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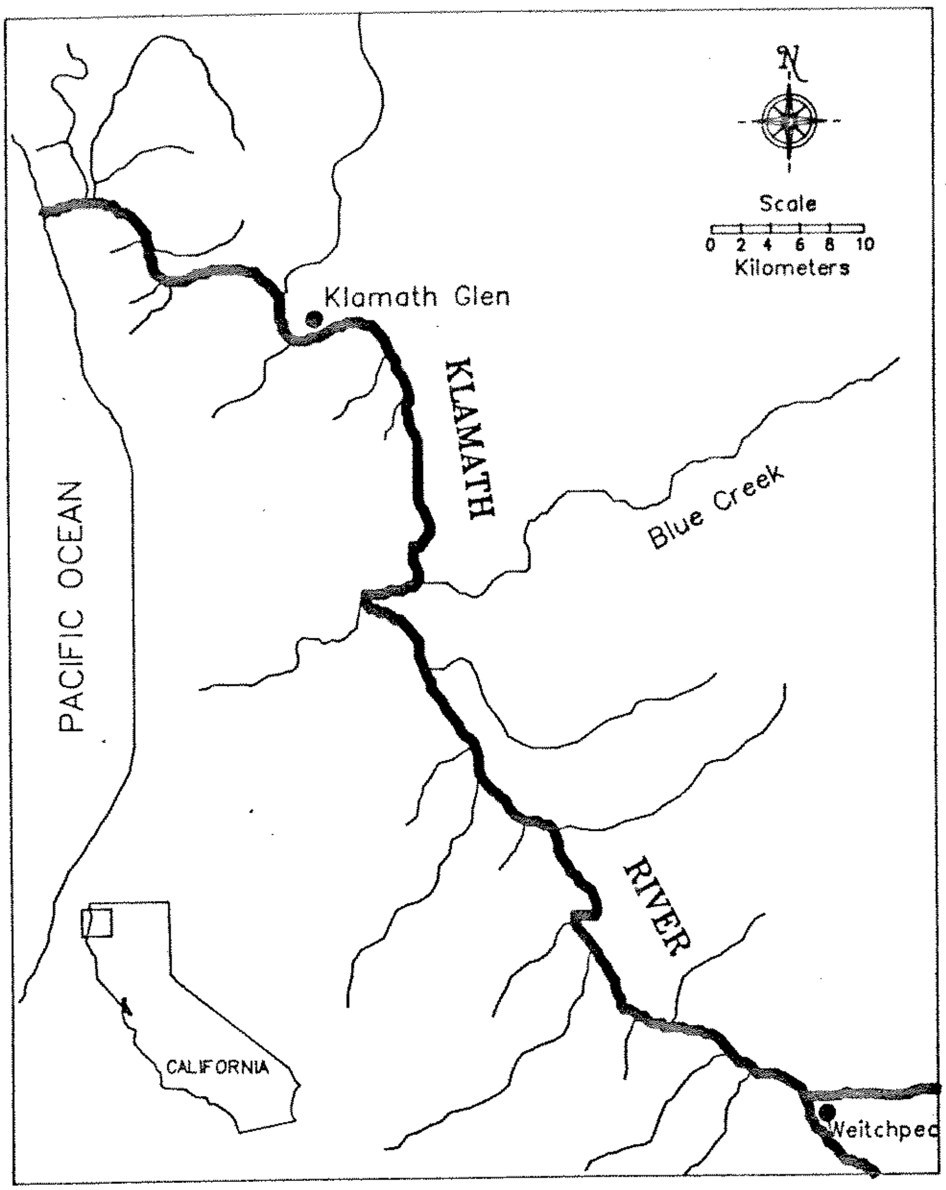
KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

INVESTIGATIONS ON THE LOWER TRIBUTARIES TO THE KLAMATH RIVER

Annual Progress Report FY 1989

February 1990

Fisheries Assistance Office
Arcata, California
Western Region



PROGRESS REPORT FOR

INVESTIGATIONS ON THE LOWER TRIBUTARIES TO THE KLAMATH RIVER

FY 1989
First year of Investigations

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Funded by:

Klamath River Basin Fisheries Task Force

ACKNOWLEDGMENTS

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First year of investigations - FY 1989

ABSTRACT

The U.S. Fish and Wildlife Service at its Fisheries Assistance Office in Arcata, CA, is currently funded to investigate spawning use, juvenile production, and habitat availability to chinook salmon in 24 streams tributary to the Klamath River downstream of the Hoopa Valley Indian Reservation. Investigations began in October, 1988, and continued through June of 1989. Preliminary spawning ground surveys, cursory habitat inventories, logistics, and historical records were used to prioritize streams for investigations by a two-man field crew. In the spring of 1989, ten streams were initially selected for investigations on patterns of juvenile emigration. Emigrating juvenile salmonids were trapped near the mouth of each stream one night per week between the end of March and the middle of June. Steelhead occurred in all streams and were the dominant salmonid species captured in all but two streams. Although juvenile chinook were present in seven of the ten streams, they were common in only three streams. Both coho salmon and cutthroat trout were uncommon in all streams. Chinook in the lower tributaries are believed to be of the fall race which rarely remain in Klamath River tributaries past the fry stage. A few yearlings, however, were captured in traps. Juvenile chinook began emigration the first week in April. By the end of the trapping season, an estimated 3,680 chinook fry had emigrated past trap sites. Since spawning habitat in most streams sampled in 1989 was rated at least moderate in abundance and quality, the low estimate for chinook fry suggest potential spawning habitat in sampled streams may be underused. More comprehensive trapping operations in subsequent years will provide information needed to substantiate this possible conclusion. On the other hand, juvenile steelhead appeared in most streams in relatively high numbers when compared to other salmonid species. Although data from trapping operations is needed to obtain estimates on steelhead production, these data must be supplemented with information on the number of juvenile steelhead rearing in streams in order to produce reliable production estimates.

INTRODUCTION

Since the turn of the century, people have voiced concerns about perceptible declines in runs of chinook salmon (Oncorhynchus tshawytscha) and steelhead trout (O. mykiss) in the Klamath River basin (Basin). These declines have accelerated during recent decades concurrent with increased demands for harvest and habitat usage. In response, Congress enacted P.L. 99-552, the Klamath River Fish and Wildlife Restoration Act on October 27, 1986, which authorizes the Secretary of the Interior to restore Basin anadromous stocks to optimum levels through restoration of anadromous species and their habitats and through management proposed by the Klamath River Fishery Management Council.

In 1988, the U.S. Fish and Wildlife Service (Service), through its Fisheries Assistance Office in Arcata, California (FAO-Arcata), submitted a proposal to the Klamath River Basin Fisheries Task Force to gain funding for investigations on tributaries to the Klamath River downstream of its confluence with the Trinity River (Figure 1). Investigations were designed to supplement information collected by the California Department of Fish and Game on natural production of chinook salmon in the Basin, to confirm the contributions by these tributaries toward Basinwide chinook production, and to provide data necessary for informed decisions to be made on restoration efforts within the Basin.

The proposal was approved for funding beginning October of fiscal year (FY) 1989. The following report summarizes findings during the initial year of these investigations that were concentrated on juvenile production, especially for chinook salmon and steelhead trout.

METHODS AND MATERIALS

Selection of Study Areas

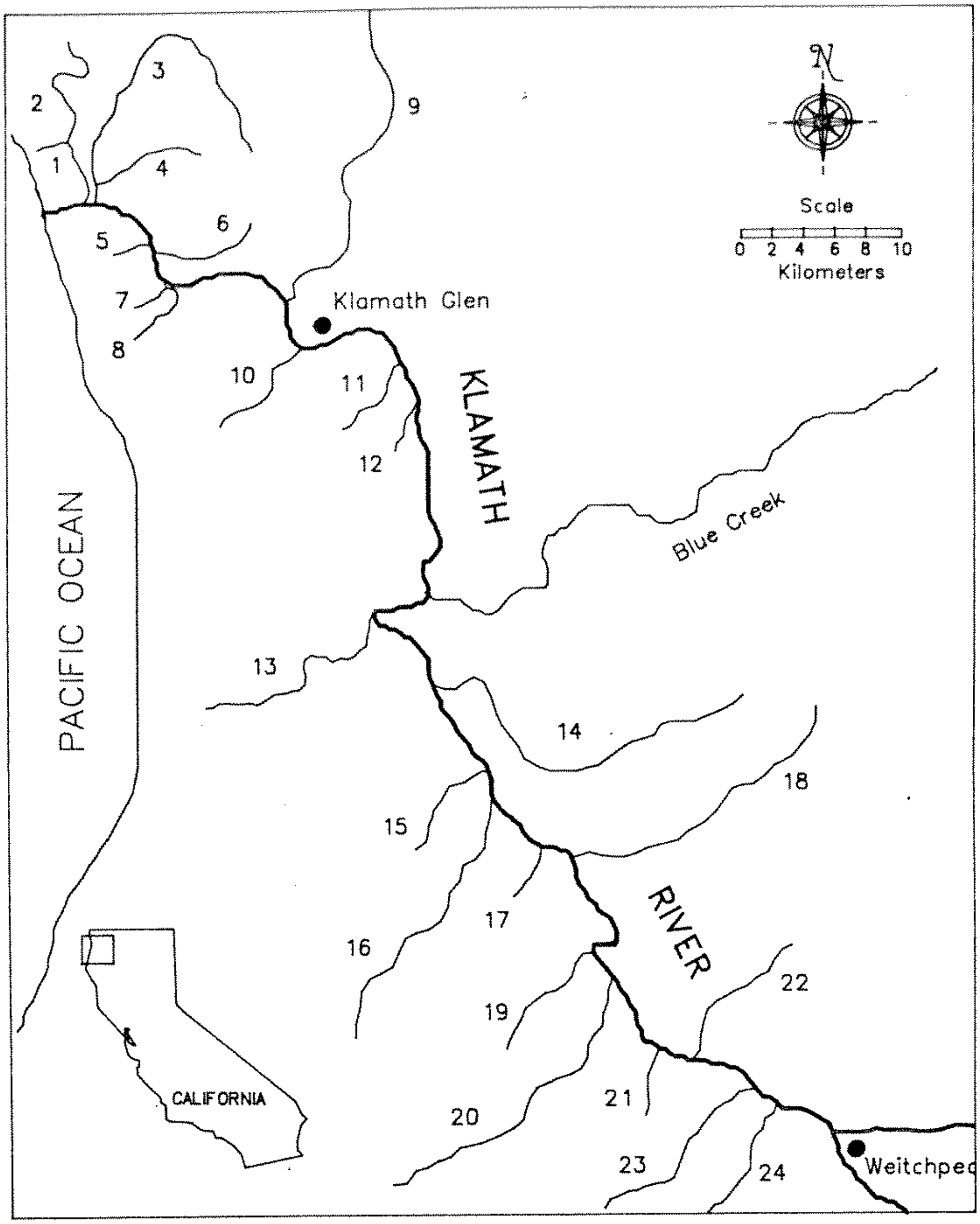
All streams included in investigations enter the Klamath River downstream of the Hoopa Valley Indian Reservation. A total of 24 tributaries were considered (Figure 1). Blue Creek, the major tributary in this part of the Basin, was not included since it is being investigated under a separate set of proposal objectives.

Proposal objectives were focussed on gaining information on production levels of fall chinook salmon. To better meet developing management concerns on population viability of all anadromous salmonids within the Basin, we have expanded objectives to include all races of chinook and steelhead. It would be logistically impossible for our two-man field crew to comprehensively survey 24 streams each year. We, therefore, ranked the 24 streams using information from observations collected during preliminary spawning ground surveys, from cursory surveys for spawning and rearing habitat availability, and from findings presented in past reports. Each stream was surveyed along its lower two miles for chinook and steelhead live adults, carcasses, and redds during the fall and winter of 1989. These efforts addressed Task I of the proposal. Concurrently, potential spawning and rearing habitats were noted and rated subjectively as minimal, low, moderate, or high in quality and abundance (Table 1). Those streams where the presence of chinook or steelhead adults were noted during the fall and winter of 1989 and where spawning and rearing habitats were rated at least moderate were generally given the highest (first) ranking for investigations (Table 2). All first and most second ranked streams (total of ten streams) were selected for preliminary investigations on juvenile production during spring of FY 1989.

Juvenile Trapping Operation

In March, we began to assess juvenile salmonid production by trapping emigrants in the ten selected streams. Our objectives during this first spring sampling season was to document the species using a stream for spawning and rearing, determine patterns in timing and duration of juvenile emigration, and compare relative abundance of juveniles of different species emigrating from the

Figure 1. Tributaries to the Klamath River included in this investigation.



NUMBERED CREEKS:

1	Salt	7	Saugep	13	Ah Pah	19	Mettah
2	High Prairie	8	Waukell	14	Bear	20	Roach
3	Hunter	9	Terwer	15	Surpur	21	Morek
4	Mynot	10	McGarvey	16	Tectah	22	Cappell
5	Richardson	11	Tarup	17	Johnson	23	Tully
6	Hoppaw	12	Omagaar	18	Pecwan	24	Pine

Table 1. Criteria for rating spawning and rearing habitats in the lower Klamath River tributaries, 1989.

