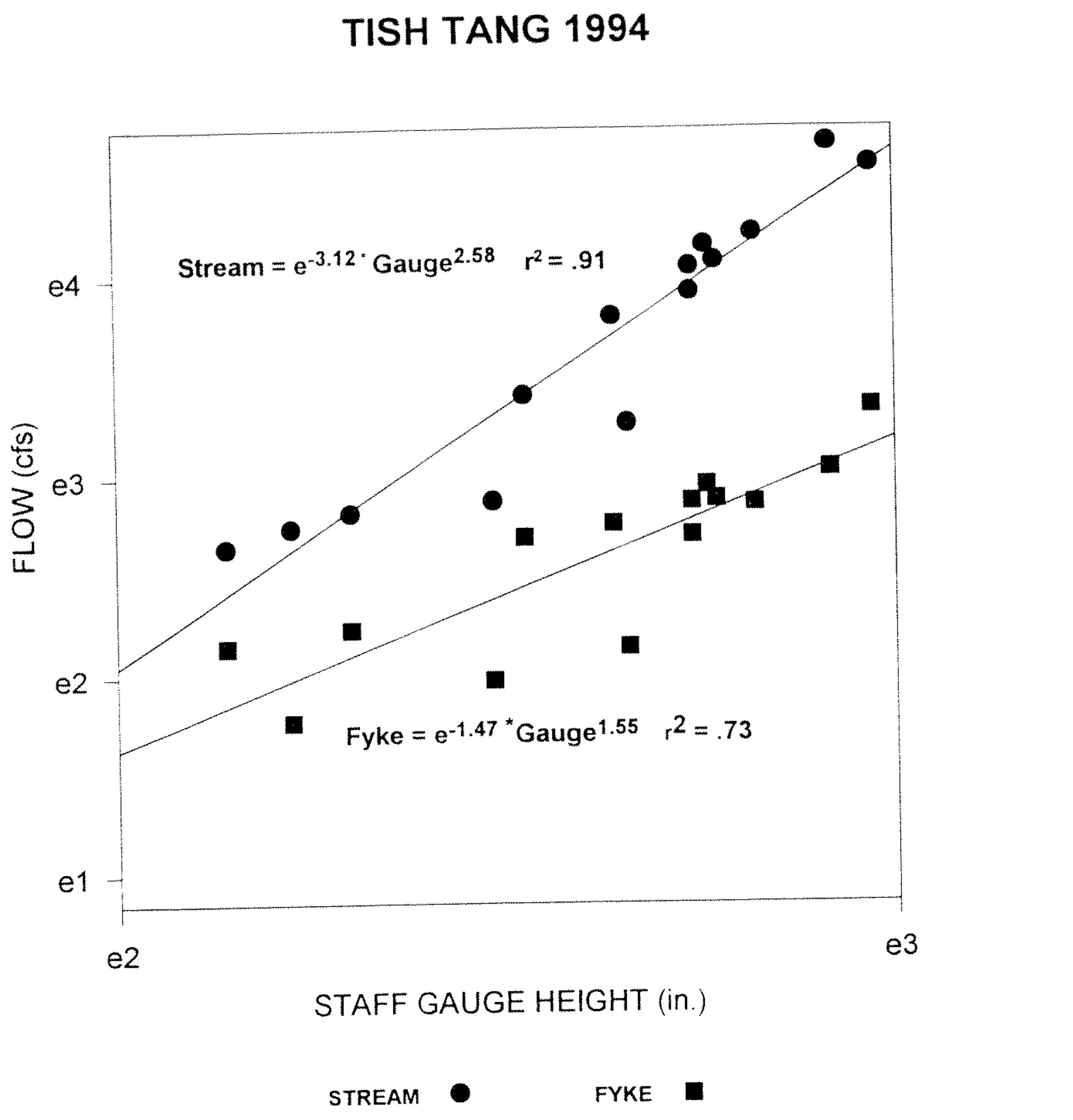


Figure 3. Tish Tang Creek 1994 : Relation of natural-log transformed stream and fyke flows to natural-log transformed staff gauge depth.

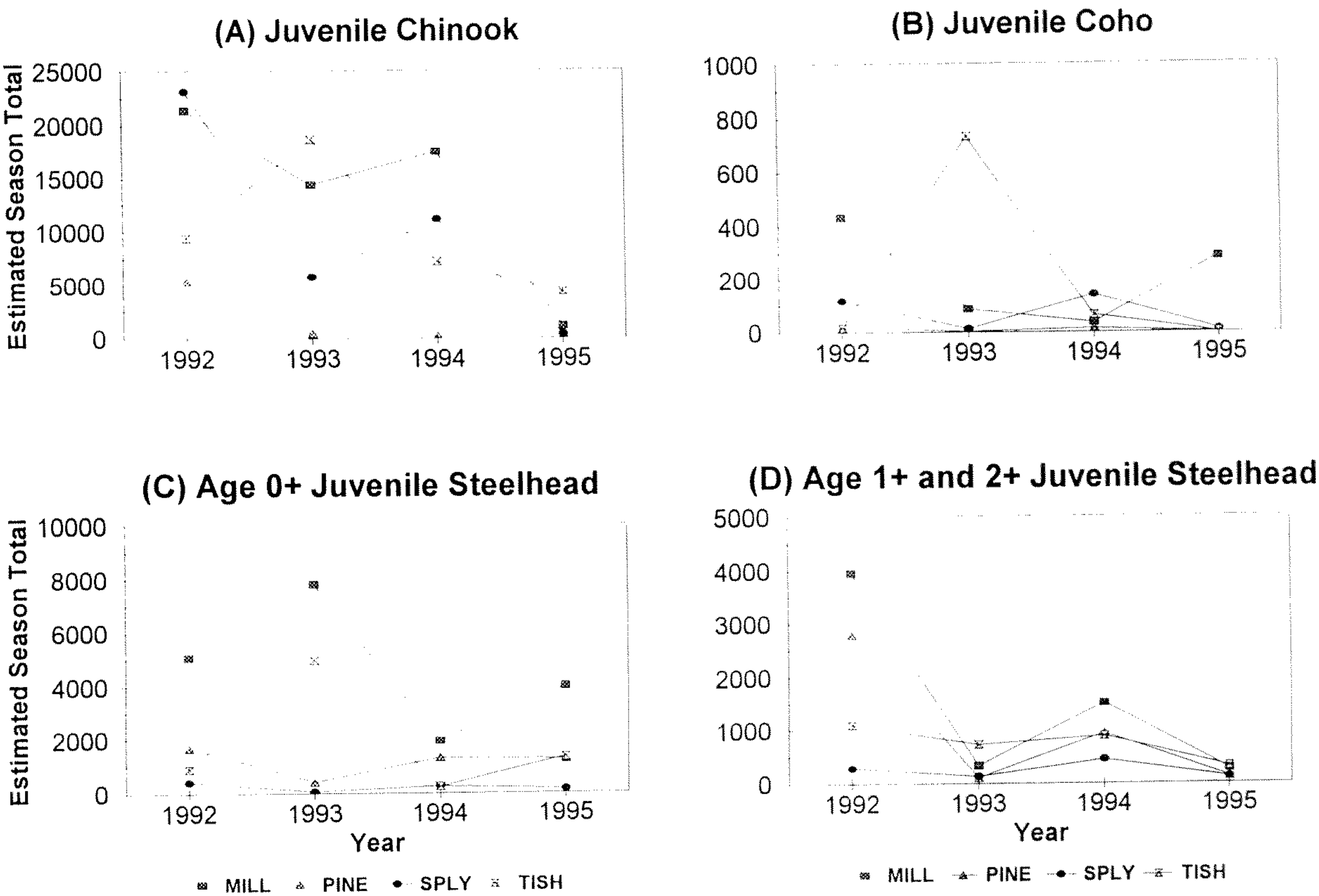


Figure 4. Estimated annual juvenile salmonid downstream migrants, 1992-1995, in Mill, Pine, Supply, and Tish Tang Creeks.

