FRI-UW-8102
January 1981

FISHERIES RESEARCH INSTITUTE
College of Fisheries
University of Washington
Seattle, Washington 98195

THE DISTRIBUTION AND ABUNDANCE OF JUVENILE SALMONIDS IN THE NISQUALLY RIVER FROM SPRING TO MIDSUMMER

by

James B. Scott

FINAL REPORT

for the period April 1 to August 30, 1980

to

The City of Tacoma
and
The City of Centralia

Approved

Submitted January 9, 1981

[signature]
Director

TABLE OF CONTENTS

	Page
INTRODUCTION	1
METHODS	1
Beach Seining	6
RESULTS	6
Timing of Emergence	9
Temporal Abundance of Juvenile Salmonids	15
Chinook	15
Coho	21
Chum	21
Pink	24
Rainbow-Steelhead	24
Comparative Abundance of Juvenile Salmonids in 1979 and 1980	24
Chinook	25
Coho	27
Chum	27
Rainbow-Steelhead	27
Density of Juvenile Salmonids by Site	28
Chinook	28
Coho	28
Chum	28
Rainbow-Steelhead	34
Preference of Juvenile Salmonids for Bank vs. Bar Habitat	34
Habitat Preferences of Age 0 Salmonids	37
Habitat Preferences of Age I Salmonids	39
SUMMARY	40
LITERATURE CITED	43
APPENDICES	44

LIST OF TABLES

Table		Page
1.	Length, characteristics, and correspondence of sample sites to those of previous year	5
2.	Mean daily flow and visibility on the Nisqually River during sampling, 1980	7
3.	Fish plantings in the Nisqually River and tributaries which may have influenced electrofisher catches during the April-July 1980 sampling season	8
4.	Salmonid escapement and tribal harvest for the years 1978-79 and 1979-80	23
5.	Average length of site sampled in 1979, length of site sampled in 1980, and average electrofisher timer units expended per meter of site sampled in 1979 and 1980	26
6.	Preference of age 0 and I chinook, coho, chum, and rainbow-steelhead for different habitat types as determined by analysis of catch data	38

Appendix Table

1.	Salmonids caught by electrofisher	44
2.	Salmonids caught by beach seine	47
3.	Length frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of rainbow-steelhead by sampling date	48
4.	Length frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of chinook by sampling date	52
5.	Length frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of coho by sampling date	54
6.	Length frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of chum by sampling date	57

LIST OF FIGURES

Figure		Page
1.	Map of Nisqually River detailing major tributaries, Centralia Diversion Canal, and sampling sites	2
2.	River mile locations on the mainstem Nisqually River of major tributary streams, Centralia Diversion Canal, dams, and study sites	3
3.	Length frequency histogram of subsampled electrofisher catch of juvenile chinook	10
4.	Percentage of total sampled emergent chinook fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches	11
5.	Length frequency histogram of subsampled electrofisher catch of juvenile coho	12
6.	Percentage of total sampled emergent coho fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches	13
7.	Length frequency histogram of subsampled electrofisher catch of chum fry	14
8.	Percentage of total sampled emergent chum fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches	16
9.	Length frequency histogram of subsampled electrofisher catch of juvenile rainbow-steelhead	17
10.	Percentage of total sampled emergent rainbow-steelhead fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches	18
11.	Electrofisher catch combined over all sites in 1979 and 1980 and total of beach seine catches at sites 1 and 4 of age 0 chinook, coho, chum, and rainbow-steelhead	19

Figure | Page

12. Electrofisher catch combined over all sites in 1979 and 1980 and total of beach seine catches at sites 1 and 4 of age I chinook, coho, chum, and rainbow-steelhead 20

13. Average discharge at La Grande for 5-day intervals in 1979 and 1980 22

14. Electrofisher catch density of age 0 chinook by habitat type and site 29

15. Electrofisher catch density of age I chinook by habitat type and site 30

16. Electrofisher catch density of age 0 coho by habitat type and site 31

17. Electrofisher catch density of age I coho by habitat type and site 32

18. Electrofisher catch density of age 0 chum by habitat type and site 33

19. Electrofisher catch density of age 0 rainbow-steelhead by habitat type and site 35

20. Electrofisher catch density of age I rainbow-steelhead by habitat type and site 36

21. Primary timing of emergence and outmigration for chinook, coho, chum, and rainbow-steelhead in the Nisqually River 41

ACKNOWLEDGMENTS

The field work necessary to complete this study required the assistance of many people. The expertise and time provided by J. Easterbrooks (Washington State Department of Fisheries), J. Gilstrom (Washington State Department of Game), B. Harrington-Tweit (Nisqually Indian Tribe), and J. Kerwin (Puyallup Indian Tribe) is appreciated.