MINIMAL

Spawning habitat is marginal in character and gravels occur in isolated pockets; embeddedness is high and fines are >25% of total substrate composition; pools for holding adults are few and generally shallow. Rearing habitat consists of isolated pockets of less than quality habitat (due to quantity and quality of cover, condition of edgewater areas, temperature, and/or channel gradient). No adults, carcasses, or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed infrequently during bankside observations and/or electroshocking operations.

LOW

Spawning habitat is largely marginal in character but quality habitat does occur infrequently in isolated pockets; embeddedness is high and/or fines are 15-25% of total substrate composition; pools are generally shallow. Quality rearing habitat occurs infrequently in distinct pockets primarily along stream edges and the tail of riffles. No adults, carcasses, or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed in low numbers during bankside observations and/or during electroshocking operations.

MODERATE

Quality spawning habitat is available in frequent isolated pockets often immediately downstream of larg substrate or in the tail-out of pools; embeddedness is moderate and fines compose <15% of total substrate composition; pools are usually >1 m in depth but are few in number. Quality rearing habitat does occur in frequent pockets along stream edges and the tail of riffles where cover complexity is moderate. Adults, carcasses, and/or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed in moderate numbers during bankside observations and/or during electroshocking operations.

HIGH

Quality spawning habitat is abundant at tail-out of pools, in glides and runs, and in isolated pockets behind large substrate; embeddedness is low and fines compose <10% of total substrate composition; pools are numerous and generally >1m in depth. Rearing habitat is usually of good quality and cover complexity is high. Adults, carcasses, and/or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed in moderate to high numbers during bankside observations and/or during electroshocking operations.

Table 2. Tributaries to the lower Klamath River basin considered for investigations, their ratings for potential spawning and rearing habitats, and their rankings for investigatory efforts.

Creek name	Entry into Klamath River (kilometers from mouth)	Drainage area (km^2)	Salmonids observed or previously reported [1]	Ratings for potential spawning habitat	Ratings for potential rearing habitat	Ranking for investigations and estimated year for concentrated effort
Salt	1.8	11.4	STH, CUTT	minimal	minimal	Fourth - 1993
High Prairie	enters Salt Creek	10.9	CUTT, CUTT/RBT hybrids	low	moderate	Third - 1992
Hunter	1.8	61.6	CHN, STH, Coho, CUTT	moderate	low	First - 1989, 1990
Mynot[2]	enters Hunter	12.7	CHN, STH, CUTT	low	low	Third - 1990
Richardson	4.5	4.7	CHN, STH, CUTT	minimal	minimal	Fourth - 1993
Hoppaw	4.7	12.7	unknown	minimal	minimal	Fourth - 1993
Saugep	5.8	4.4	unknown	minimal	minimal	Fourth - 1992
Waukell	5.8	9.3	unknown	minimal	minimal	Fourth - 1992
Terwer	8.5	85.0	CHN, STH, Coho	high	moderate	First - 1989,1992[3]
McGarvey	10.6	22.3	CHN, STH, CUTT	minimal	minimal	Fourth - 1993
Tarup	12.6	12.7	CHN, STH, Coho, CUTT	low	moderate	Second - 1989, 1991
Omagaar	16.9	6.5	CHN, RBT/STH	minimal	minimal	Fourth - 1993
Ah Pah	27.7	42.2	CHN, STH, Coho	low	moderate	Second - 1989, 1991
Bear	29.9	50.0	CHN, STH, Coho	moderate	moderate	Second - 1989, 1990
Surpur	33.0	14.8	CHN, STH	low	moderate	Second - 1991
Tectah	35.6	51.5	CHN, STH, Coho	high	high	First - 1989, 1990
Johnson	39.1	8.8	CHN, STH, CUTT	low	low	Third - 1992
Pecwan	40.7	71.7	STH, Coho	minimal	low	Third - 1989, 1992
Mettah	46.3	27.7	STH	low	moderate	Third - 1991
Roach	50.7	76.4	CHN, STH	moderate	high	Second - 1989, 1991
Morek	52.3	10.4	STH	minimal	minimal	Fourth - 1993
Cappell	53.3	22.3	STH	minimal	minimal	Fourth - 1993
Tully	62.0	44.8	STH	low	moderate	First - 1989, 1990
Pine	65.8	123.8	CHN, STH	high	high	First - 1989, 1990

1) Observations were made by Service employees using snorkeling, bankside observations, and/or electroshocking but do not include findings from juvenile sampling in 1989 since ratings were made prior to that operation; CHN = chinook, STH = steelhead, CUTT = Cutthroat trout, RBT = rainbow trout.
2) Mynot Creek will be investigated in 1990 since it is a tributary to Hunter Creek.
3) Although rated first for investigations, operations in Terwer Creek will be postponed until 1992 by request of Simpson Timber Company.

streams. These efforts addressed Task II of the proposal. Due to manpower and logistic constraints, initial efforts to sample each of the ten selected streams at least two times per week were reduced to sampling eight streams one time per week (Table 3). Trapping operations on Pecwan, Roach, Tully, and Pine Creeks were initiated late in the season (mid-April) due to high spring flows that precluded the use of trapping equipment.

Traps were operated through the night based on observations by Hoar (1953), Miller (1970), Reimers (1973), and Faudskar (1980), who documented that the majority of juvenile salmonids migrate under cover of darkness. Usually two streams were sampled each trapping night with one trap set per stream; fish were removed the following morning. There were four trapping nights per work week. Traps were set as near to the mouth of streams as possible in areas accessible during periodic spring flood events and where sampling could approach 100% of the stream width. Each trap consisted of a 1.07 m x 1.52 m fyke net with a live box attached at the cod end. Weir panels, constructed of 0.64 cm hardware cloth mounted on wooden frames, abutted each side of a fyke net to increase the proportion of stream sampled.

All fish removed from traps were classified by species and enumerated. All chinook and steelhead were further identified to year class based on size criteria. Up to 50 individuals from each salmonid species captured each night in a trap were measured for fork length (to the nearest mm) and volume (in ml using volumetric displacement) and then released.

Weather, lunar phase, and stream width at the trap mouth were also noted. Trapping operations ceased by late June when either the mouth of streams went subsurface (Hunter, Terwer, and Bear Creeks) or emigration ceased or decreased to extremely low numbers (Tectah, Roach, Pecwan, Tully, and Pine Creeks).

Treatment of Data

Data were entered onto Lotus 123 spreadsheets and analyzed using Statgraphics software package. Comparisons were made using one-way ANOVA and Student's t-tests. A trap night was defined as the operation of a trap through one period of darkness (one night). Expanded estimates were made for the total number of juveniles of a species or age class emigrating from a stream each trap night. These estimates were calculated as:

$$N_i \;/\; P_i = E_i$$

where N_i = the actual number of juveniles of a species or age class captured in a trap on night i, P_i = the proportion of total stream width that was sampled during that trap night, and E_i = the expanded number of juveniles of a species or age class emigrating past a trap on night i. Such expansions were made with the assumptions that all species and age classes were equally distributed across the stream channel.

Estimates were also made for the total number of juveniles of a species or age class that emigrated past a trap site during the entire trapping season. These were made by summing all E_i for a stream and interpolating expanded estimates for nights when traps were not in operation (non-trap nights). These interpolated estimates were made under the assumptions that stream width at a trap site did not vary from an average decrease (or increase) between one trap night and the next and that emigration by a species or age class of juveniles was at a constant rate between trap nights.

Estimates were made for the number of chinook adults and jacks that used a stream for spawning during the winter of 1988-89. These estimates were formed using the equation:

$$S_j = (E_j / V \times F) \times R$$

where S_j = estimate for male, female, or jack spawners in stream j, E_j = the expanded estimate of chinook fry emigrating from stream j, F = the fecundity for adult fall chinook females in the Klamath River (n=3,634/female reported by Allen and Hassler, 1986), V = the survival of chinook from egg to fry stage using an average estimate from Bogus Creek, tributary to the Klamath River (9.2%), and R = the average sex ratio for male:female:jack fall chinook returning to hatchery racks at Iron Gate State Fish Hatchery from 1980 to 1988 (ratio = 0.838:1:0.254). These estimates were made under the following assumptions: 1) estimates made for chinook fry emigrating streams were reliable, 2) survival of chinook fry from egg to fry stage in lower tributaries was similar to that in Bogus Creek, and 3) sex ratios for fall chinook in natural streams were similar to average ratios observed at hatchery racks in Iron Gate S.F.H.

RESULTS AND DISCUSSION

Cursory spawning ground surveys in the fall and winter of 1989 supplemented information used in the selection of streams for initial juvenile trapping efforts to be conducted in the spring. Chinook and steelhead live adults, carcasses, and/or redds were observed in Hunter, Terwer, Tarup, Bear, Tectah, Roach, Mettah, and Pine Creeks. Potentially good or moderate rearing habitat was observed in High Prairie, Terwer, Tarup, Ah Pah, Bear, Surpur, Tectah, Mettah, Roach, Tully, and Pine Creeks (Table 2). Based on habitat ratings, spawning ground surveys, historical records, and logistics, Hunter, Terwer, Tarup, Ah Pah, Bear, Tectah, Pecwan, Roach, Tully, and Pine Creeks were initially selected for spring juvenile trapping efforts. Early in the trapping season, we ceased efforts on Tarup and Ah Pah Creeks due to manpower constraints.

Chinook salmon

Although spring chinook often dominate populations of chinook in the upper reaches of the Klamath River, chinook in the lower tributaries of the Basin are believed to be of the fall race. Most chinook in traps were fry (young-of-year); however, traps at Hunter, Terwer, Ah Pah, and Bear Creeks captured a few yearlings (n = 2, 1, 1, and 3, respectively). The occurrence of the yearling stage is uncommon among fall chinook in the Klamath River basin but frequently occurs among spring chinook. Three potential explanations for the presence of yearling chinook in the lower tributaries are: 1) they were fall chinook that adopted a life history strategy uncommon to fall chinook in the Klamath River, 2) they were progeny from spring chinook, or 3) they were fall chinook that delayed emigration due to instream conditions. All four creeks in which yearlings were trapped are streams that frequently go subsurface at or near their mouths by late spring. Emigration of these juveniles may have been blocked when the lower reaches of the streams went subsurface (i.e. explanation 3).

They were able to adapt to prevailing conditions and delayed emigration until the following spring. We question, however, why these juveniles did not emigrate once stream flows increased and reopened stream channels during fall rains. Explanation 2 is also unacceptable. Since spring chinook generally enter tributaries in August-September and Terwer, Ah Pah, and Bear Creeks were subsurface at their mouths until fall rains in November, there is a low probability that spring chinook could have gained access to these tributaries to spawn. We are inclined, therefore, to chose explanation 1.

Emigration from tributaries by juvenile chinook began the first week in April and ceased or decreased to relatively low numbers by mid-June when trapping operations were stopped. Chinook were captured in all streams sampled except Tarup, Pecwan, and Tully Creeks (Table 3). By the close of the trapping season, approximately 3,680 chinook fry had emigrated past trap sites in the seven streams. In Hunter, Terwer, and Tectah Creeks, over 40% of the total number of salmonids captured during the season were chinook (Table 4). In the remaining four tributaries, chinook numbers were exceedingly low and their occurrence infrequent. The following analyses on juvenile chinook will include data from only Hunter, Terwer, and Tectah Creeks unless otherwise noted. In these three streams, trends could be followed through time and sample size from each creek was large enough to be used in statistical tests.

Emigration peaked in Terwer and Tectah Creeks the second week in April (April 9-14) (Figure 2). Although this peak was not observed in Hunter Creek, it may have occurred prior to our first trap night (4/11). Fry were captured in Hunter Creek during the first trap night which suggests emigration probably began prior to our arrival. A second, less pronounced peak occurred in all three streams the first week in May. Since none of these peaks were coincidental with inclement weather that might cause increased flows and chinook fry did not emigrate in significantly different numbers during different weather types ($P=.488$), we believe emigration was voluntary rather than resulting from dislodgment. Although Miller (1970) and Mason (1975) suggests lunar periodicity is strongly associated with timing of emigration among juvenile salmonids, our data did not support their findings. There was no discernible difference in the number of chinook juveniles emigrating during different lunar phases ($P=.267$) (Figure 3).

Yearling chinook were taken from traps prior to April 28 and ranged in fork length from 101 to 160 mm. Fork lengths of chinook fry sampled from traps in all seven streams ranged from 32 to 58 mm (average = 42 mm) prior to April 28 and from 47 to 89 mm (average = 64 mm) after that date. Among Hunter, Terwer, and Tectah Creeks, there was a discernible difference ($P<.001$) in mean fork length of chinook fry emigrating these streams (Figure 4). It appeared that mean fork length was progressively larger in streams closer to the ocean. This trend could be followed through the entire trapping season (Figure 5). The observed trend could be associated with earlier spawning activity and subsequent earlier emergence of fry in streams closer to the ocean or related to differences in stream temperatures. Since Tectah Creek has more shading by riparian vegetation than do Terwer and Hunter Creeks, instream temperatures in Tectah Creek would be expected to be cooler. We do not yet have sufficient data to explain the trend we observed, but we hope to substantiate our findings by monitoring temperatures, assessing stream shading, and determining the onset of spawning activity in each stream.