Chinook

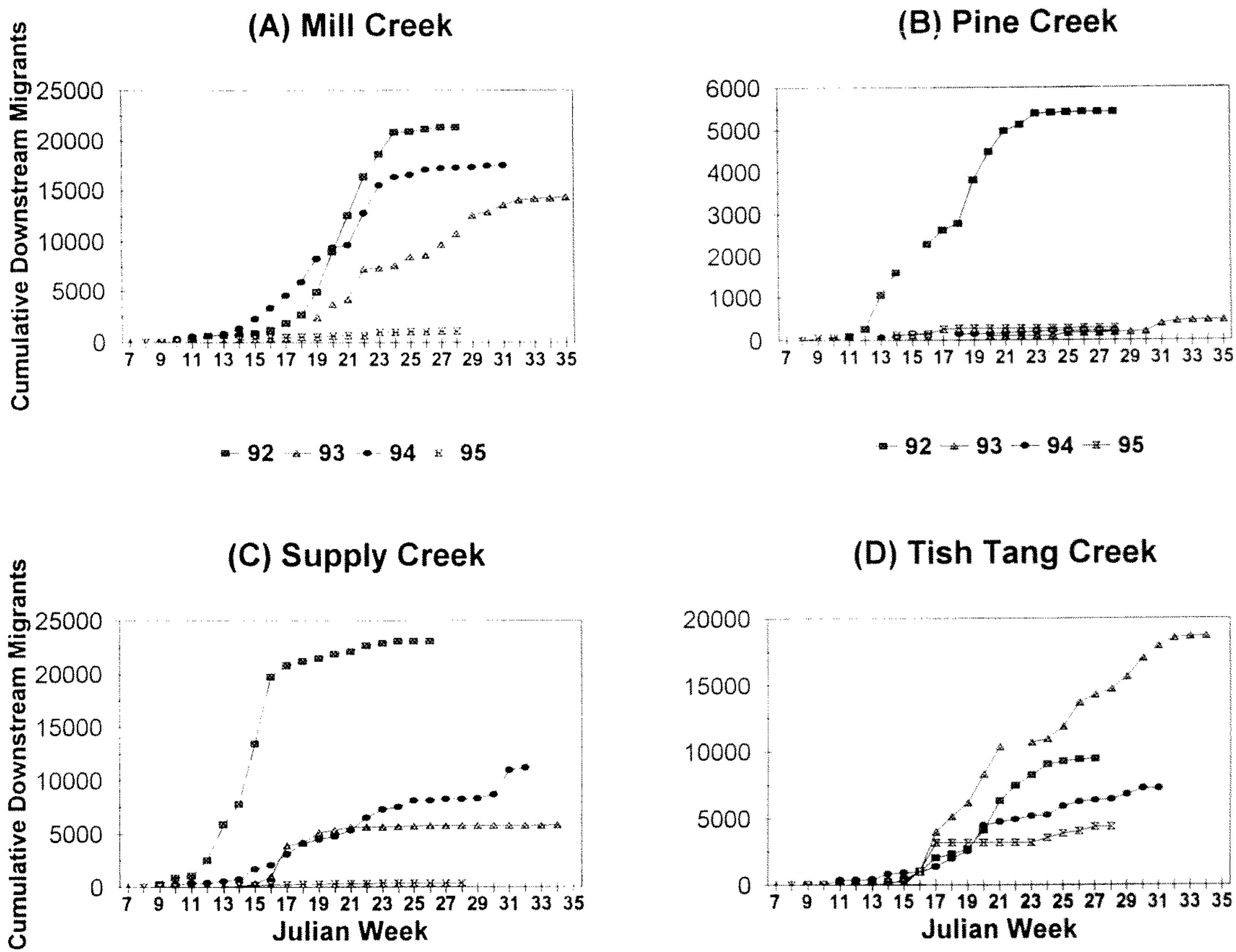


Figure 5. Hoopa Valley Tributaries: Estimated Downstream Migrant Juvenile Chinook 1992 - 1995

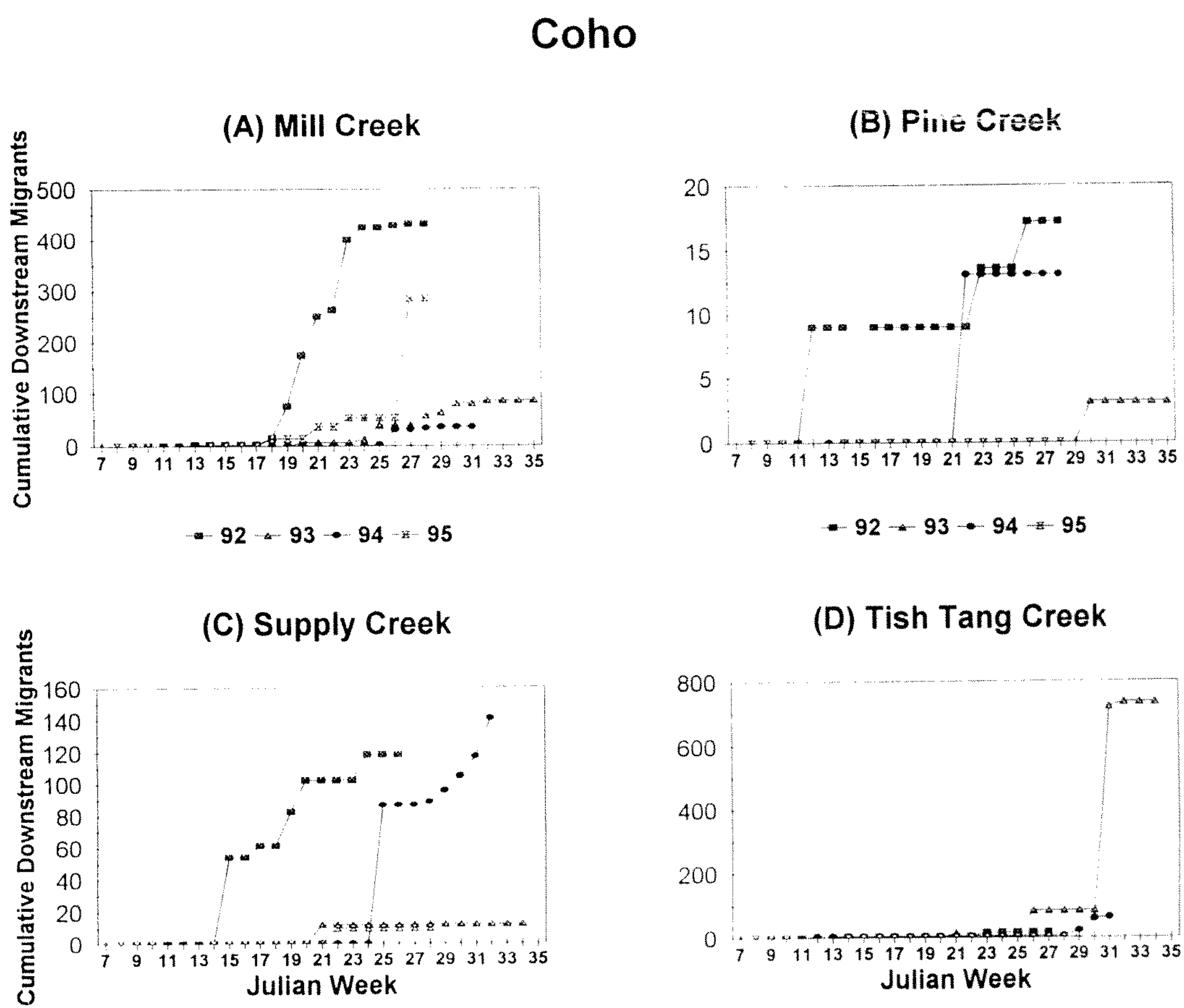


Figure 6. Hoopa Valley Tributaries : Estimated Downstream Migrant Juvenile Coho 1992 - 1995.