Thanks is also due to the Nisqually Indian Tribe for allowing the use of their facilities for laboratory work. The help of tribal biologist P. Svoboda was instrumental in obtaining catch and escapement estimates for Nisqually River salmon and steelhead.

Drs. Roy E. Nakatani and Robert L. Burgner, Richard W. Tyler, and C. Steward all provided comments which were helpful in the development of this report.

Financial support for this investigation was provided by the cities of Centralia and Tacoma.

INTRODUCTION

The Nisqually River, with headwaters on Mt. Rainier, is one of the larger streams draining into southern Puget Sound, Washington. As such, it supports runs of salmon (chinook, coho, chum, pink) and steelhead trout which are important to the commercial and sport fisheries of the region, and particularly to the Nisqually Indian Tribe, which conducts a fishery within the river (Tyler 1980). Enhancement of natural stocks by hatchery plants is expected to increase the magnitude of these runs in future years.

The abundance of anadromous fish in the future may also be influenced by the manner in which the three hydroelectric dams on the Nisqually River are operated. Further enhancement (or degradation) of the resource could occur to the degree which these dams are able to modify river discharge.

Discharge is primarily controlled by the City of Tacoma's LaGrande power dam (RM 42.5). However, flow may be further reduced between river miles 12.6 to 26.2 (Yelm Reach) (Figs. 1 and 2) by diversion of water to the City of Centralia's power plant.

Hearings held under the jurisdiction of the Federal Energy Regulatory Commission have sought to establish a flow regime which meets both fish and hydroelectric power generation needs. An important consideration in the development of a flow regime will be the spatial distribution of the indigenous salmonid species as it is affected by the temporal cycle of fry emergence, rearing, and outmigration. Data on the distribution and abundance of juvenile salmonids in the Nisqually River during the period April 1979 through March 1980, is provided by Tyler (1980). Field sampling was extended through July 1980 in order to supplement Tyler's results and to examine the degree of annual variability associated with them.

METHODS

The location of the sites sampled in the present study correspond to those used by Tyler (1980) at the termination of his investigation. Approximate locations of the sites were river miles 11.0, 19.6, 25.4, and 32.8 (Figs. 1 and 2). The lowermost site was designated as 1 and the others were numbered consecutively upstream. Sites 2 and 3 were located in the Yelm Reach, while sites 1 and 4 were located below and above it, respectively.

Two types of habitat, bank and bar, were sampled at each site. A site was termed bank if the greater portion of it had shoreline with a slope exceeding 30 degrees. Shoreline with a slope of less than 10 degrees was termed bar.