Table 3. Trapping season and species captured for tributaries sampled during spring 1989.

Creek name	Number nights trapped	Period of time of trapping operations	Species captured[1)]								
			CHN	STH	Coho	CUTT	STCKBK	Sucker	LAMPR	Dace	Sculpin
Hunter	9	4/11 - 5/29	X	X	X	X	X	X	X	X	X
Terwer	15	3/20 - 6/12	X	X	X	X	X	X	X	X	X
Tarup[2)]	6	3/21 - 4/18		X	X	X		X		X	X
Ah Pah[2)]	12	3/20 - 5/29	X	X	X	X		X		X	X
Bear	6	4/19 - 5/30	X	X	X		X	X		X	X
Tectah	11	4/05 - 6/20	X	X	X		X	X	X	X	X
Pecwan	7	4/27 - 6/13		X			X				X
Roach	8	4/27 - 6/20	X	X	X		X	X	X	X	X
Tully	7	4/29 - 6/22		X							
Pine	7	4/29 - 6/22	X	X							X

1) CHN = chinook, STH = steelhead, CUTT = cutthroat trout, STCKBK = stickleback, LAMPR = lamprey.

2) Trapping on these streams discontinued early due to logistics and manpower constraints.

Table 4. Total number, proportion of total, and average per night of fish captured in each tributary sampled during spring trapping, 1989.

	Hunter	Terwer	Tarup	Ah Pah	Bear	Tectah	Pecwan	Roach	Tully	Pine
TOTAL FISH CAPTURED PER SPECIES OR AGE CLASS:										
Chinook fry	28	116	0	1	0	87	0	4	0	3
Chinook yearlings	2	1	0	1	3	0	0	0	0	0
Steelhead fry	0	4	0	0	1	85	6	250	89	10
Steelhead 1+ juvenile	3	94	10	5	10	22	0	60	0	1
Coho	1	37	2	7	3	6	0	2	0	0
Cutthroat trout	1	8	7	8	0	0	0	0	0	0
Stickleback	75	20	0	0	4	6	106	26	0	0
Sucker	141	346	37	24	150	110	0	7	0	0
Lamprey	8	7	0	0	0	13	0	17	0	0
Dace	403	673	184	67	701	436	0	15	0	0
Sculpin	681	503	93	15	651	286	16	145	0	1
PROPORTION OF TOTAL SALMONIDS CAPTURED:										
Chinook fry	80.0	44.6	0.0	4.5	0.0	43.5	0.0	1.3	0.0	21.4
Chinook yearlings	5.7	0.4	0.0	4.5	17.6	0.0	0.0	0.0	0.0	0.0
Steelhead fry	0.0	1.5	0.0	0.0	5.9	42.5	100.0	79.1	100.0	71.4
Steelhead 1+ juvenile	8.6	36.2	52.6	22.7	58.8	11.0	0.0	19.0	0.0	7.1
Coho	2.9	14.2	10.5	31.8	17.6	3.0	0.0	0.6	0.0	0.0
Cutthroat trout	2.9	3.1	36.8	36.4	0.0	0.0	0.0	0.0	0.0	0.0

(continued Table 4)

	Hunter	Terwer	Tarup	Ah Pah	Bear	Tectah	Pecwan	Roach	Tully	Pine
PROPORTION OF TOTAL FISH CAPTURED:										
Chinook fry	2.1	6.4	0.0	0.8	0.0	8.3	0.0	0.8	0.0	20.0
Chinook yearlings	0.1	0.1	0.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0
Steelhead fry	0.0	0.2	0.0	0.0	0.1	8.1	4.7	47.5	100.0	66.7
Steelhead 1+ juvenile	0.2	5.2	3.0	3.9	0.7	2.1	0.0	11.4	0.0	6.7
Coho	0.1	2.0	0.6	5.5	0.2	0.6	0.0	0.4	0.0	0.0
Cutthroat trout	0.1	0.4	2.1	6.3	0.0	0.0	0.0	0.0	0.0	0.0
Stickleback	5.6	1.1	0.0	0.0	0.3	0.6	82.8	4.9	0.0	0.0
Sucker	10.5	19.1	11.1	18.8	9.8	10.5	0.0	1.3	0.0	0.0
Lamprey	0.6	0.4	0.0	0.0	0.0	1.2	0.0	3.2	0.0	0.0
Dace	30.0	37.2	55.3	52.3	46.0	41.5	0.0	2.9	0.0	0.0
Sculpin	50.7	27.8	27.9	11.7	42.7	27.2	12.5	27.6	0.0	6.7
AVERAGE CAPTURED PER NIGHT OF TRAPPING:										
Chinook fry	3	8	0	0	0	8	0	1	0	0
Chinook yearlings	0	0	0	0	1	0	0	0	0	0
Steelhead fry	0	0	0	0	0	8	1	31	13	1
Steelhead 1+ juvenile	0	6	2	0	2	2	0	8	0	0
Coho	0	2	0	1	1	1	0	0	0	0
Cutthroat trout	0	1	1	1	0	0	0	0	0	0
Stickleback	8	1	0	0	1	1	15	3	0	0
Sucker	16	23	6	2	25	10	0	1	0	0
Lamprey	1	0	0	0	0	1	0	2	0	0
Dace	45	45	31	6	117	40	0	2	0	0
Sculpin	76	34	16	1	109	26	2	18	0	0

Figure 2. Migration pattern of young-of-year chinook emigrating selected streams during spring trapping, 1989, using expanded numbers per trap night.

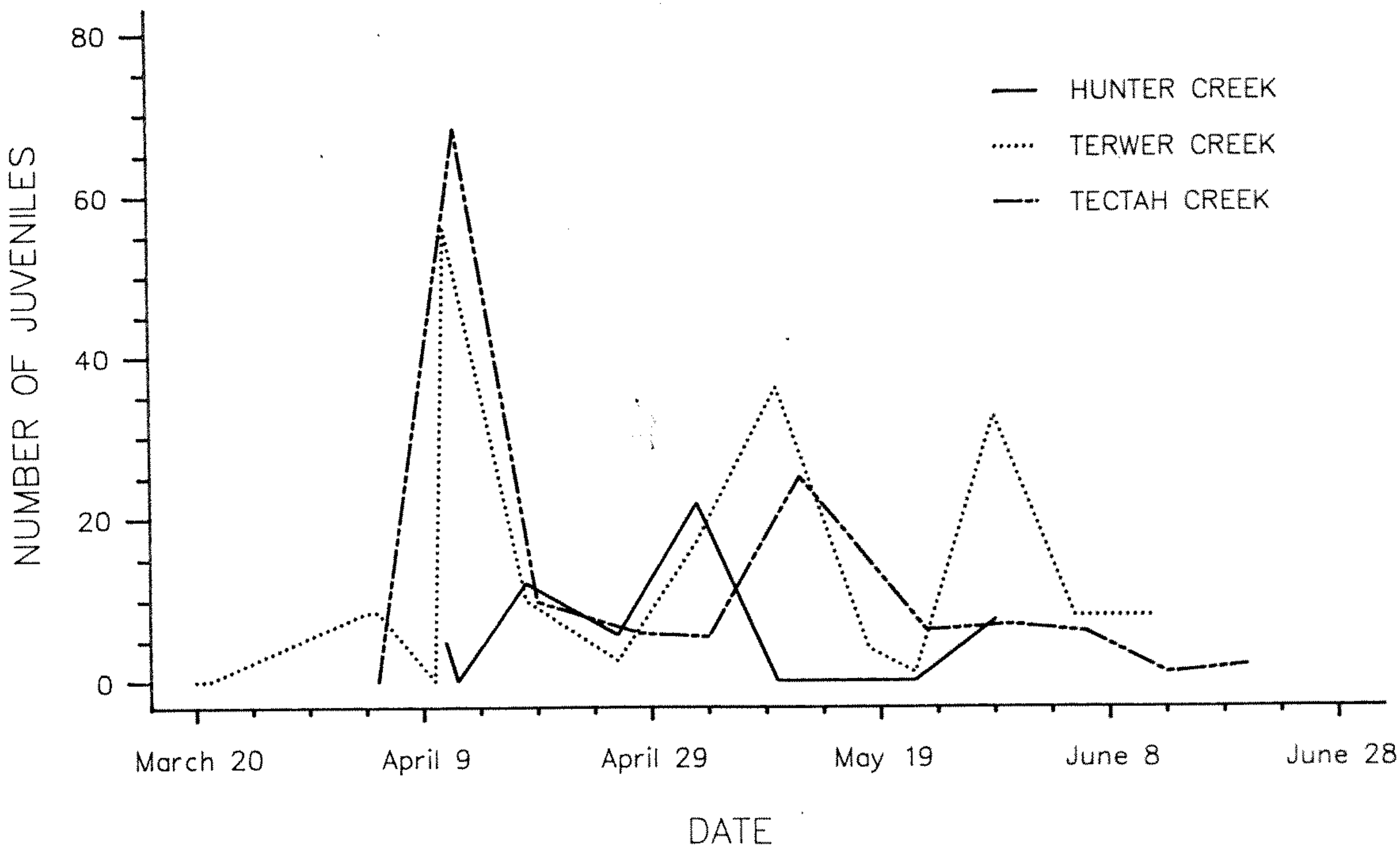


Figure 3. Influence of lunar phase and weather on numbers of young-of-year chinook emigrating tributaries to the lower Klamath River, spring 1989.

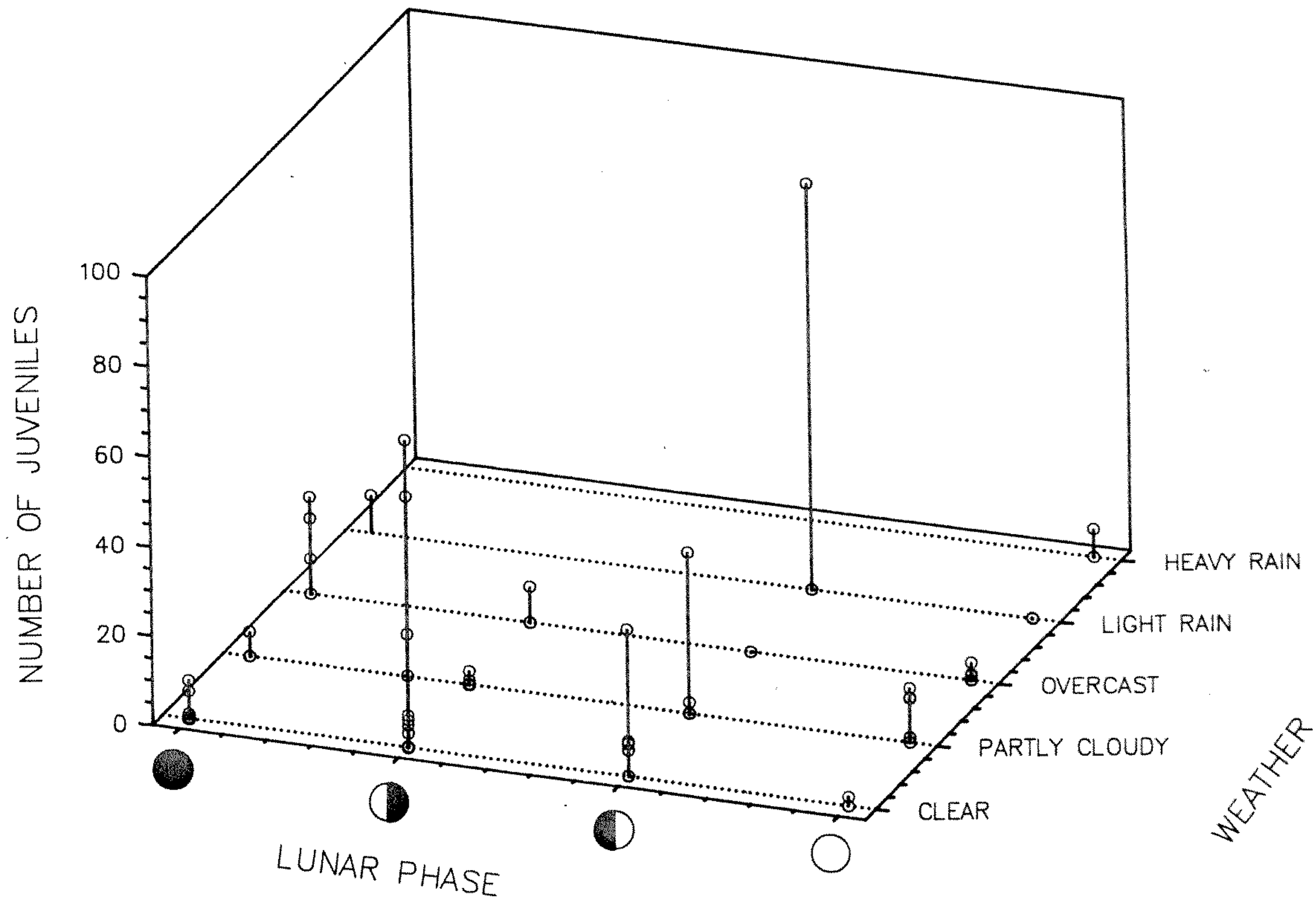


Figure 4. 95 percent confidence intervals for means of fork lengths for young-of-year chinook captured in traps, 1989.