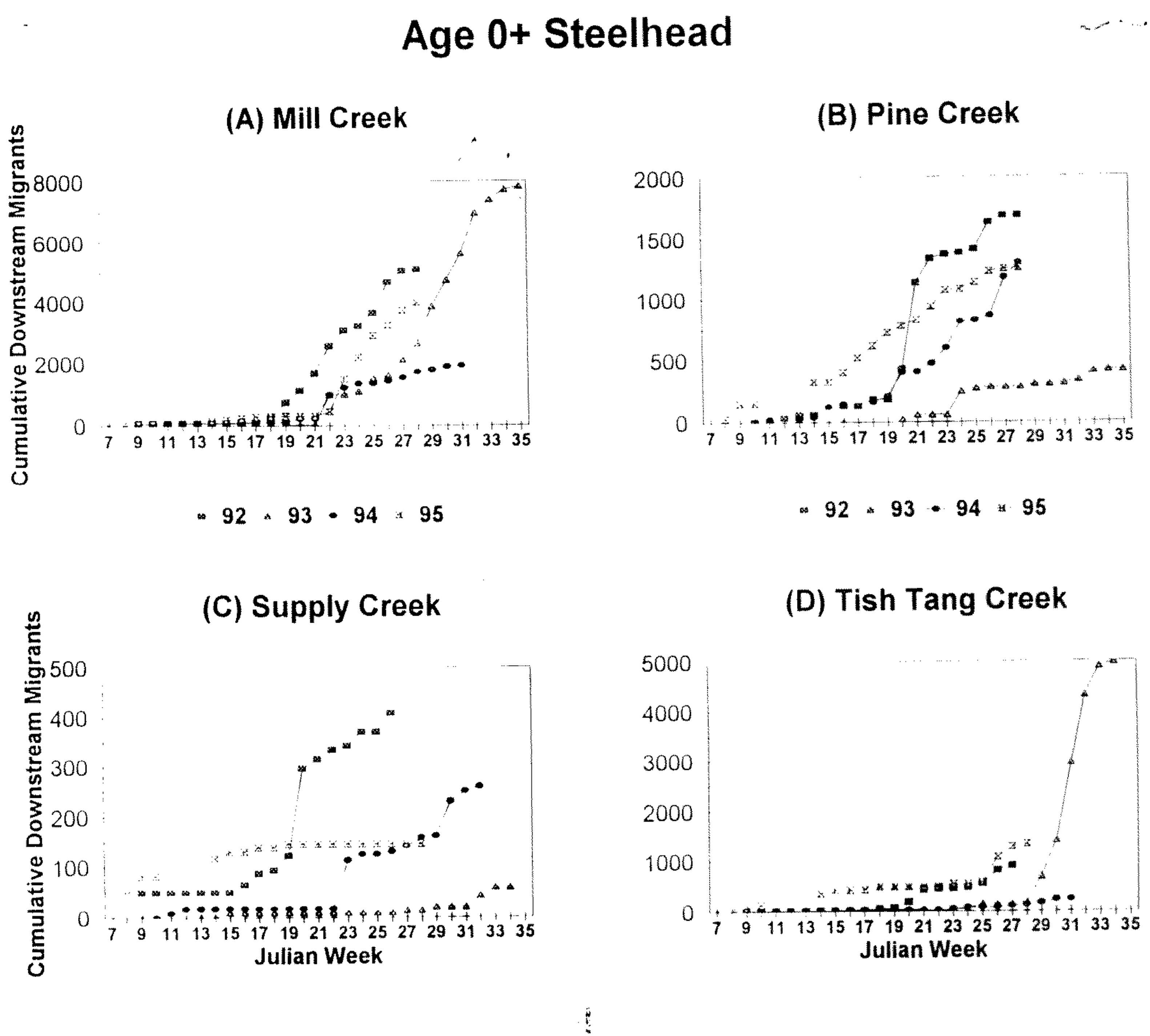


Figure 7 Hoopa Valley Tributaries : Estimated Downstream Migrant Age 0+ Steelhead1992 - 1995.

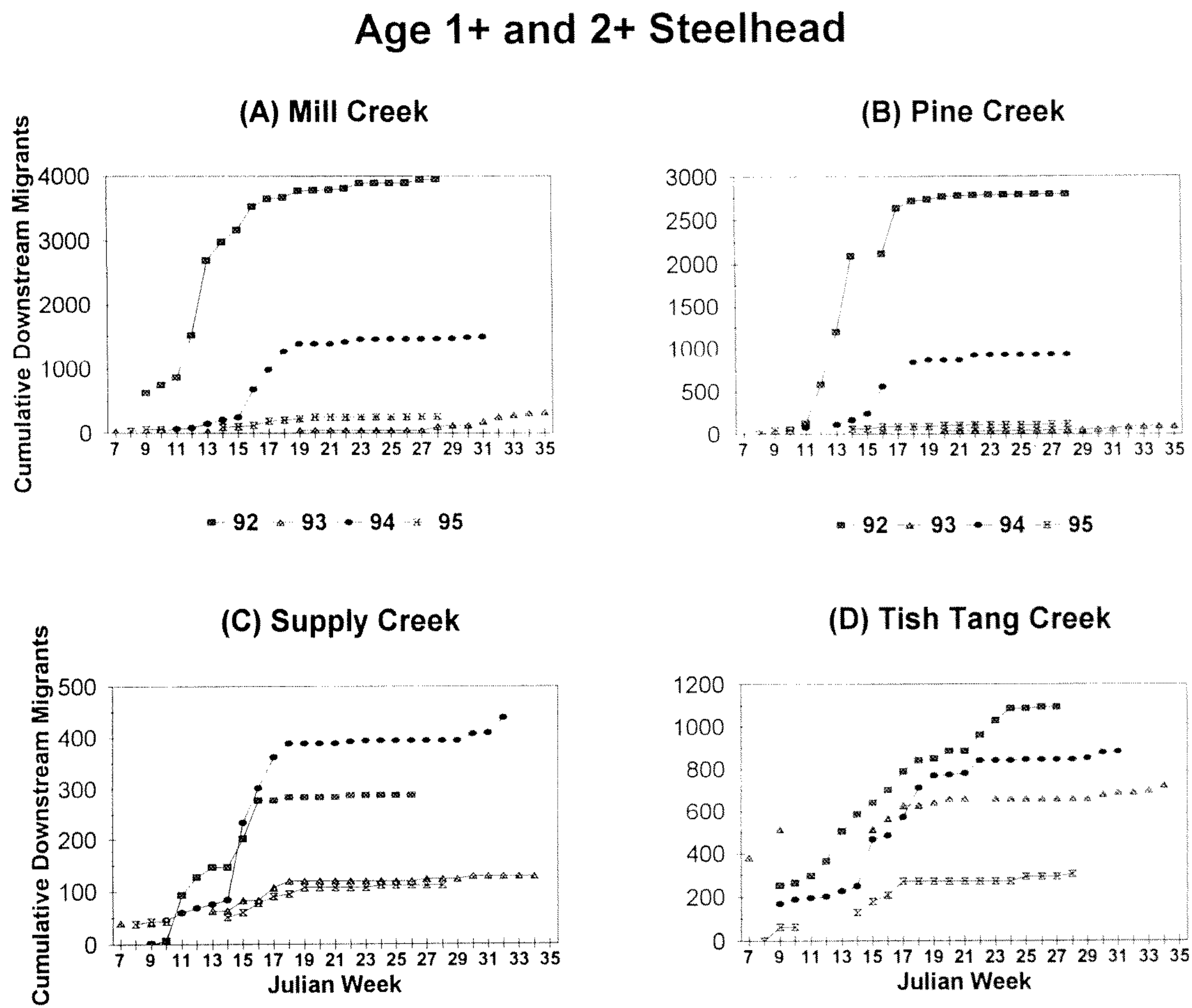


Figure 8. Hoopa Valley Tributaries: Estimated Downstream Migrant Age 1+ and 2+ Steelhead, 1992 - 1995.

Chinook

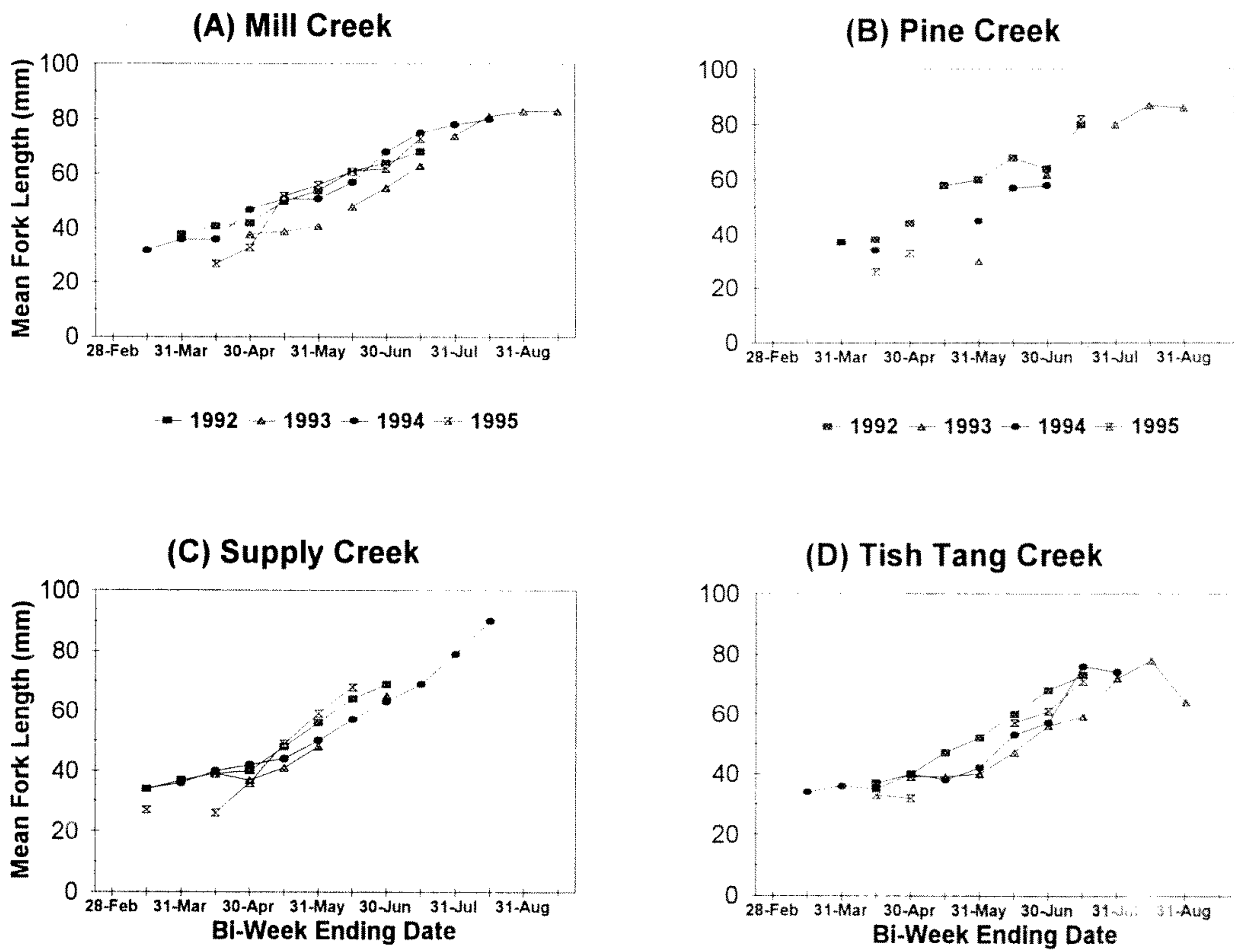


Figure 9. Mean bi-weekly lengths of downstream m[illegible] juvenile chinook in Mill, Pine, Supply and Tish Tang Creeks; 1992-1994.