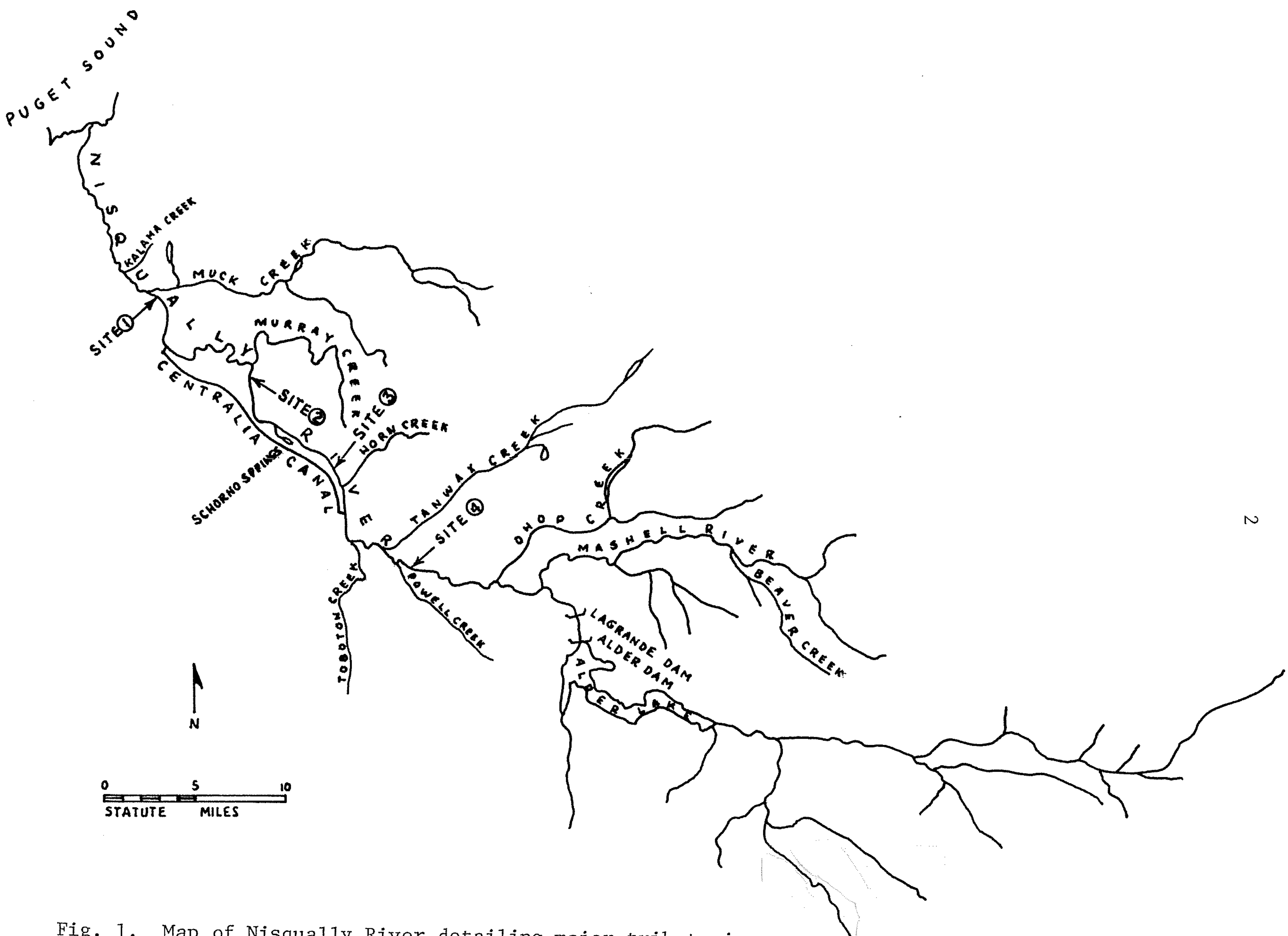

Fig. 1. Map of Nisqually River detailing major tributaries, Centralia Diversion Canal, and sampling sites. (From Tyler, 1980)