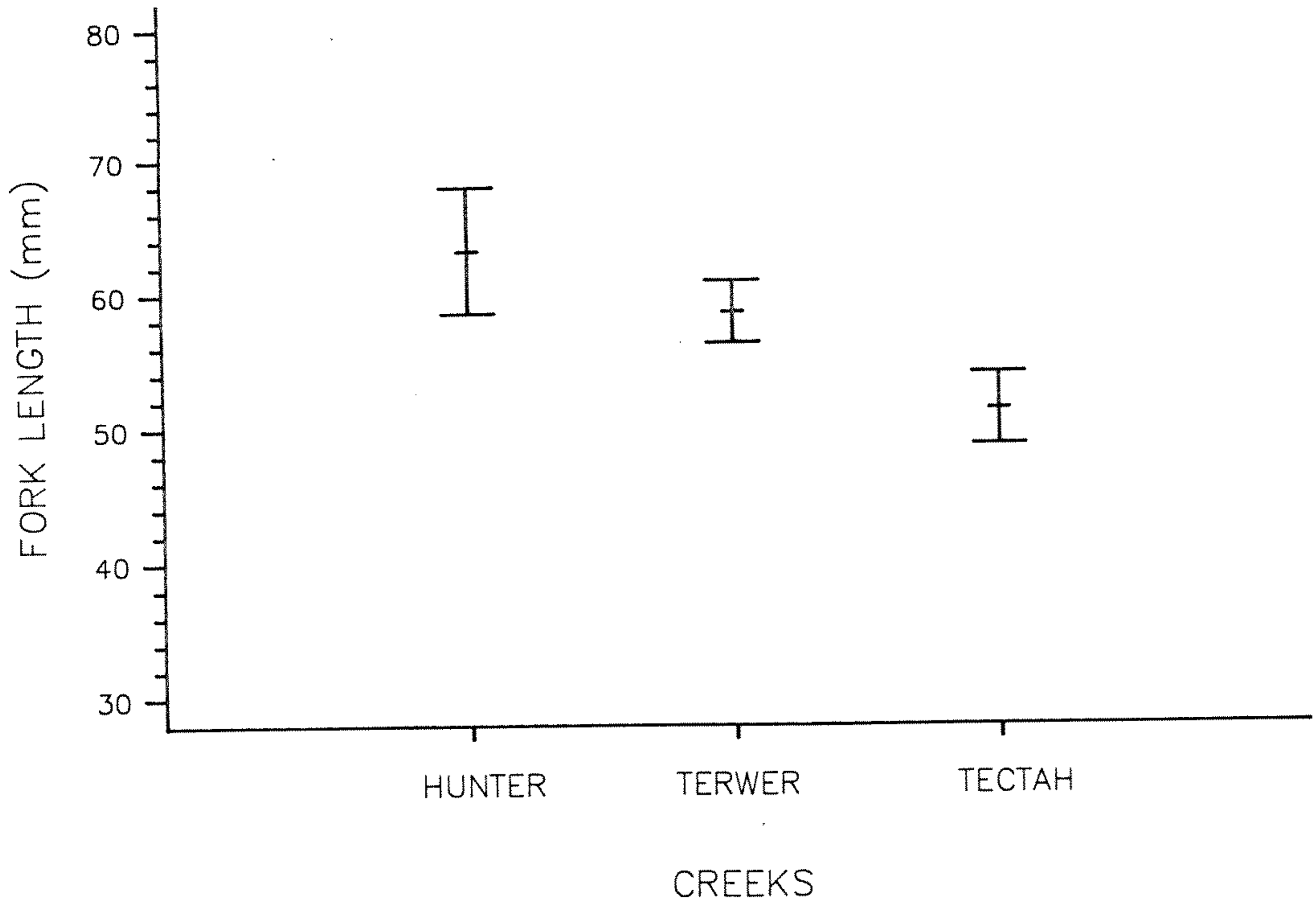
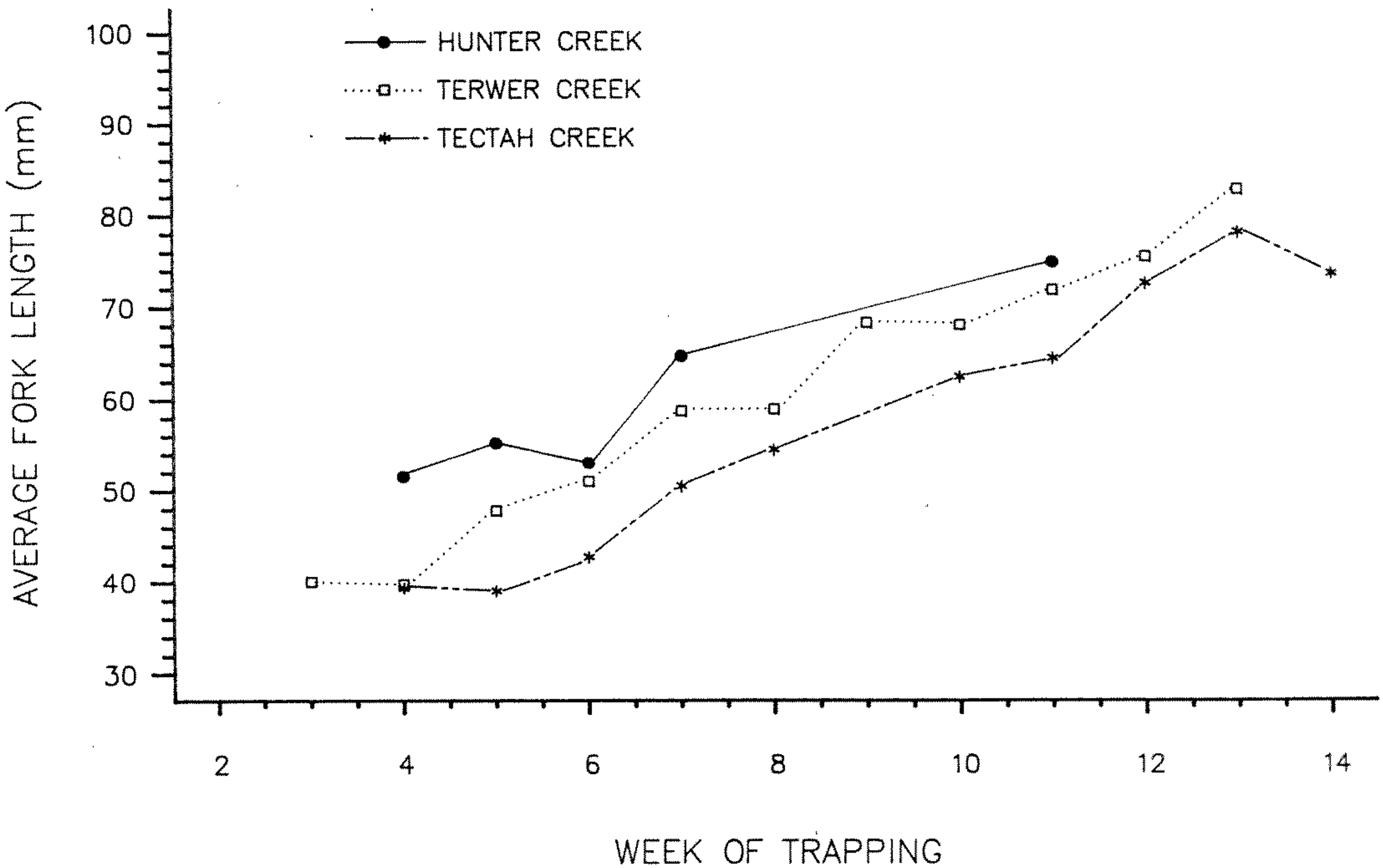


Figure 5. Average fork length of young-of-year chinook captured each week in traps at Hunter, Terwer, and Tectah Creek, 1989.



Given the expanded estimate for chinook fry emigrating past trap sites over the season (n=3,680), the spawning population needed to produce this number of fry would be only 11 females, 9 males, and 3 jacks. We believe these estimates are low. The accuracy of the estimates are confounded by the broad assumptions that are associated with their formation, and that we do not know what proportion of the total number of emigrating chinook fry were actually sampled. Since spawning and rearing habitat were rated at least moderate in the streams sampled this season, we would expect greater production of chinook fry than was observed. Although estimates are questionably low, they may suggest that available spawning habitat is underused (spawner limited), and/or emigration is protracted and may increase again in the fall. The more comprehensive juvenile trapping, stream inventories, and spawning ground surveys projected for streams in ensuing years will substantiate production trends and estimates.

Steelhead trout

Both winter and summer steelhead trout enter the Klamath River, and both races probably use the lower tributaries for spawning and rearing. Juvenile steelhead were captured in all ten streams sampled during spring, 1989, and were the dominant salmonid species captured in all except Hunter and Terwer Creeks (Table 4). Steelhead were most often captured as fry in Tectah, Pecwan, Roach, Tully, and Pine Creeks and as 1+ juveniles (yearlings and 2-year-olds) in Terwer, Tarup, and Bear Creeks (Table 4). Although steelhead were the dominant species in most creeks, their numbers were low and occurrence infrequent through the season in several of the streams. Therefore, analyses on emigration timing and duration, tracking of fork lengths through time, and statistical comparisons between creeks will be made using data from Terwer, Tarup, Bear, Tectah, and Roach Creeks for steelhead 1+ juveniles and from Tectah, Roach, Tully, and Pine Creeks for steelhead fry, unless otherwise noted.

Emigration of steelhead fry began the second week in May, peaked the last week in May, and remained at low numbers to the end of the trapping season (Figure 6). Unlike the chinook fry, peaks frequently coincided with light to heavy rains (Figure 7). Tests revealed that there was a discernable difference in the number of fry emigrating during different types of weather (P=.020). These results suggest that observed peaks in emigration may have resulted from dislodgment of fry during high flows caused by rains rather than by volition. Similar to emigration by chinook fry, there was no significant difference in the number of steelhead fry emigrating during different lunar phases (P=.171).

Peak emigration of steelhead 1+ juveniles occurred prior to the onset of emigration by steelhead fry. Emigration for these larger juveniles peaked in Terwer and Tectah Creeks the third week in April and in Roach Creek during the first week in May (Figure 8). Following these peaks, the numbers of steelhead 1+ juveniles captured in traps remained very low but frequent to the end of trapping operations. Unlike the steelhead fry, peaks in emigration did not coincide with inclement weather (Figure 9). Neither weather nor lunar phase were significantly associated with the number of 1+ juveniles captured in traps (P=.342 and P=.609, respectively). Reliability of data and interpretation of results were confounded by the suspected low efficiency of traps in capturing steelhead 1+ juveniles. On several occasions, these larger juveniles were observed swimming in and out of the mouth of the fyke nets. Curiously, the emigration peaks observed for these larger juveniles in Terwer and Tectah Creeks

Figure 6. Migration pattern of young-of-year steelhead emigrating selected streams during spring trapping, 1989, using expanded numbers per trap night.

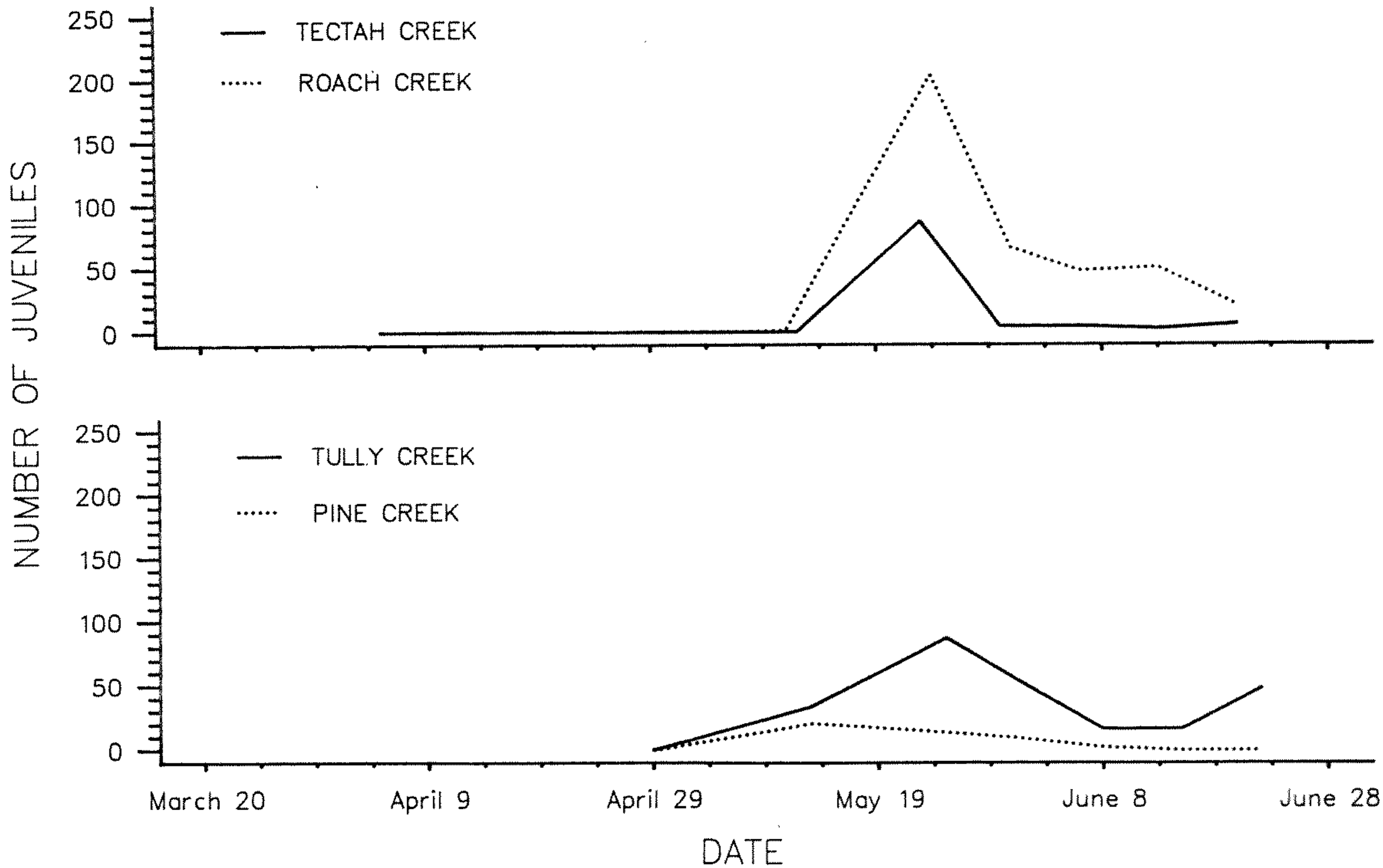


Figure 7. Influence of lunar phase and weather on numbers of young-of-year steelhead emigrating tributaries to the lower Klamath River, spring 1989.