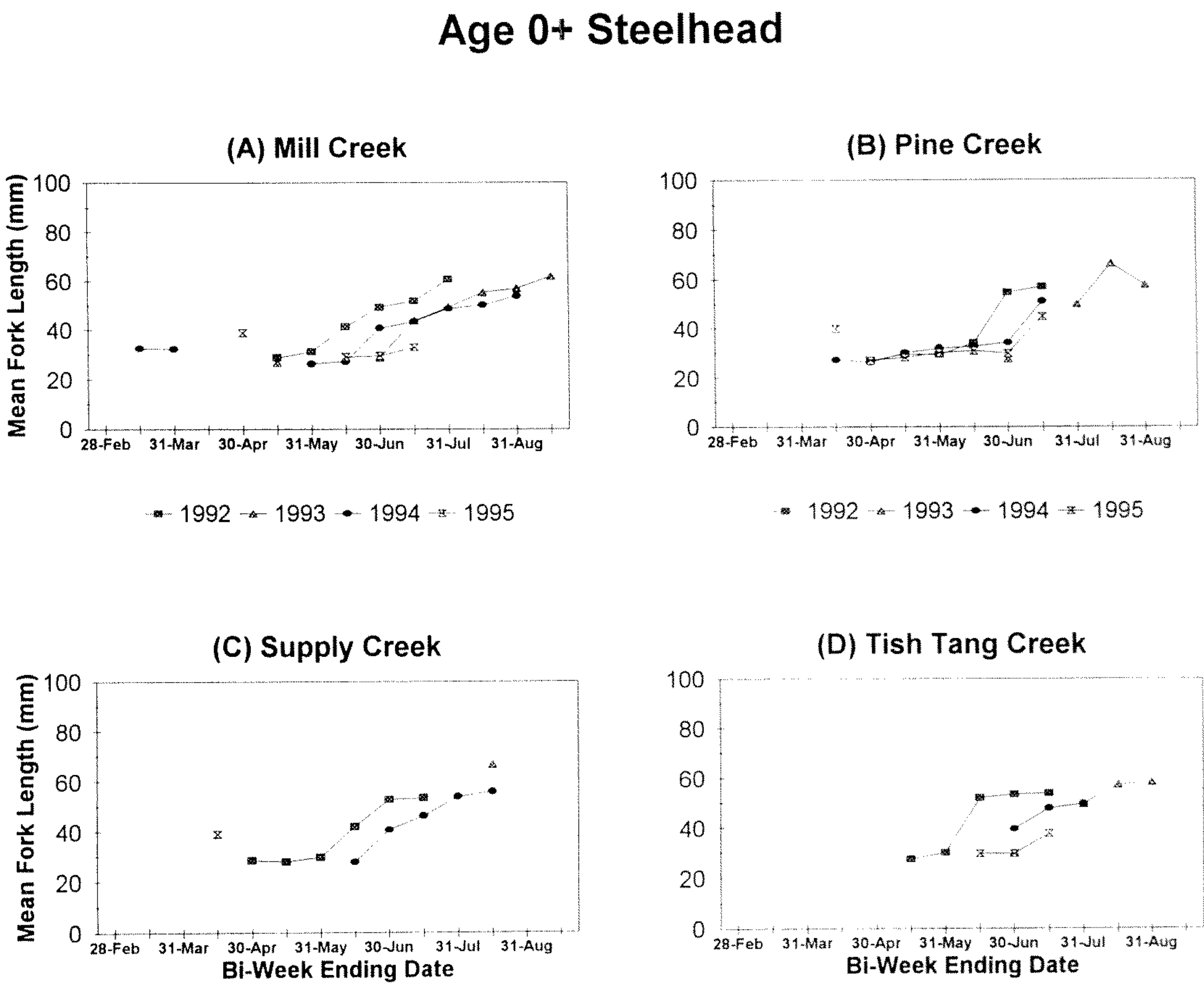


Figure 10. Mean bi-weekly fork-length of age 0+ steelhead in Mill, Pine, Supply, and Tish Tang creeks; 1992 - 1994.

Age 1+ Steelhead

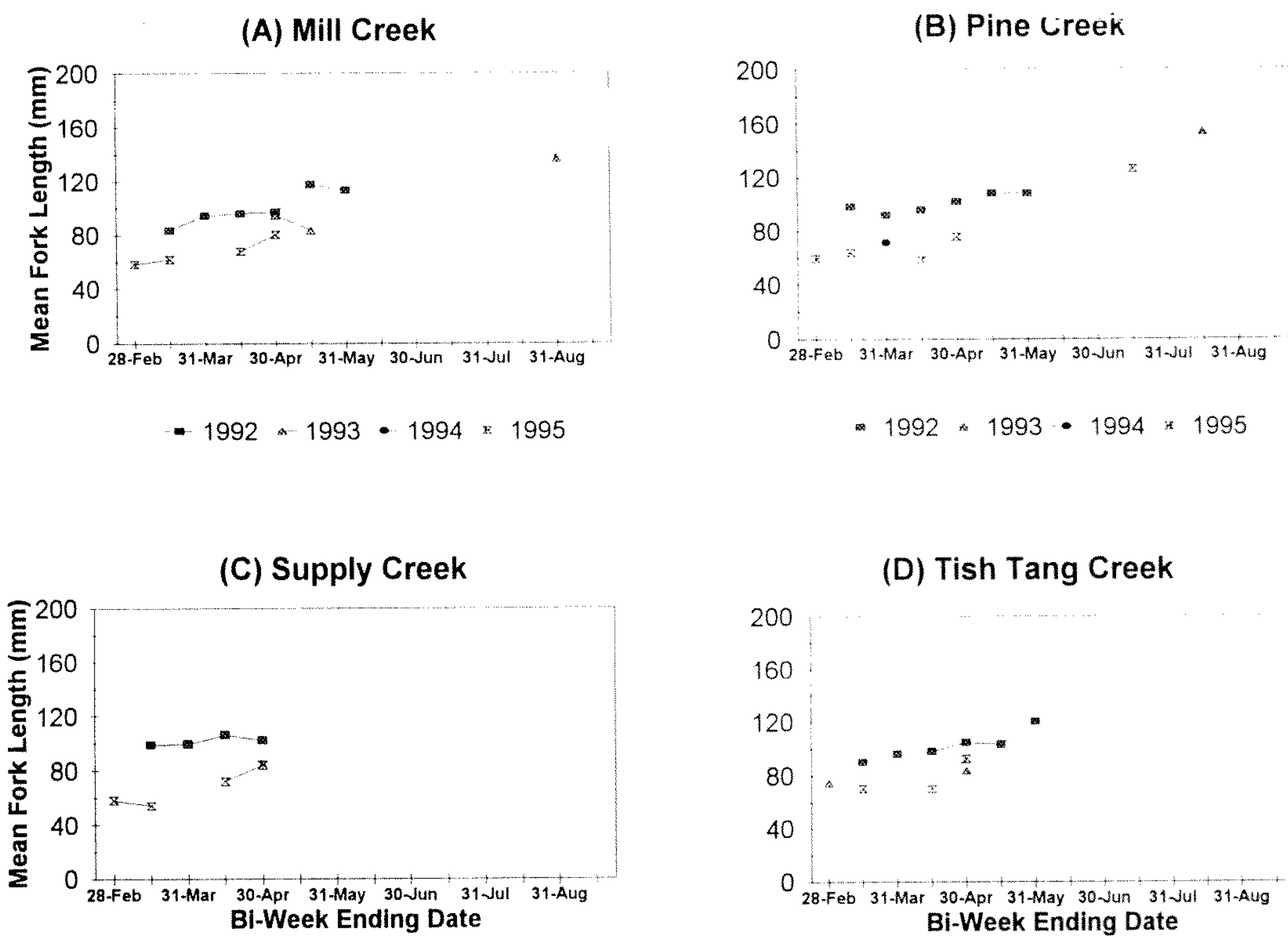


Figure 11. Mean bi-weekly fork-length of age 1+ steelhead in Mill, Pine, Supply, and Tish Tang creeks; 1992 - 1994.