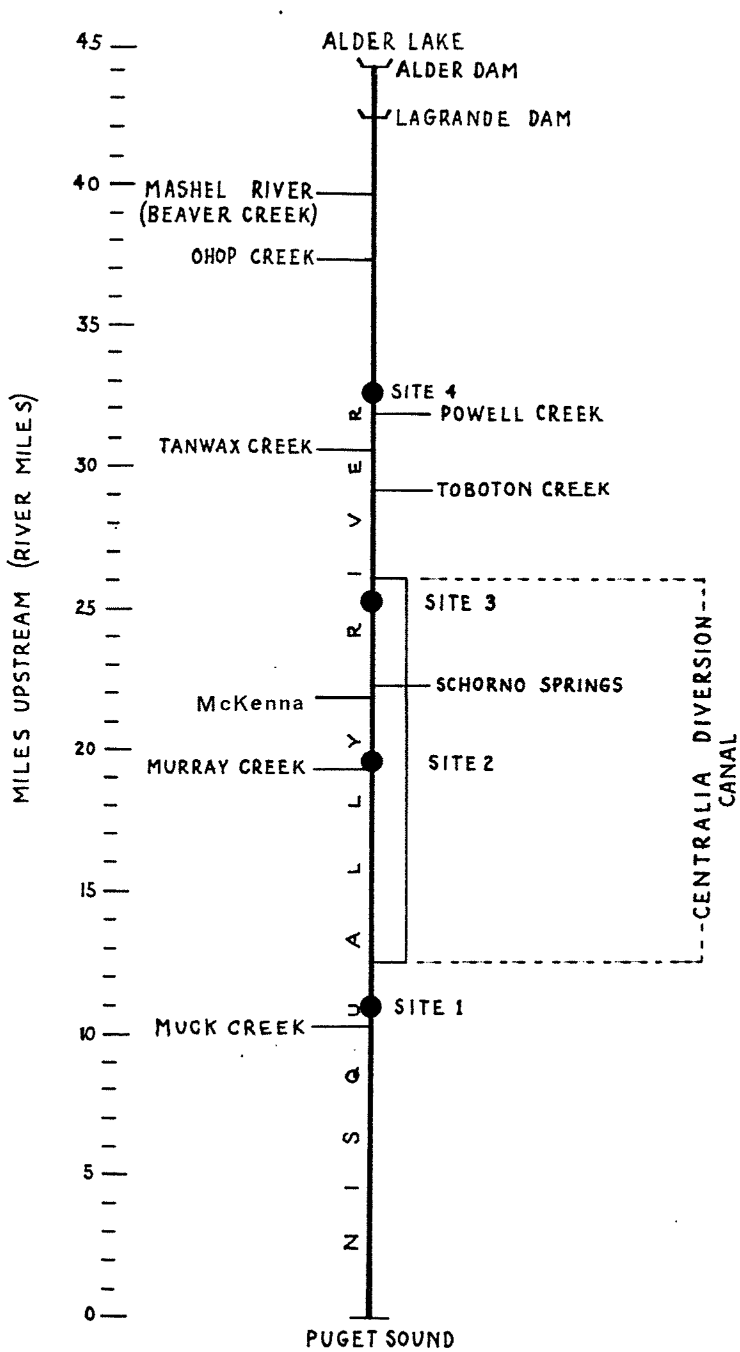

Fig. 2. River mile locations on the mainstem Nisqually River of major tributary streams, Centralia Diversion Canal, dams, and study sites. (From Tyler, 1980)

Length, characteristics, and correspondence of the current sites to those of 1979 are summarized in Table 1.

Sampling at each site was conducted biweekly, with each session taking 1-3 days, depending on the abundance of fish and the problems encountered. A two man team consisting of one biologist from FRI and one biologist from the Nisqually Tribe, Puyallup Tribe, Washington State Department of Game (WDG), or Washington State Department of Fisheries (WDF) was required to man the fish sampling gear.

Fish were sampled using a Smith-Root Type VII backpack electrofisher with the pulse interval set at 6 msec. Voltage was varied between 400 and 500 v and frequency between 58 and 70 hz as conditions warranted.

At each site, sampling proceeded upstream with the stunned fish netted and placed in a bucket filled with water. In shallow bar areas, emergent sized rainbow-steelhead frequently dove under rocks before they could be netted. To compensate for this, a downstream pass was also made at each bar with the exception of site 2, where fry were extremely abundant.

At the completion of sampling a particular bank or bar, the number of each species of salmonid caught was recorded. A subsample (∿20 fish of each species) of the catch was retained for length-weight measurements and the remainder released. To reduce the mortality of age I+ fish, their length was often determined in the field and no sample was taken. The fork length of each fish in the subsample was measured to the nearest millimeter. All fish within a 5 mm grouping (26-30, 31-35,...) were weighed to the nearest .01 g. Condition factors for each length group interval were calculated using the formula:

$$C_J = \frac{\bar{W}_J \times 10^5}{\bar{L}_J^3}$$

where: C = condition factor of fish in length group J.

$\bar{L}$ = mean length (mm) of fish in length group J.

$\bar{W}$ = mean weight (g) of fish in length interval J.

J = length groups by 5 mm intervals.

A Secchi disk was used to measure water clarity during each sampling session at the banks of sites 1 and 4.

Table 1. Length, characteristics, and correspondence of sample sites to those of previous year.

	Location (RM)	Length (m)	Correspondence of location to 1979	Cover	Stability
Site 1	11.0				
Bank		165	Identical	Poor	Poor
Bar		95	Identical	Poor	
Site 2	19.6				
Bank		119	Identical	Excellent	Excellent
Bar		90	Identical	Poor	
Site 3	25.4				
Bank		90	Identical*	Poor	Poor
Bar		90	Identical	Poor	
Site 4	32.8				
Bank		103	Identical	Excellent	Excellent
Bar		68	Identical*	Poor	

*Identical to the latter one used by Tyler (1980).

Beach Seining

Beach seining, using a 30-m long by 2-m deep 1/8" delta mesh net, was conducted in the months of May, June, and July by Nisqually Tribal biologists with assistance from the Washington State Departments of Fisheries and Game. An outboard powered skiff was used to set the seine near the head of an eddy pool before working down with the current and back to shore.