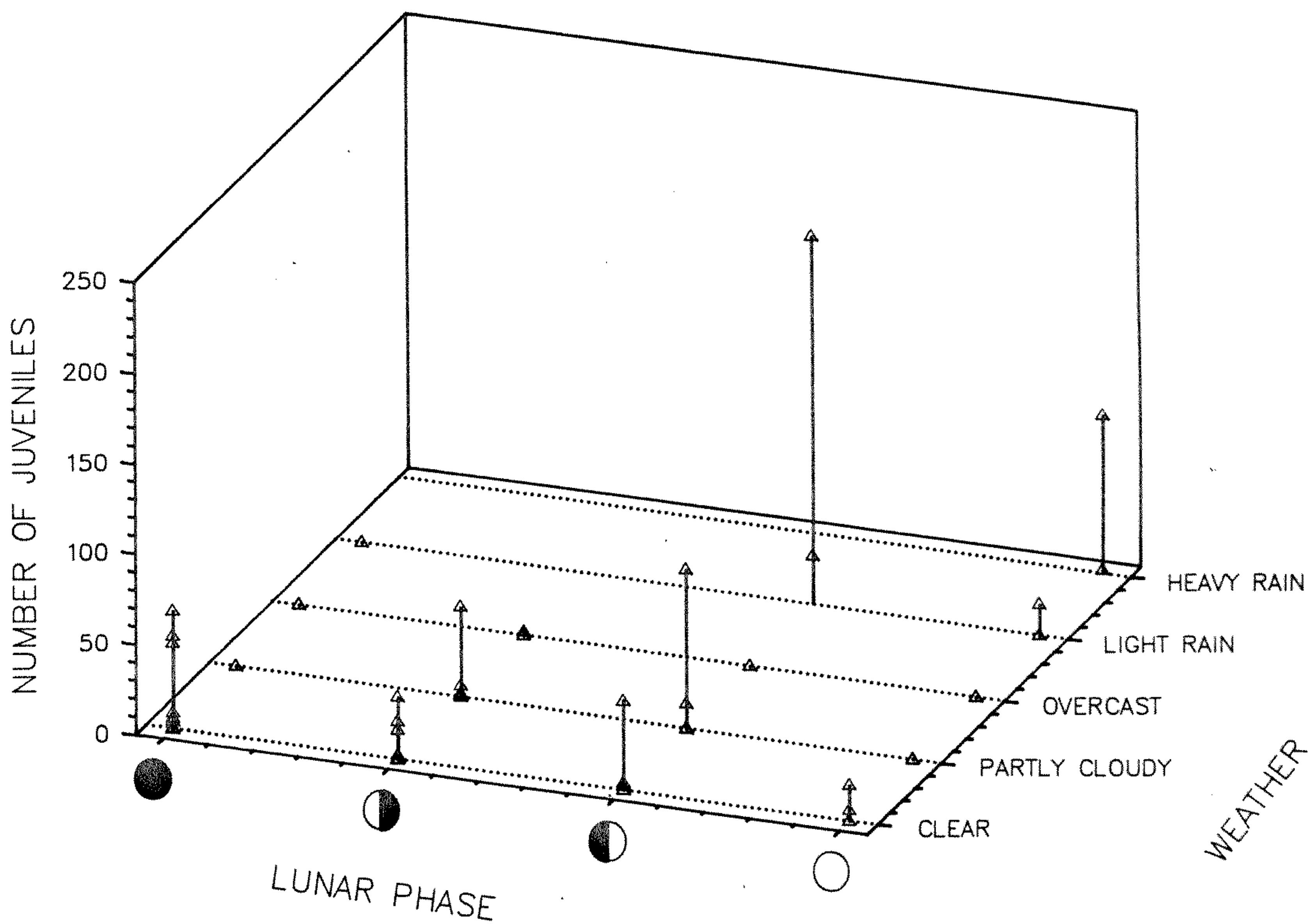


Figure 8. Migration pattern of steelhead 1+ juveniles emigrating selected streams during spring trapping, 1989, using expanded numbers per trap night.

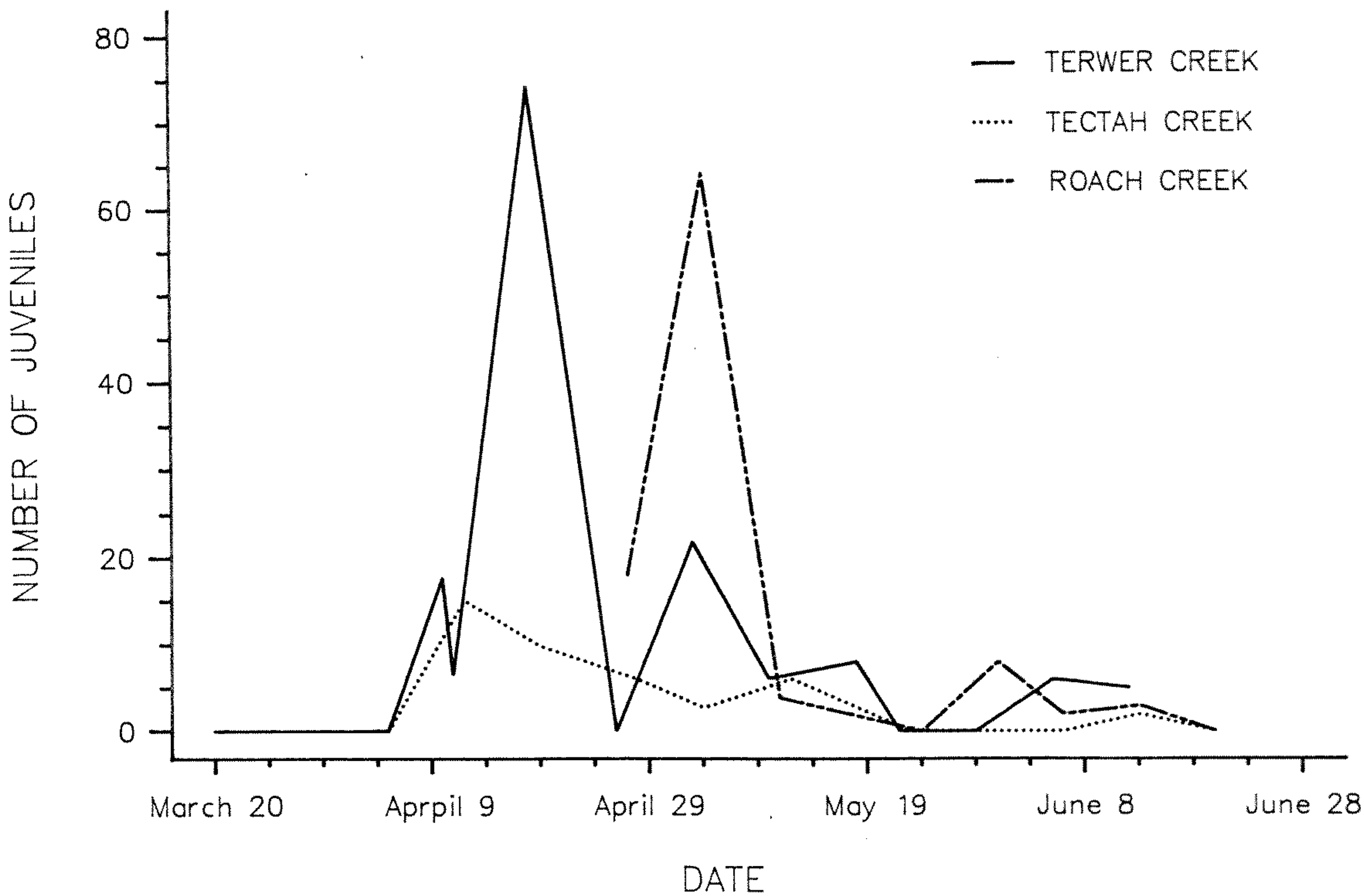
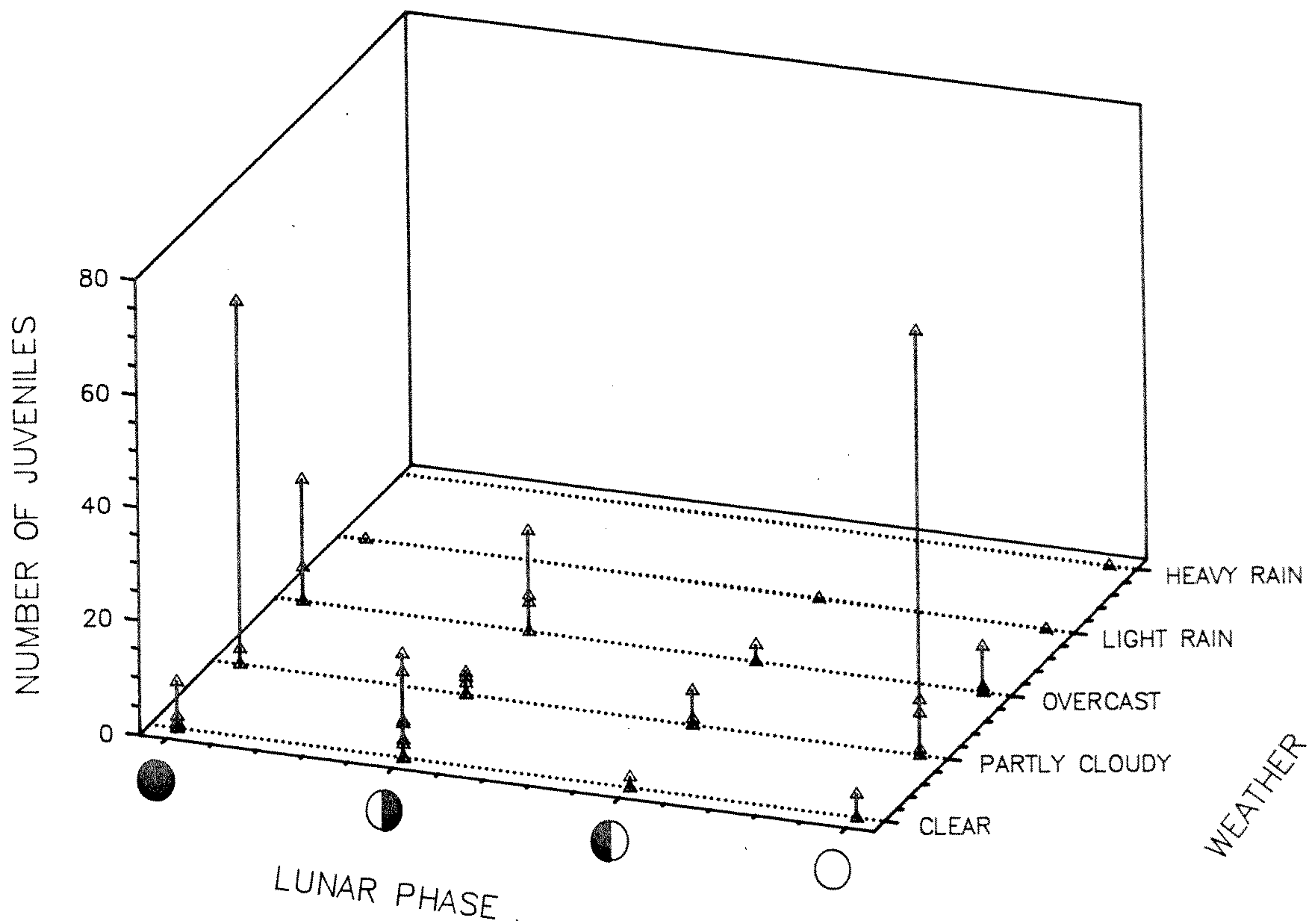


Figure 9 . Influence of lunar phase and weather on numbers of steelhead 1+ juveniles emigrating tributaries to the lower Klamath River, spring 1989.



coincided with peaks observed for chinook fry in those creeks (Figures 6 and 8). It is possible the larger juveniles were preying on chinook fry and subsequently followed them into traps. If this is true, patterns of emigration observed for steelhead 1+ juvenile may be more indicative of what was occurring among the chinook fry than what was actually occurring among the these larger steelhead juveniles. In view of this interpretation, the only results on emigration for steelhead 1+ juveniles that might be reliable are those observed for Roach Creek where chinook fry were in very low numbers.