Coho

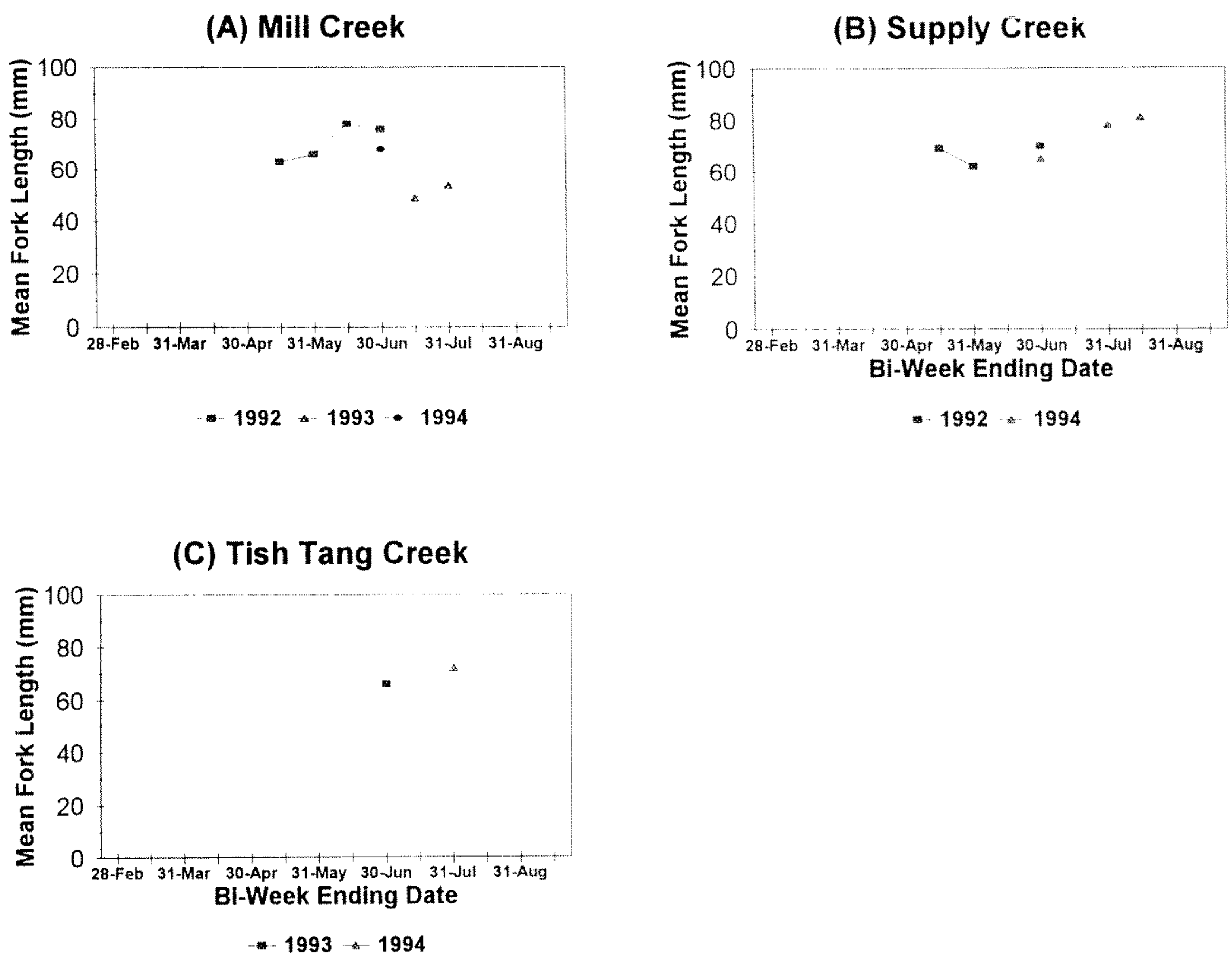


Figure 12. Mean bi-weekly lengths of downstream migrant juvenile coho in Mill, Pine, Supply and Tish Tang Creeks; 1992-1994.

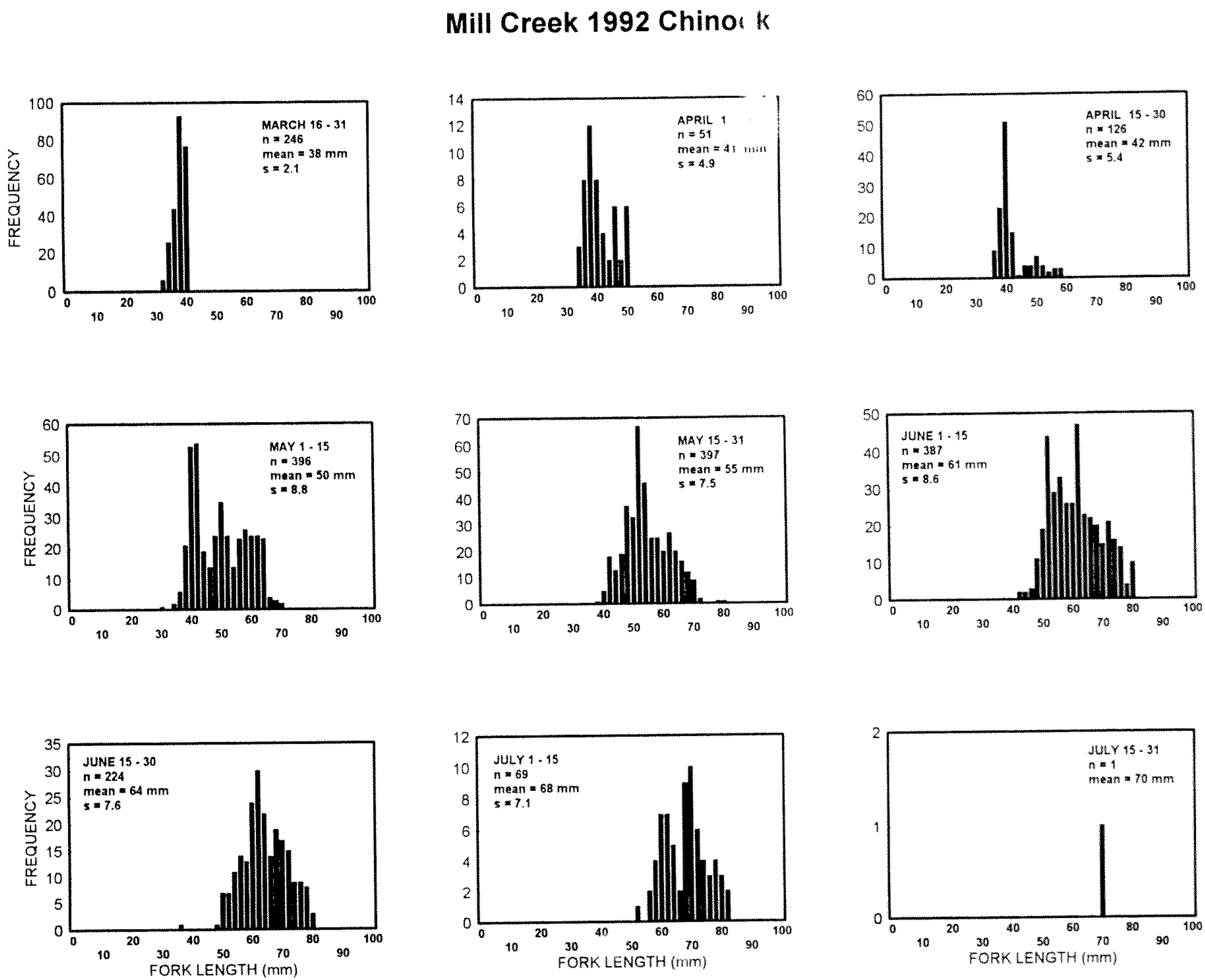


Figure 13. Length-frequency of downstream migrant juvenile chinook in Mill Creek during 1992.