Data on the size and species composition of the catch by beach seine is included in this report primarily to document the use of mid-river habitat by juvenile salmonids. As sites 1 and 4 were most consistently sampled, the sum of catches in the first set at each of these sites was used to compare species abundance in each month.

RESULTS

Three known factors other than fry abundance may have affected the size and distribution of electrofisher catches. These are hatchery plantings, flow, and turbidity. Tyler (1980) believed turbidity exerted the greatest effect on the results obtained during the previous year's sampling. However, during the April-July period of this study, visibility was generally good and the riverbed could often be seen (Table 2).

Particularly at the bank portions of sites 2 and 4, low discharges reduced the amount of water flowing into areas with extensive cover, and thus reduced their capacity to hold fish. Site 2 bar (an island) was also very sensitive to changes in flow. During high flow periods it was completely covered with water and no longer qualified as bar habitat. Conversely, low flows increased the length of bar habitat available to fish. River flow was fairly stable after the April 29 sampling session (Table 2, and Fig. 13).

Hatchery plantings of chinook, coho, chum, and rainbow-steelhead were made in the Nisqually River and its tributaries from February through June. Plantings which occurred above the lowermost sampling site (RM 11.0) during the period April through June are tabulated in Table 3. In most cases the similarity in weight of hatchery and resident fish precluded any attempt to distinguish between them by this characteristic. Two exceptions are the chinook planted on June 2 and the coho planted on April 21, both of which were composed of fish considerably larger than any which were observed in the electrofisher catch.

Table 2. Mean daily flow and visibility on the Nisqually River during sampling, 1980.

Sampling date	Flow (cfs)*		Secchi disk (cm)	
	La Grande	McKenna	Station 4	Station 1
4-10	712	1,370	49	
4-29	1,730	1,150	>150	>61
5-13	1,180	572	>130	>60
5-28	1,000	863	82	90
5-30	918	552		
6-12	1,010	473	>75	>125
6-23	1,000	492		
6-25	1,000	564		>112
7-7	1,030	499		>110
7-8	1,030	494	56	
7-11	1,040	**		
7-24	1,100	**	77	
7-25	1,110	**		96

*U.S.G.S. water discharge records.
**Data unavailable at this time.

Table 3. Fish plantings in the Nisqually River and tributaries which may have influenced electrofisher catches during the April-July 1980 sampling season.

Species	Date	Location	Number planted	Weight each (g)
Chinook	4-12	Schorno Springs	251,600	1.16
	6-2	Schorno Springs	244,500	3.78
Coho	4-21	Taboton Creek	39,900	21.62
		Mashel River	46,200	21.62
		Tanwax Creek	89,250	21.62
		Murray Creek	108,150	21.62
	4-25	Tanwax Creek	147,750	0.46
	5-22	Taboton Creek	52,800	1.03
		Murray Creek	91,960	1.03
	5-23	Horn Creek	48,400	1.03

Source: Condensed from Nisqually Drainage Enhancement Report 1980, prepared by Puyallup tribal biologist John Kerwin for the Nisqually River Coordinating Committee.

Timing of Emergence

The time of fry emergence was determined in the same manner as in the previous year--that is, it was assumed to coincide with the presence of emergent-sized fry in the electrofisher catch. However, as noted by Tyler (1980), the period of time required for fry to grow out of the emergent-sized category should be subtracted from the final sample date in which newly emergent fry were captured. The length of this developmental period is assumed to be one week, as orginally estimated by Tyler.

For a given species, the temporal abundance of emergent fry was estimated by multiplying the total catch on each sampling date by the proportion of emergent fry found in the subsample. The percentage of the total emergent fry catch which this represented was determined by dividing the estimated catch of emergent fry on each sampling date by the sum of the estimated emergent fry catches for the entire sampling season.

Emergent-sized chinook (<41 mm) were captured from April 10 through June 12 (Fig. 3). A graph of emergent fry abundance versus time (Fig. 4) (data for February and March 1980 from Tyler 1980) shows that initial emergence began in mid-February. Peak emergence occurred between early April and late June, though sampling error obscured the relationship somewhat. Estimated initial and final emergence dates are February 5 and June 5, respectively.

Sampling during 1979 indicated that chinook emergence was over by the end of June (Tyler 1980), but the general trend in the temporal abundance of emergent chinook in the two years is very similar. The difference between the estimates of the final emergence date for each year may be due in part to the larger number of fish caught in 1979, which increased the probability that the extreme tail of the emergence period would be detected.