Overall, there was no significant difference in mean fork length of steelhead fry captured in traps in Tectah, Roach, Tully, and Pine Creeks (P=.252) (Figure 10). However, there were significant differences in average fork lengths among fry captured in these creeks when data were compared within trap weeks for weeks 11 - 14 (May 28 - June 24). During those weeks, Pine and Tully Creeks had significantly smaller average fork lengths than Tectah and Roach Creeks during weeks 11 - 12, and Pine Creek had significantly smaller average fork length than the other three creeks during weeks 13 - 14 (P ranged from .036 and <.001). We do not know if these differences were related to patterns of growth or timing of emergence. In Tectah, Roach, and Tully Creeks, average fork length ranged from 29-32 mm at the start of emigration in April and dramatically increased after week 12 (June 4 - June 10) to the end of the trapping operation (Figure 11). In Pine Creek, the observed lack of increase in average size of steelhead fry through time may be a function of relatively low sample size rather than an indication of slow or impaired growth.

As with the fork lengths of steelhead fry, there were no significant difference in mean fork length of steelhead 1+ juveniles captured in traps in Terwer, Tarup, Bear, Tectah, and Roach Creeks (P=.374) (Figure 12). Although scale samples were not taken on these juveniles, we believe most of the steelhead 1+ juveniles captured in traps were yearlings, based on the range and average fork lengths captured each week through the trapping season (Table 5). It is possible that 2-year-old steelhead could have avoided traps and were not sampled. However, since most of the larger juvenile steelhead captured in traps appeared to be undergoing smoltification (silvery color, easy descaling), it is possible that 2-year-old steelhead are not common in these streams.

There was very little overlap in sizes of steelhead fry and 1+ juveniles that could cause misidentification of age class. At the end of the trapping season, the largest steelhead fry captured in a trap was 73 mm. The smallest steelhead 1+ juvenile was captured the fourth week of trapping (April 9 - 15), prior to the onset of steelhead fry emigration, and measured 68 mm. When steelhead fry were initially captured in traps (week 8 of the trapping operation = May 7-May 13) they ranged in fork length from 22-52 mm. At that time, the smallest steelhead 1+ juvenile captured in a trap was 75 mm.

Expanded estimates for steelhead fry and 1+ juveniles emigrating from sampled streams during the trapping season were 6,964 and 1,928, respectively. Half of the steelhead 1+ juveniles (n=943) emigrated from Terwer Creek. These estimates represent only those juveniles that emigrated past trap sites during the short spring trapping season. The production of steelhead in these streams is probably much greater than estimates suggest. We may have sampled only a small portion of the steelhead emigrating from nursery streams since emigration of juveniles is commonly protracted and we currently have no data to determine how many juveniles remain in streams for rearing. These data do suggest, however, that the production in sampled streams was considerably higher for

Figure 10 . 95 percent confidence intervals for means of fork lengths for young-of-year steelhead captured in traps, 1989.

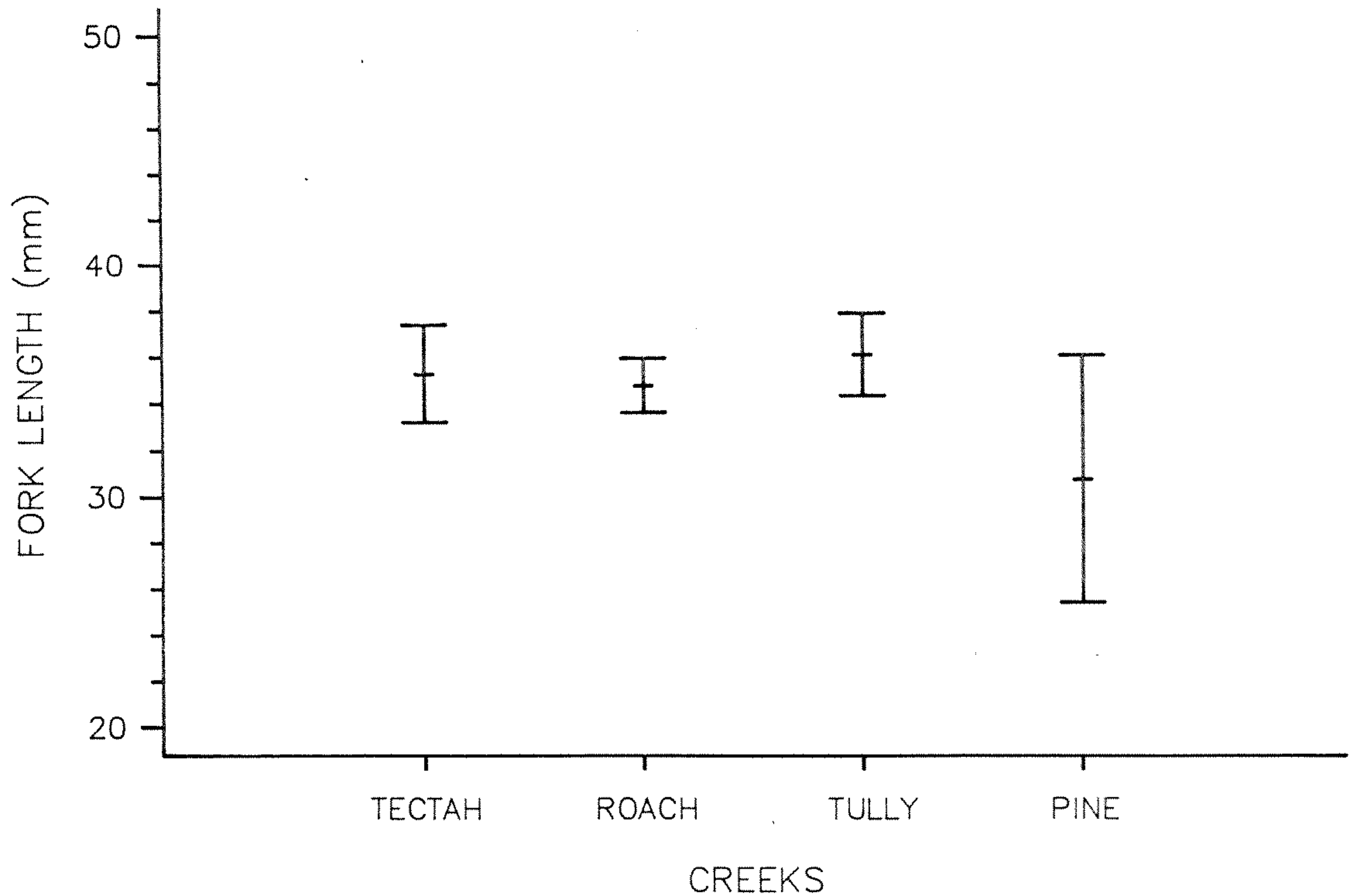


Figure 11. Average fork length of young-of-year steelhead captured each week in traps at Tectah, Roach, Tully, and Pine Creeks, 1989.

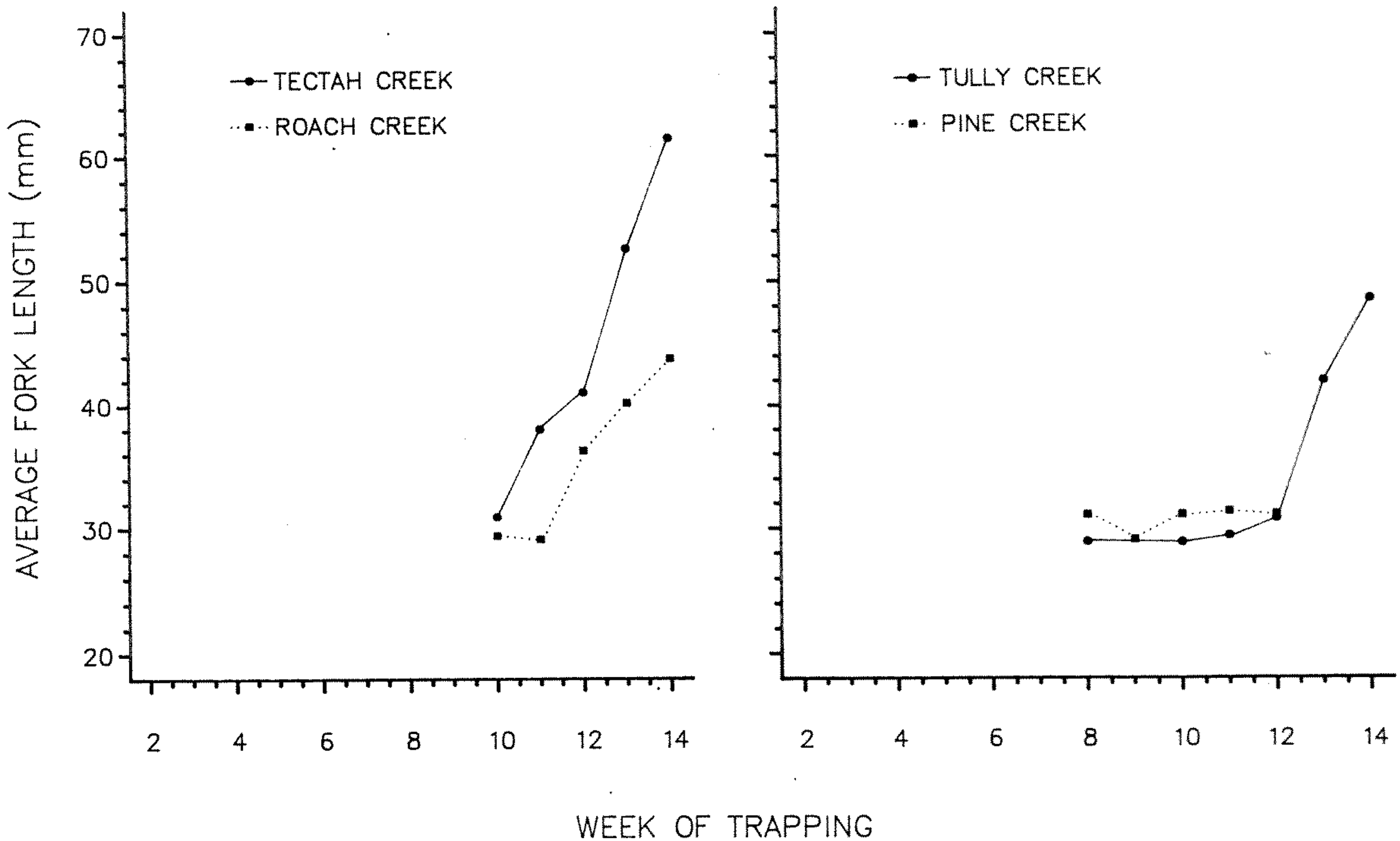


Figure 12. 95 percent confidence intervals for means of fork lengths for steelhead 1+ juveniles captured in traps, 1989.