Mill Creek 1992 Steelhead

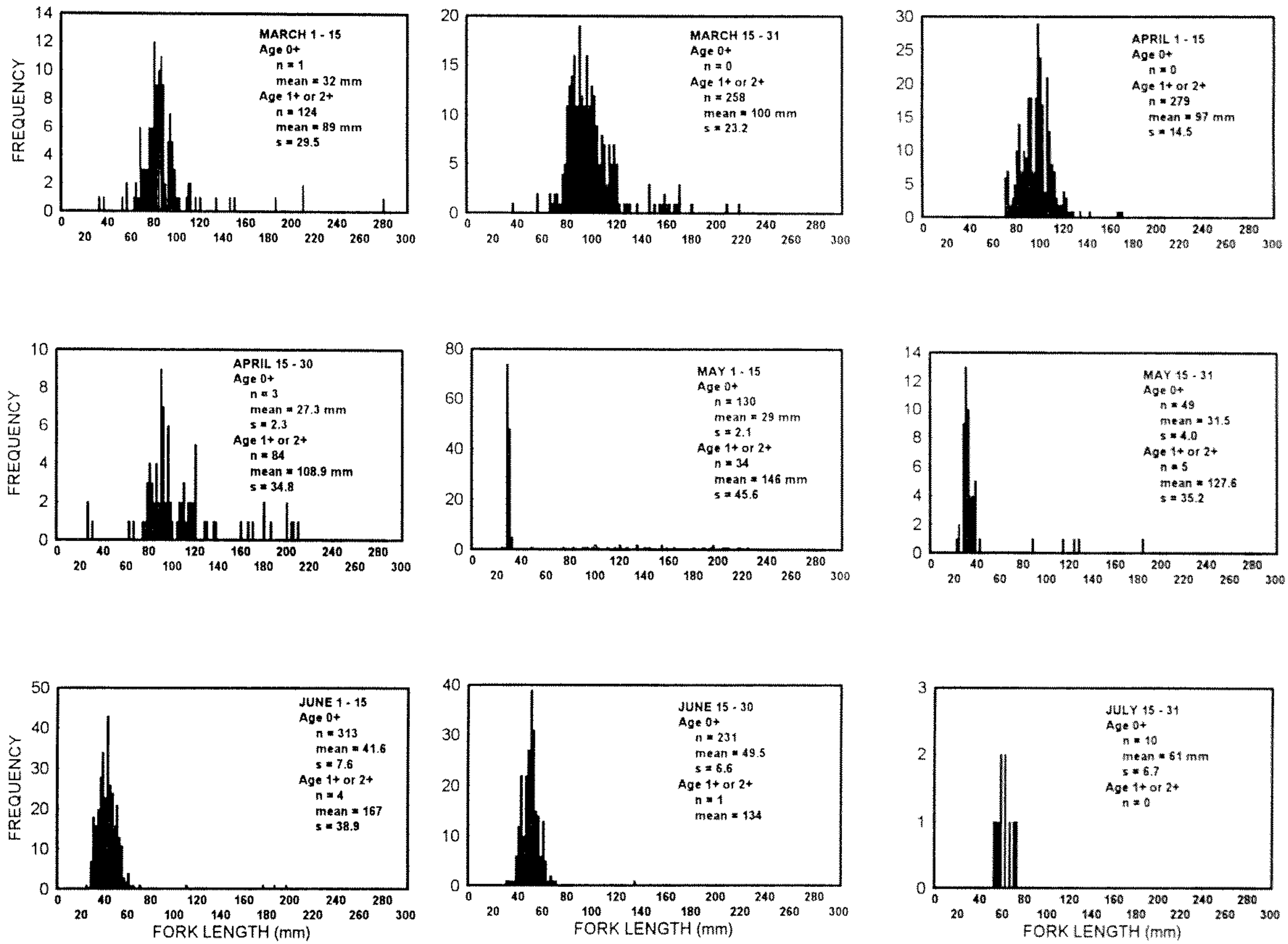
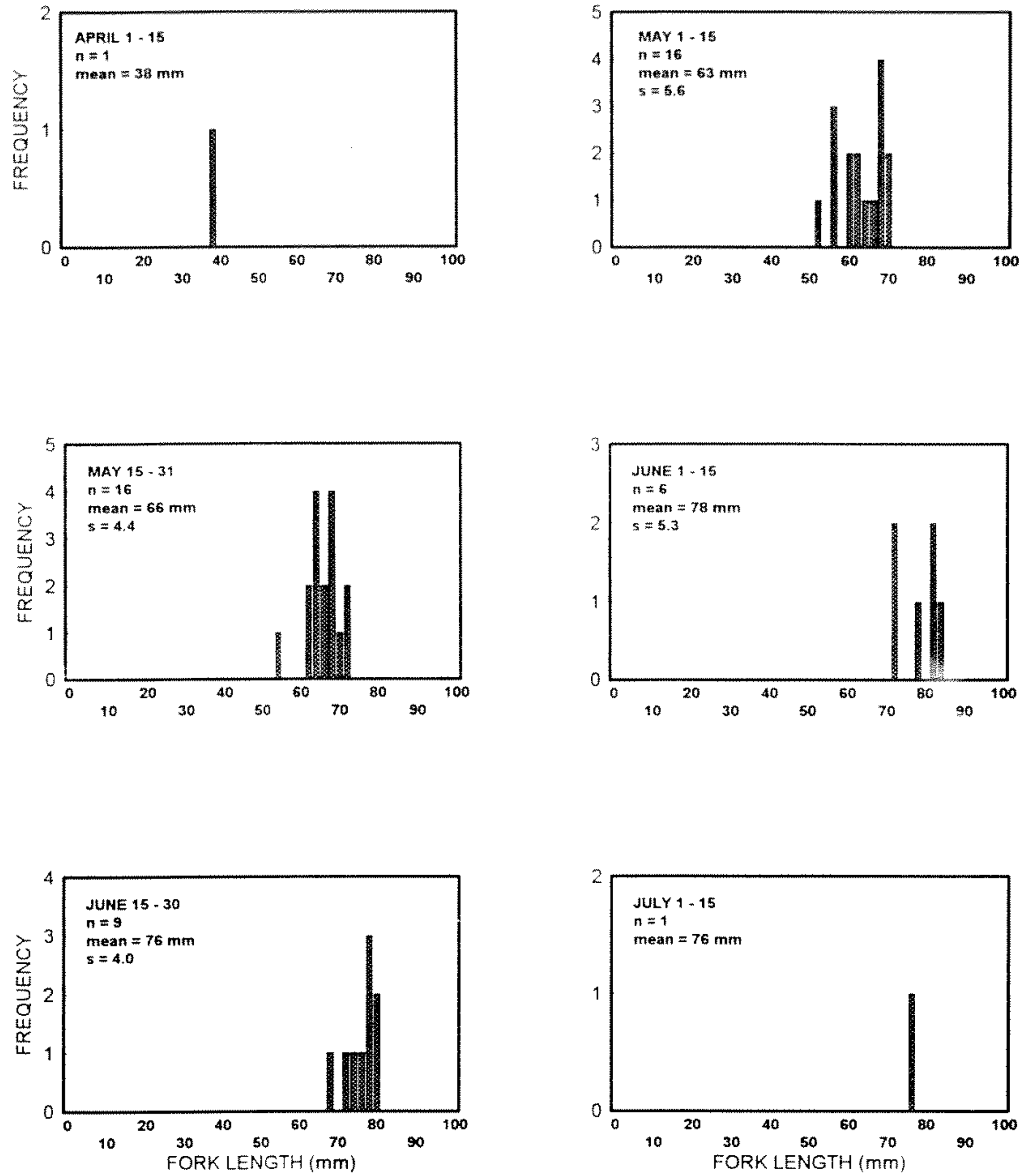
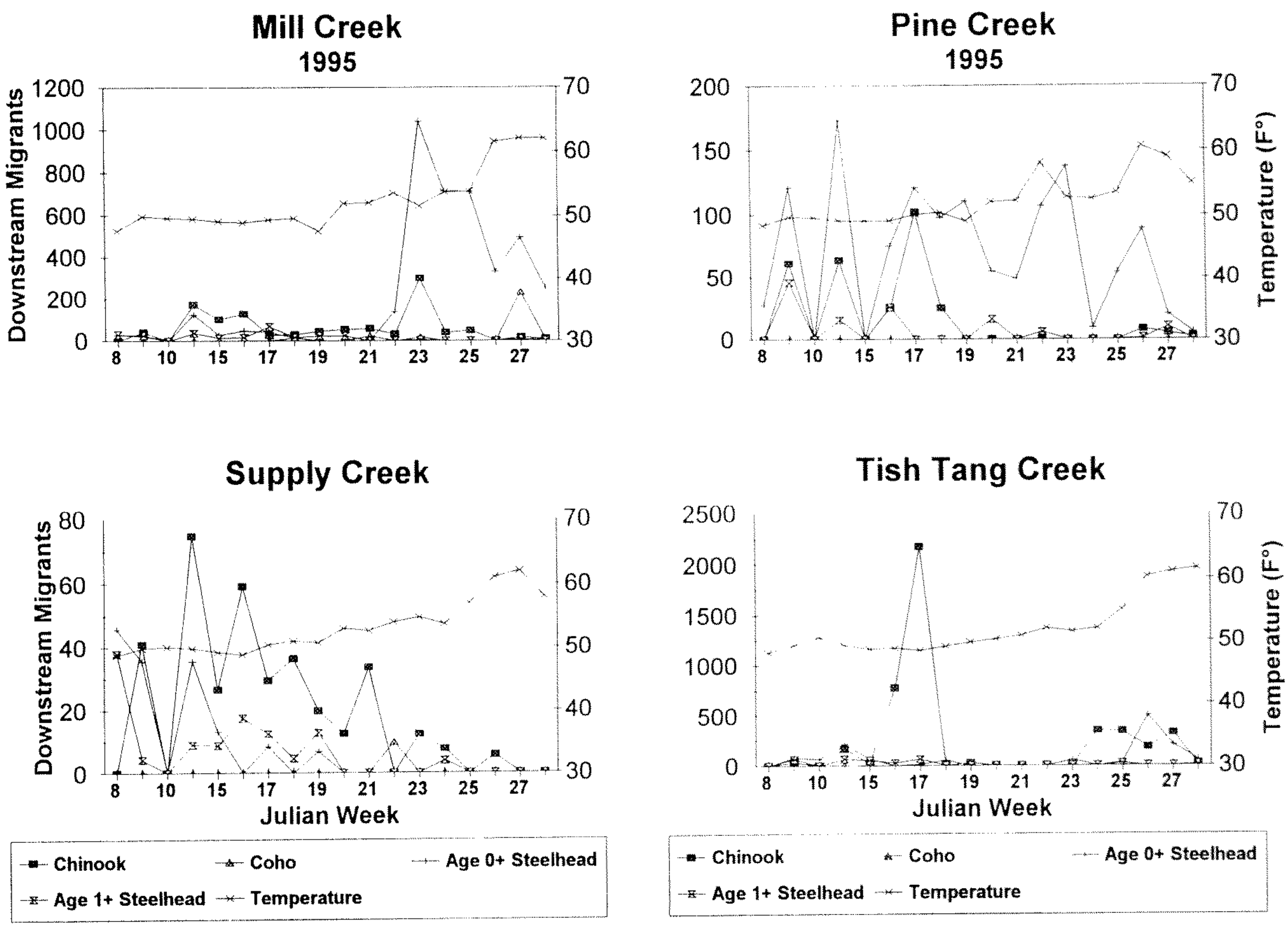