Emergent-sized coho (<36 mm) were first present in the subsampled catch in 1980 on April 10 (Fig. 5) and were last observed on June 12. The corresponding estimates of initial and final emergence are April 3 and June 5. Tyler's (1980) estimate of May 30 as the final date of coho emergence in 1979 agrees well with that for 1980. The period (mid-May) of peak abundance for emergent-sized coho in each year is similar as well (Fig. 6).

The small size of chum catches in 1980 makes estimation of their emergence dates difficult. Emergent-sized chum (<36 mm) were present in the subsampled catch from April 29 until June 25 (Fig. 7). Estimated initial and final emergence dates are April 22 and June 18, respectively.

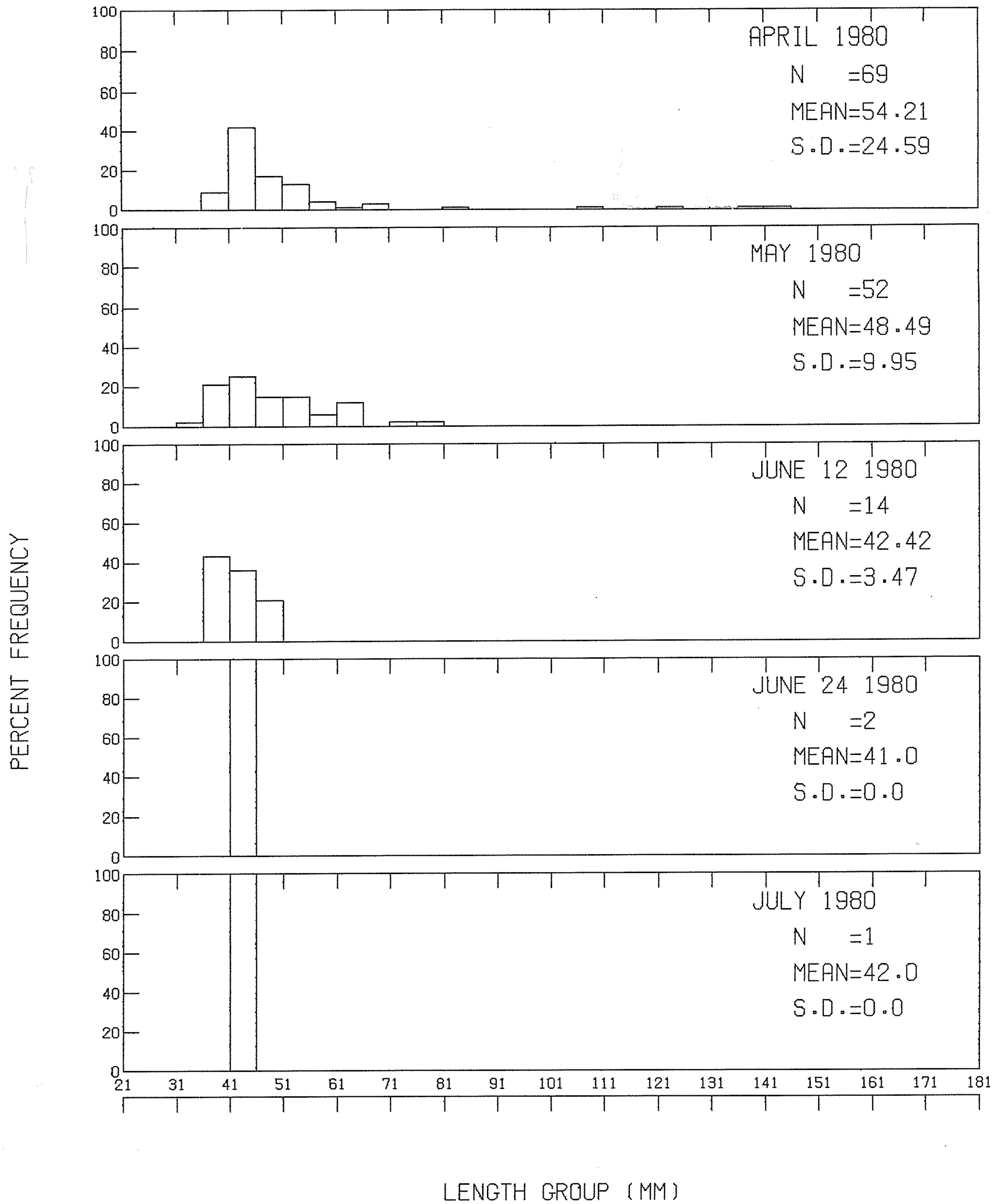

Fig. 3. Length frequency histogram of subsampled electrofisher catch of juvenile chinook.