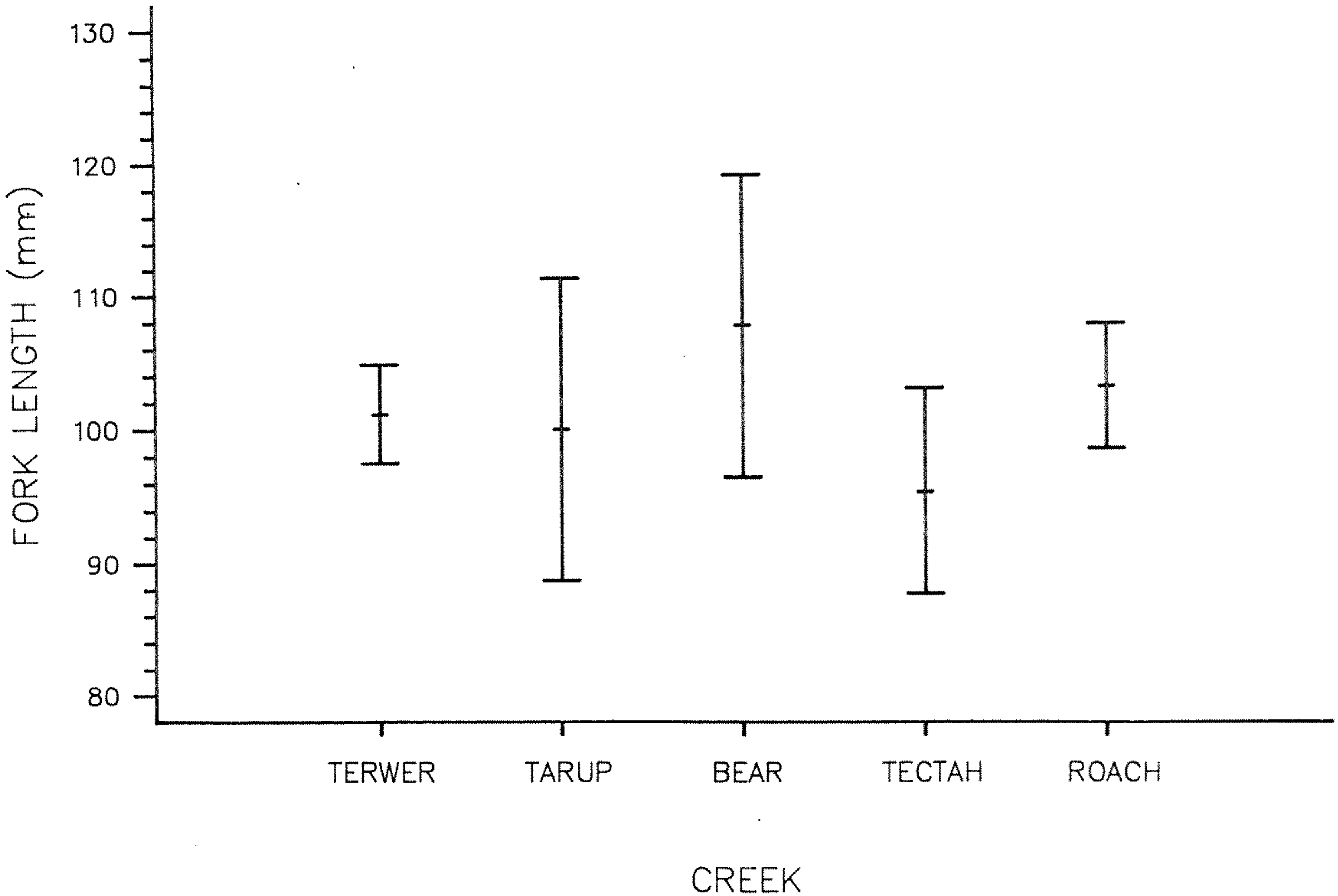


Table 5. Average, minimum, and maximum fork lengths (mm) of steelhead 1+ juveniles by week of capture during trapping operations in Terwer, Tarup, Bear, Tectah, and Roach Creeks, 1989.

Weeks	Sample size	Average	Minimum	Maximum
4	23	87.35	68	117
5	57	97.26	70	150
6	10	106.00	71	174
7	56	101.38	82	135
8	15	106.13	75	137
9	8	114.50	85	134
11	8	106.50	102	113
12	8	126.13	100	180
13	11	109.73	70	148

steelhead than for other salmonid species. In ensuing years of investigation, we hope to determine if lower tributaries are near carrying capacity for steelhead.

Coho salmon (O. kisutch)

Juvenile coho were captured in seven of the ten streams sampled in spring, 1989 (Table 4). Coho numbers were very low and their occurrence infrequent except in Terwer Creek. Both coho fry and coho yearlings were taken from traps. We began capturing juvenile coho the first week in April. In Terwer Creek, two emigration peaks were observed (Figure 13). The first peak occurred the second week in April and consisted entirely of coho fry. The second peak, occurring the first week in May, consisted mostly of yearling coho. Emigration peaks observed for juvenile coho in Terwer Creek did not coincide with inclement weather. There was no discernible difference in numbers of coho juveniles captured during different weather types or lunar phases (P=.553 and .792, respectively) (Figure 14). These results suggest that emigration by coho in Terwer Creek may have been by volition rather than dislodgment by rain induced high flows.

Although scale samples were not taken from juvenile coho, we could easily distinguish fry from yearlings by size. Fork lengths for coho fry averaged 52.59 mm for the trapping season and ranged from a minimum of 38 mm during the week of April 9-15 to a maximum of 75 mm during the week of May 28-June 3. Fork lengths for coho yearlings ranged from a minimum of 93 mm during the week of April 16-22 to a maximum of 130 mm during the week of May 14-20 and averaged 115.08 mm. We did note that most of the juvenile coho taken from traps, regardless of age class, were undergoing smoltification. This observation suggests that coho in these streams have adopted two life history strategies: some juveniles emerge in streams and remain there during their first year of life while others emerge, undergo smoltification, and emigrate as fry.

The expanded estimate for juvenile coho emigrating during the trapping season was 482; most of these (n=386) were from Terwer Creek. Emigration by juvenile coho probably extends beyond the time frame of our trapping season. Although our data is limited, it does suggest that coho populations in the lower tributaries are very low and that coho production was highest in Terwer Creek.

Cutthroat trout (O. clarki)

Juvenile cutthroat trout were captured in only Hunter, Terwer, Tarup, and Ah Pah Creeks (Table 3). The occurrence of cutthroat trout in Terwer and Ah Pah Creeks was not noted in previous reports (Table 2). It is interesting to note that these streams enter the Klamath River downstream of river kilometer 30 and were the downstream- most streams included in trapping operations. Due to the location of these streams, we feel the probability is high for these juveniles to be anadromous.

Cutthroat captured in traps were extremely low in number and their occurrence was very infrequent (Table 4). We were unable to establish peak, duration, and trends of emigration among juvenile cutthroat due to low sample size in all streams. Among the 23 cutthroat captured in all four streams, fork lengths ranged from 89 to 158 mm and averaged 123.83 mm. In view of these fork lengths, the juvenile cutthroat captured were probably at least yearlings.

Figure 13 . Migration pattern of juvenile coho emigrating Terwer Creek during spring trapping, 1989, using expanded numbers per trap night.

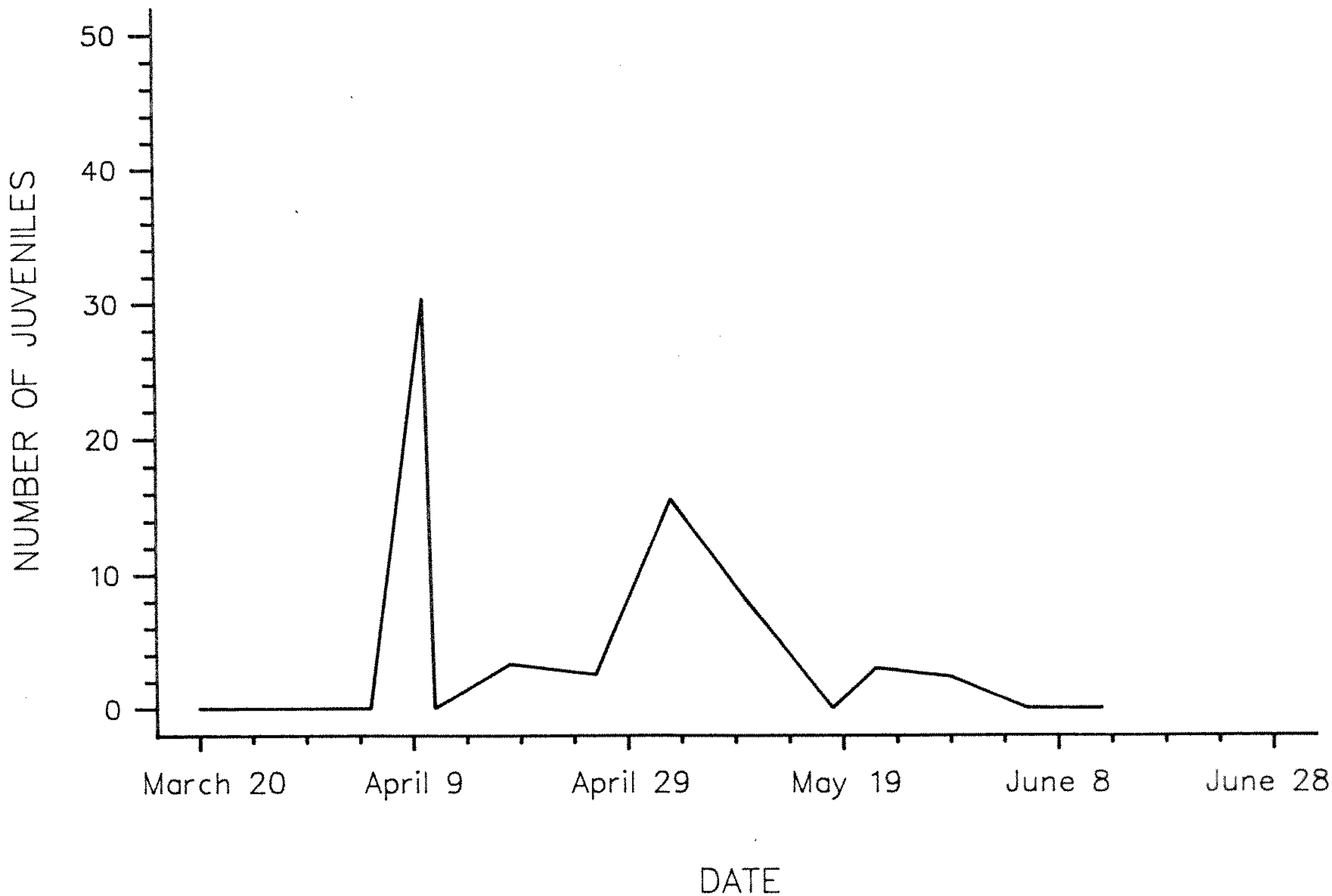
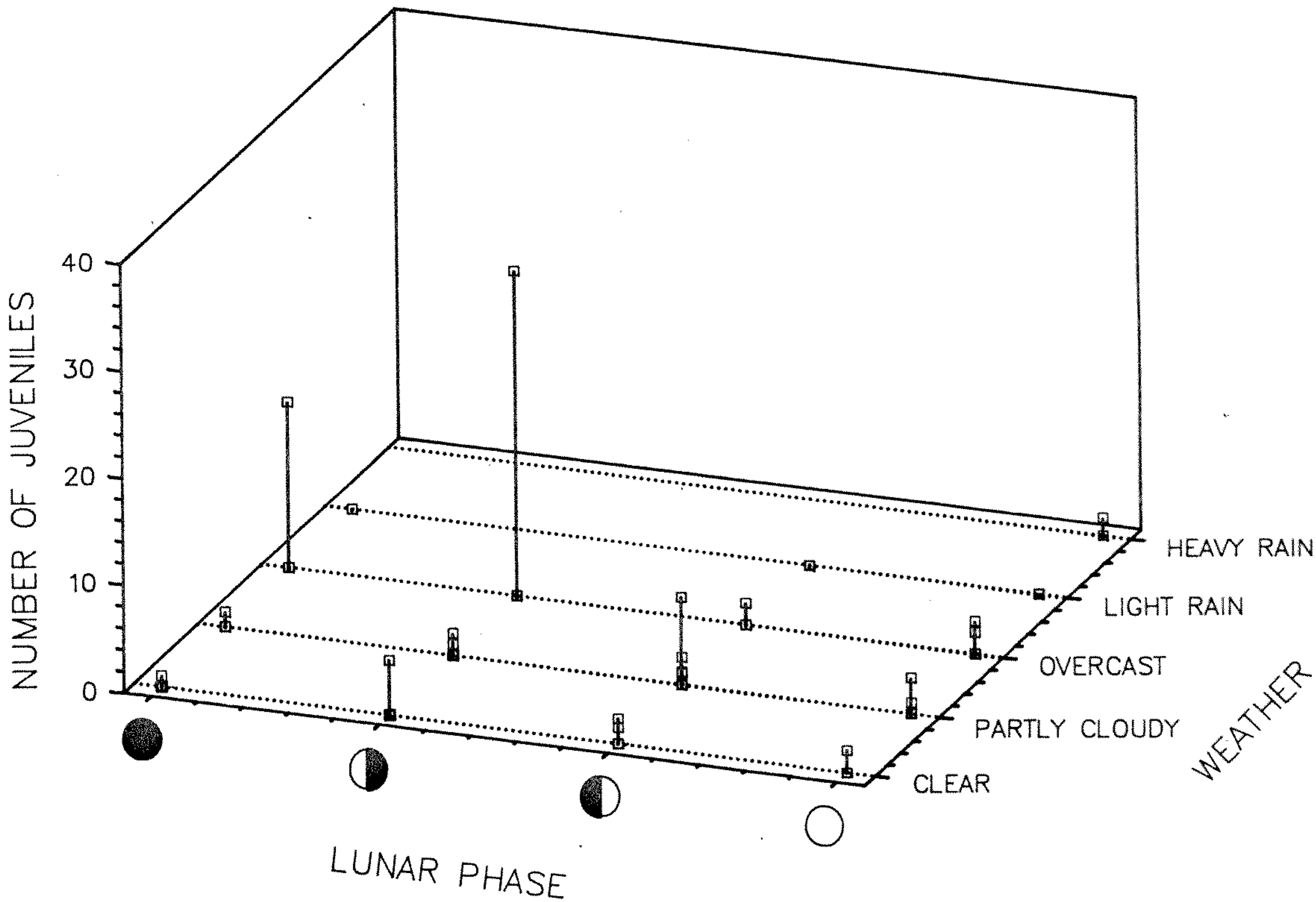


Figure 14 . Influence of lunar phase and weather on numbers of juvenile coho emigrating tributaries to the lower Klamath River, spring 1989.