Figure 14. Length-frequency of downstream migrant juvenile steelhead in Mill Creek during 1992.

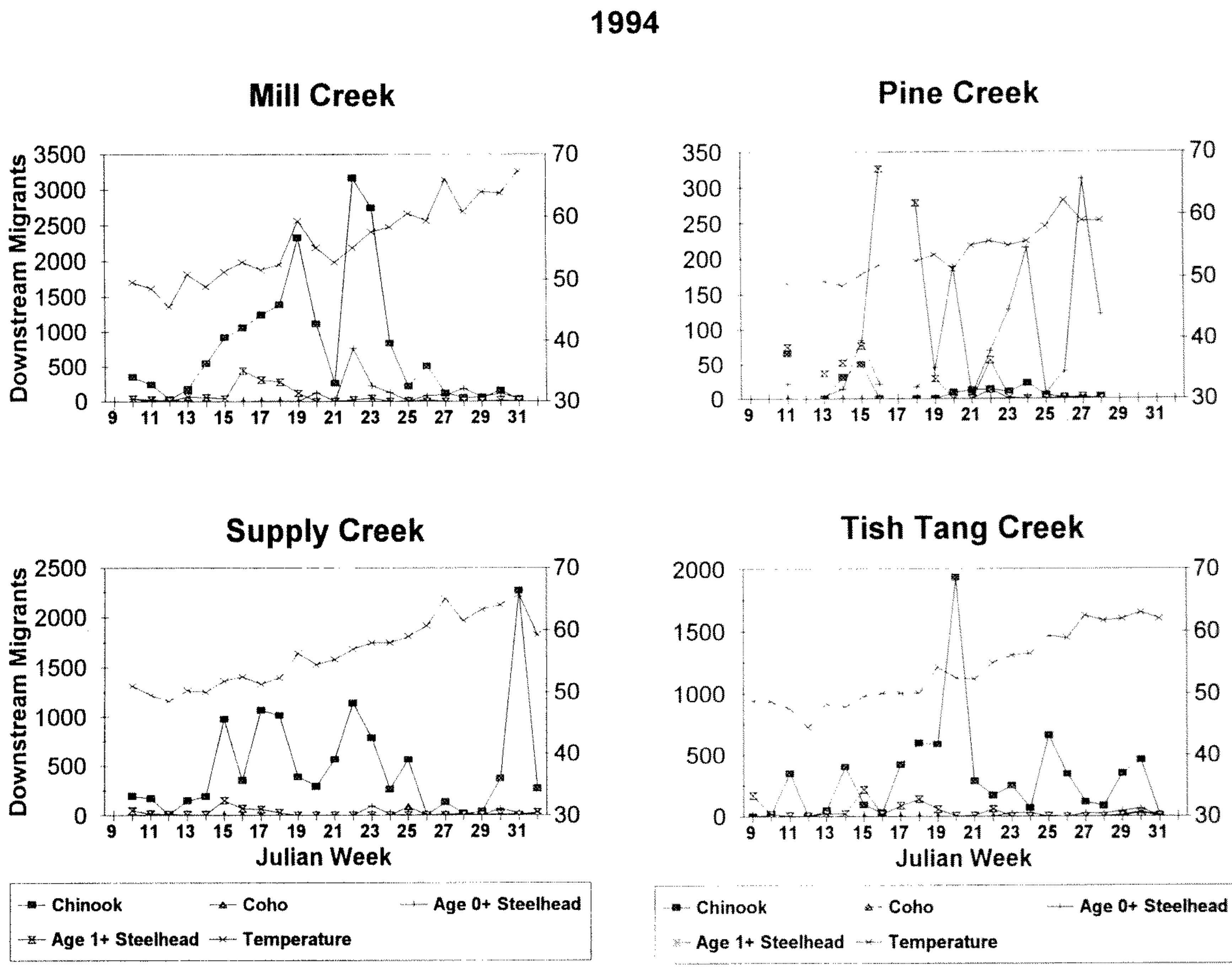
Mill Creek Coho 1992



1995

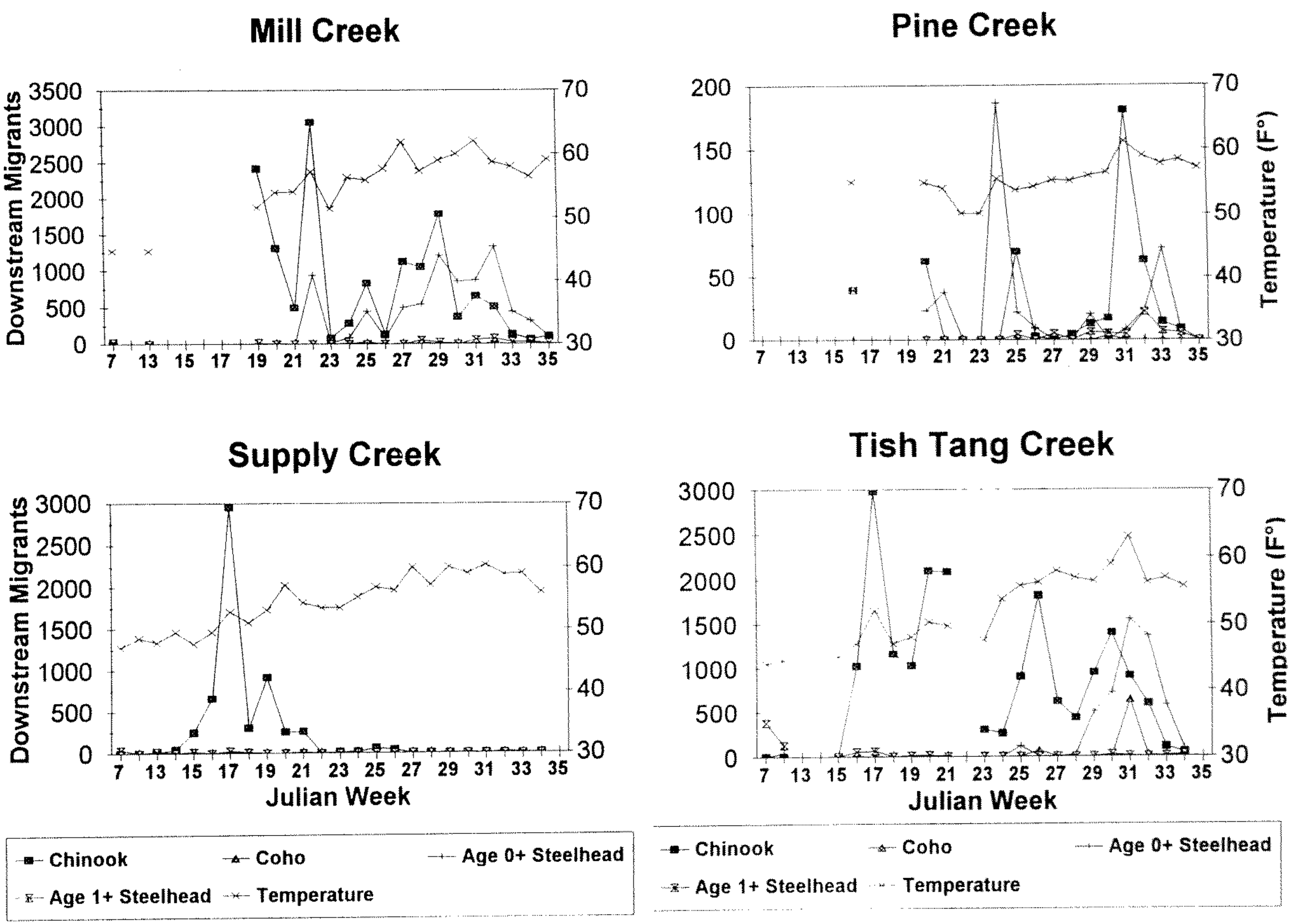


Appendix A4: Hoopa Valley Tributaries : Estimated Downstream Migrant Juvenile Salmonids, and Water Temperature : 1995