Non-salmonid species

Five species of non-salmonids were captured in traps: threespine stickleback (<u>Gasterosteus aculeatus</u>), sucker (<u>Catostomus</u> spp.), lamprey adults and ammocetes (<u>Lampetra</u> spp.), dace (<u>Rhynichthys</u> spp. - probably the speckled dace <u>R. osculus</u>), and sculpin (<u>Cottus</u> spp.) (Table 3). In five of the streams, dace and sculpins made up over 60% of the total fish captured in each creek during the trapping season (Table 4). Sculpins were usually captured as adults in spawning condition. These adults often preyed on small steelhead and chinook fry in trap boxes. Although the degree of predation on chinook and steelhead was not closely monitored, we will need to address this problem in subsequent years of trapping to avoid potential bias of estimates.

SUMMARY

The following list highlights results from findings for the first year of investigations on the lower tributaries to the Klamath River:

1) In the winter of 1989, 12 of the 24 lower tributaries under investigation were rated minimal to low in quality and quantity of potential spawning and rearing habitat. Another seven streams were rated low to moderate in potential while only five streams received moderate to high ratings (Table 2).

2) In the spring of 1989, preliminary trapping operations were conducted to capture emigrating juvenile salmonids in 10 streams previously rated at least moderate for potential spawning habitat and/or where adult chinook or steelhead had been observed during the fall and winter of 1989. The streams sampled were Hunter, Terwer, Tarup, Ah Pah, Bear, Tectah, Pecwan, Roach, Tully, and Pine Creeks.

3) Juvenile chinook were captured in all streams except Tarup, Pecwan, and Tully Creeks. Juvenile steelhead were captured in all ten streams and were the dominant salmonid species in each. Juvenile coho were taken from all traps except those on Pecwan, Tully, and Pine Creeks. Juvenile cutthroat trout were captured only in Hunter, Terwer, Tarup, and Ah Pah Creeks (Table 3).

4) Among the ten streams sampled in 1989, chinook fry were most common in Hunter, Terwer, and Tectah Creeks while juvenile steelhead were relatively abundant in Terwer, Tectah, Roach, and Tully Creeks. Although juvenile coho were relatively uncommon in all ten streams, they were captured more frequently in Terwer Creek than any other stream. Juvenile cutthroat trout were very uncommon in all streams.

5) Most chinook were captured as fry, but a few yearlings were taken from traps in Hunter, Terwer, Ah Pah, and Bear Creeks. This was unexpected since chinook in the lower tributaries are believed to be of the fall race and the yearling stage is uncommon among fall chinook in the Klamath River Basin.

6) Emigration of juvenile chinook began the first week in April, peaked the second week in April and again the first week in May (Figure 2).

7) No significant relationship was found between the number of chinook fry emigrating from streams and lunar periodicity or weather (Figure 3).

8) Mean fork length of chinook fry was progressively larger for fry in streams closer to the ocean (Figures 4 and 5).

9) Expanded estimates of chinook fry emigrating from streams during the trapping season (n=3,680) would require the successful spawning of only 11 females, 9 males, and 3 jacks. Although we question the reliability of these estimates, they do alert us the potential underuse of available spawning habitat (spawner limited) in these streams.

10) Emigration by steelhead fry began the second week in May, peaked the last week in May, and was significantly greater during inclement weather. Lunar periodicity, however, was not significantly associated with the number of fry emigrating streams.

11) Emigration by steelhead 1+ juveniles peaked prior to the onset of emigration by steelhead fry from streams and did not show a significant association with lunar periodicity or weather.

12) Emigration patterns observed among the larger steelhead juveniles closely paralleled those of the chinook fry. These larger steelhead may have been preying on the chinook fry and were captured when they followed their prey into traps.

13) Most steelhead 1+ juveniles captured in traps were suspected to be yearlings (one-year-old) that were undergoing smoltification.

14) Expanded estimates for steelhead fry and 1+ juveniles suggest steelhead production in the lower tributaries is relatively healthy when compared with relative abundances of other salmonid species captured in sampled streams.

15) Juvenile coho were captured as both fry and yearlings and most of these individuals, regardless of age class, were undergoing smoltification.

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SUMMARY OF EXPENDITURES

OBJECT	COST ($)	
Salaries:		
Field crew (1 GS-5 Fishery Biologist and 1 GS-5 Biological Technician)	18,228	
Oversite (1 GS-9 Fishery Biologist)	2,853	
Per diem (overnight in field)	410	
Vehicle (GSA rental and gas)	2,819	
Equipment:		
Minor	1,139	
Major	0	
TOTAL	25,449	(funded for $24,000; $1,449 absorbed by FAO-Arcata)

Appendix A. Actual numbers of juveniles captured and expanded numbers of juveniles using proportion of stream width sampled during each trap night during spring season, 1989.

Creek name	Trap night	Proportion of stream sampled	Actual number of juveniles						Expanded number of juveniles					
			CHN 0	CHN 1+	STH 0	STH 1+	Coho	CUTT	CHN 0	CHN 1+	STH 0	STH 1+	Coho	CUTT
Hunter	April 11	0.419	2	0	0	0	0	0	5	0	0	0	0	0
	April 12	0.419	0	0	0	1	0	0	0	0	0	2	0	0
	April 18	0.497	6	0	0	0	0	0	12	0	0	0	0	0
	April 26	0.529	1	2	0	1	0	0	2	4	0	2	0	0
	May 3	0.640	14	0	0	0	0	0	22	0	0	0	0	0
	May 10	1.000	0	0	0	0	0	0	0	0	0	0	0	0
	May 18	1.000	0	0	0	1	0	0	0	0	0	1	0	0
	May 22	1.000	0	0	0	0	0	1	0	0	0	0	0	1
	May 29	0.658	5	0	0	0	1	0	8	0	0	0	2	0
Terwer	March 20	0.222	0	0	0	0	0	0	0	0	0	0	0	0
	March 21	0.190	0	0	0	0	0	0	0	0	0	0	0	0
	April 4	0.118	1	0	0	0	0	0	8	0	0	0	0	0
	April 5	0.118	1	0	0	0	0	0	8	0	0	0	0	0
	April 10	0.395	0	0	0	7	12	1	0	0	0	18	30	3
	April 11	0.465	26	0	1	3	0	0	56	0	2	6	0	0
	April 18	0.606	5	1	0	45	2	1	8	2	0	74	3	2
	April 26	0.401	1	0	0	0	1	0	2	0	0	0	2	0
	May 3	0.644	11	0	0	14	10	4	17	0	0	22	16	6
	May 10	1.000	36	0	0	6	8	1	36	0	0	6	8	1
	May 18	1.000	4	0	0	8	0	0	4	0	0	8	0	0
	May 22	1.000	1	0	0	0	3	0	1	0	0	0	3	0
	May 29	0.431	14	0	1	0	1	0	32	0	2	0	2	0
	June 5	1.000	8	0	0	6	0	1	8	0	0	6	0	1
	June 12	1.000	8	0	2	5	0	0	8	0	2	5	0	0
Tarup	March 21	0.500	0	0	0	0	0	0	0	0	0	0	0	0
	April 3	0.794	0	0	0	0	0	0	0	0	0	0	0	0
	April 4	0.794	0	0	0	0	0	0	0	0	0	0	0	0
	April 10	0.962	0	0	0	6	0	2	0	0	0	6	0	2
	April 11	0.962	0	0	0	0	0	2	0	0	0	0	0	2
	April 18	0.961	0	0	0	4	2	3	0	0	0	4	2	3

(continued Appendix A)

Creek name	Trap night	Proportion of stream sampled	Actual number of juveniles						Expanded number of juveniles					
			CHN 0	CHN 1+	STH 0	STH 1+	Coho	CUTT	CHN 0	CHN 1+	STH 0	STH 1+	Coho	CUTT
Ah Pah	March 20	0.720	0	0	0	0	0	0	0	0	0	0	0	0
	March 21	0.720	1	0	0	0	0	0	1	0	0	0	0	0
	April 3	0.667	0	0	0	0	0	0	0	0	0	0	0	0
	April 4	0.667	0	0	0	0	0	0	0	0	0	0	0	0
	April 10	1.000	0	0	0	0	0	0	0	0	0	0	0	0
	April 18	0.988	0	1	0	0	1	3	0	1	0	0	1	3
	April 28	0.871	0	0	0	1	1	1	0	0	0	1	1	1
	May 3	1.000	0	0	0	0	0	0	0	0	0	0	0	0
	May 10	1.000	0	0	0	0	0	0	0	0	0	0	0	0
	May 18	1.000	0	0	0	1	2	1	0	0	0	1	2	1
	May 22	1.000	0	0	0	3	2	3	0	0	0	3	2	3
	May 29	1.000	0	0	0	0	1	0	0	0	0	0	1	0
Bear	April 19	0.946	0	1	0	7	0	0	0	1	0	7	0	0
	April 28	0.652	0	2	0	2	0	0	0	3	0	3	0	0
	May 5	1.000	0	0	0	1	0	0	0	0	0	1	0	0
	May 12	1.000	0	0	0	0	2	0	0	0	0	0	2	0
	May 23	0.600	0	0	1	0	1	0	0	0	2	0	2	0
	May 30	1.000	0	0	0	0	0	0	0	0	0	0	0	0
Tectah	April 5	0.624	0	0	0	0	0	0	0	0	0	0	0	0
	April 12	0.468	32	0	0	7	0	0	68	0	0	15	0	0
	April 19	0.103	1	0	0	1	0	0	10	0	0	10	0	0
	April 28	0.679	4	0	0	4	0	0	6	0	0	6	0	0
	May 4	0.738	4	0	0	2	1	0	5	0	0	3	1	0
	May 12	1.000	25	0	0	6	5	0	25	0	0	6	5	0
	May 23	0.800	5	0	69	0	0	0	6	0	86	0	0	0
	May 30	1.000	7	0	4	0	0	0	7	0	4	0	0	0
	June 6	1.000	6	0	4	0	0	0	6	0	4	0	0	0
	June 13	1.000	1	0	2	2	0	0	1	0	2	2	0	0
	June 20	1.000	2	0	6	0	0	0	2	0	6	0	0	0
Pecwan	April 27	0.512	0	0	0	0	0	0	0	0	0	0	0	0
	May 5	0.163	0	0	0	0	0	0	0	0	0	0	0	0
	May 11	0.160	0	0	0	0	0	0	0	0	0	0	0	0
	May 24	0.076	0	0	2	0	0	0	0	0	26	0	0	0
	May 31	0.351	0	0	2	0	0	0	0	0	6	0	0	0

(continued Appendix A)

Creek name	Trap night	Proportion of stream sampled	Actual number of juveniles						Expanded number of juveniles					
			CHN 0	CHN 1+	STH 0	STH 1+	Coho	CUTT	CHN 0	CHN 1+	STH 0	STH 1+	Coho	CUTT
	June 6	0.310	0	0	0	0	0	0	0	0	0	0	0	0
	June 13	0.324	0	0	2	0	0	0	0	0	6	0	0	0
Roach	April 27	0.222	0	0	0	4	0	0	0	0	0	18	0	0
	May 4	0.625	0	0	0	40	0	0	0	0	0	64	0	0
	May 11	0.787	0	0	1	3	0	0	0	0	1	4	0	0
	May 24	0.332	30	0	67	0	0	0	90	0	202	0	0	0
	May 31	1.000	0	0	65	8	0	0	0	0	65	8	0	0
	June 6	1.000	1	0	47	2	1	0	1	0	47	2	1	0
	June 13	1.000	3	0	50	3	1	0	3	0	50	3	1	0
	June 20	1.000	0	0	20	0	0	0	0	0	20	0	0	0
Tully	April 29	0.167	0	0	0	0	0	0	0	0	0	0	0	0
	May 13	0.176	0	0	6	0	0	0	0	0	34	0	0	0
	May 25	0.298	0	0	26	0	0	0	0	0	87	0	0	0
	June 1	0.333	0	0	17	0	0	0	0	0	51	0	0	0
	June 8	0.372	0	0	6	0	0	0	0	0	16	0	0	0
	June 15	0.350	0	0	6	0	0	0	0	0	17	0	0	0
	June 22	0.573	0	0	28	0	0	0	0	0	49	0	0	0
Pine	April 29	0.127	2	0	0	0	0	0	16	0	0	0	0	0
	May 13	0.144	1	0	3	0	0	0	7	0	21	0	0	0
	May 25	0.148	0	0	2	0	0	0	0	0	14	0	0	0
	June 1	0.461	0	0	4	1	0	0	0	0	9	2	0	0
	June 8	0.496	0	0	1	0	0	0	0	0	2	0	0	0
	June 15	0.638	0	0	0	0	0	0	0	0	0	0	0	0
	June 22	0.568	0	0	0	0	0	0	0	0	0	0	0	0