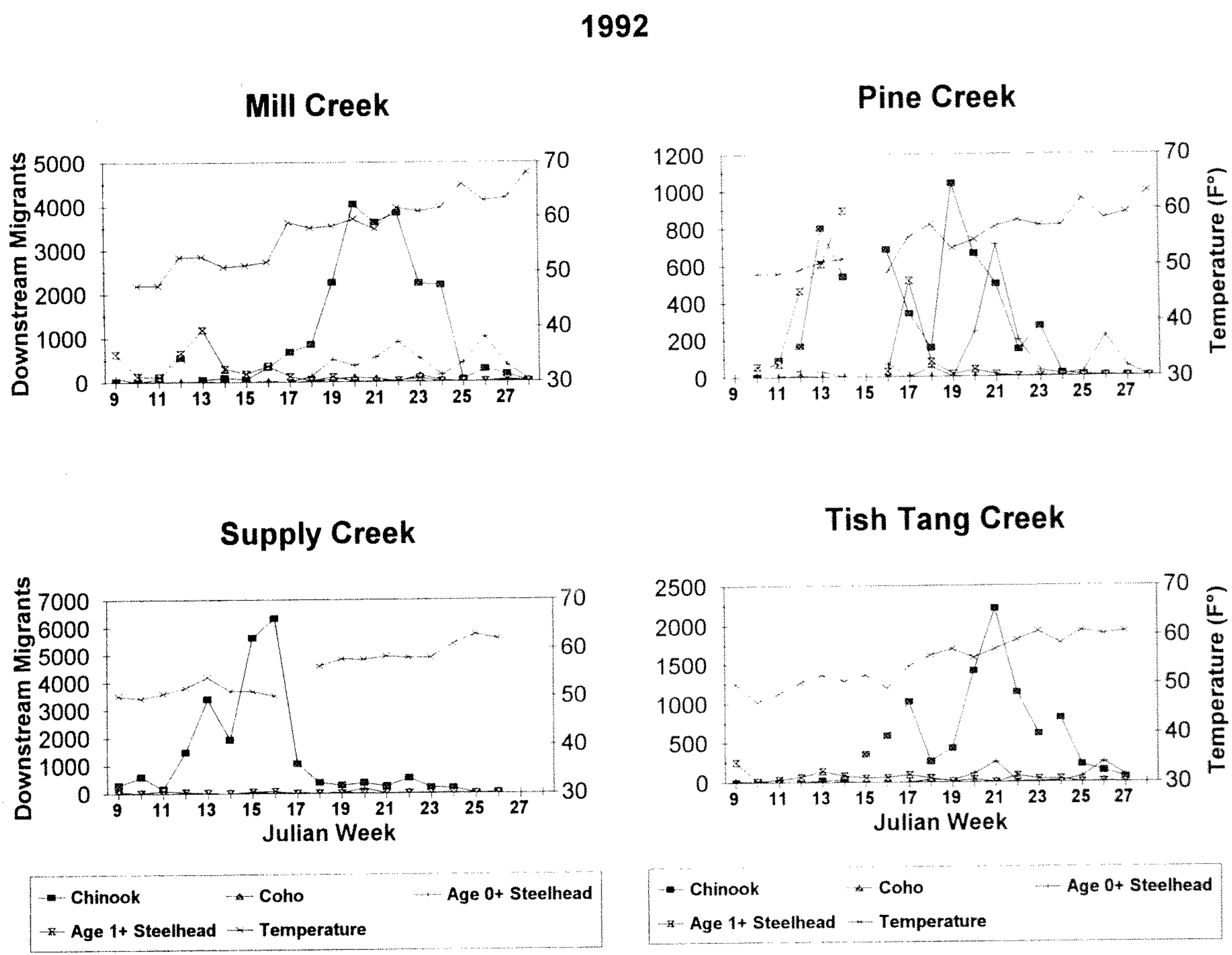


Appendix A3: Hoopa Valley Tributaries : Estimated Downstream Migrant Juvenile Salmonids, and Water Temperature : 1994

1993

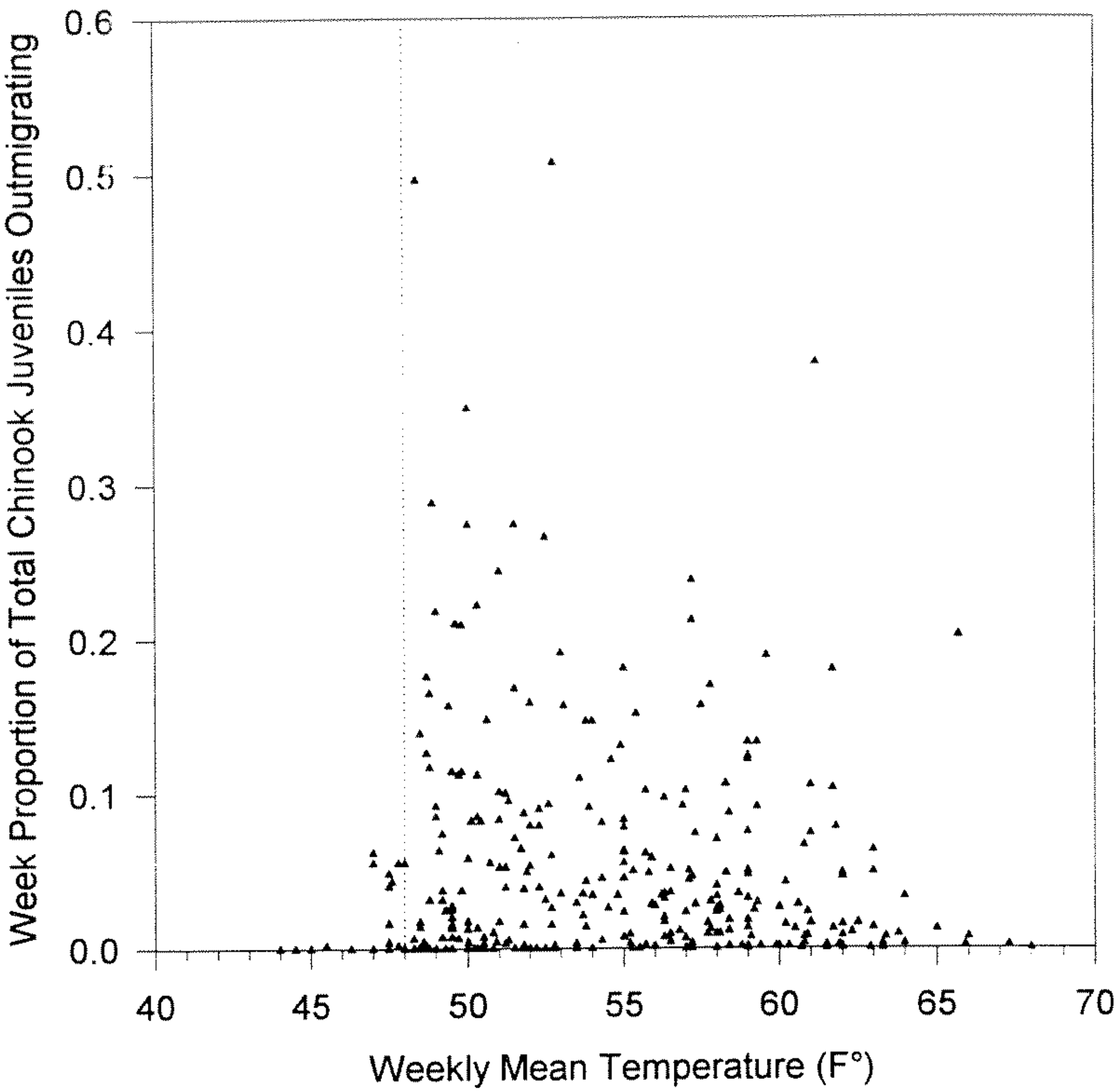


Appendix A2: Hoopa Valley Tributaries : Estimated Downstream Migrant Juvenile Salmonids, and Water Temperature : 1993



Appendix A1: Hoopa Valley Tributaries : Estimated Downstream Migrant Juvenile Salmonids, and Water Temperature : 1992

Juvenile Chinook 1992 - 1995



Appendix A5: Mill, Pine, Supply, and Pine Creeks: Estimated Weekly Downstream Migrant Chinook vs. Mean Stream Temperature