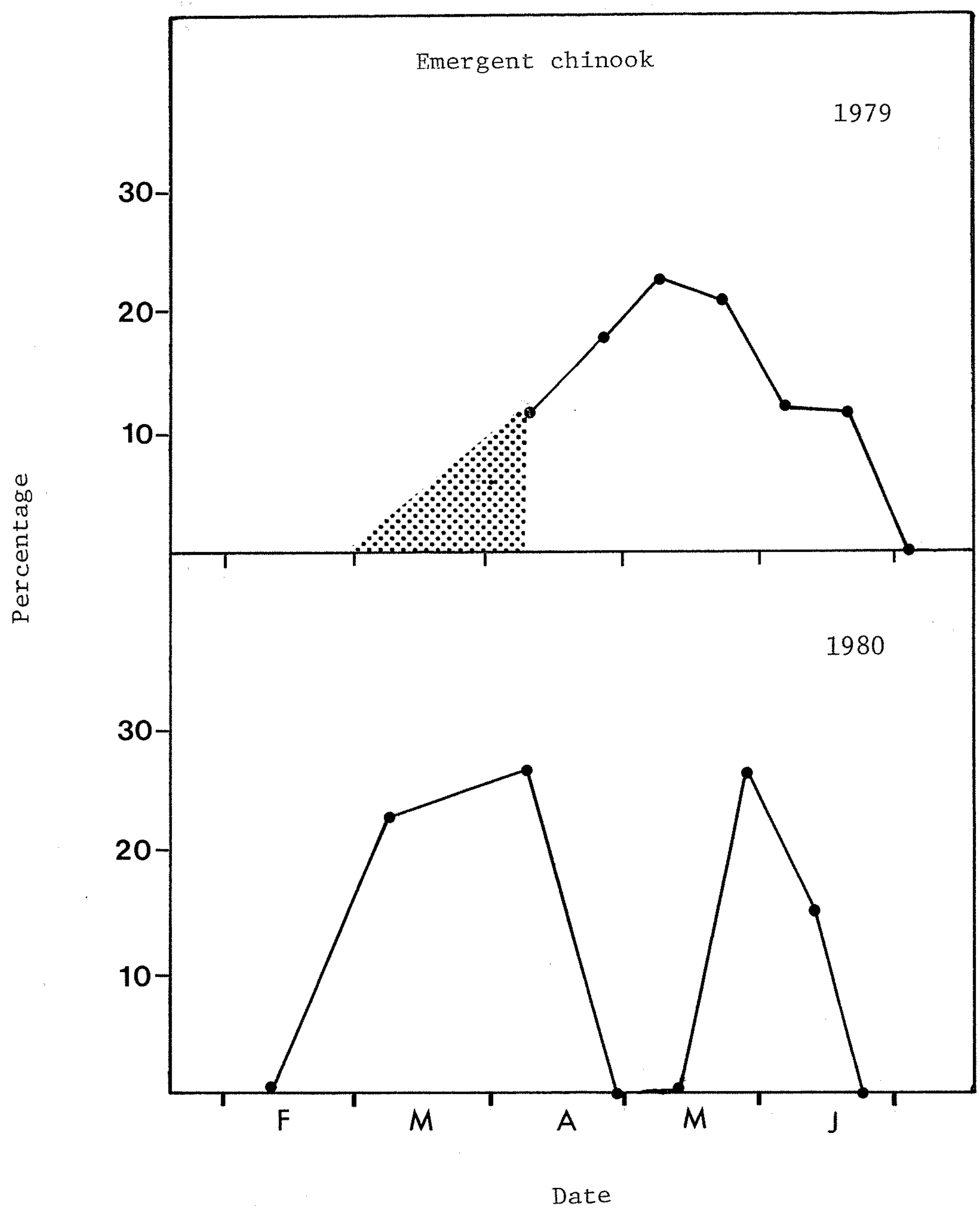

Fig. 4. Percentage of total sampled emergent chinook fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches. Shaded area indicates time period in which emergent fry may be present though sampling was not conducted.

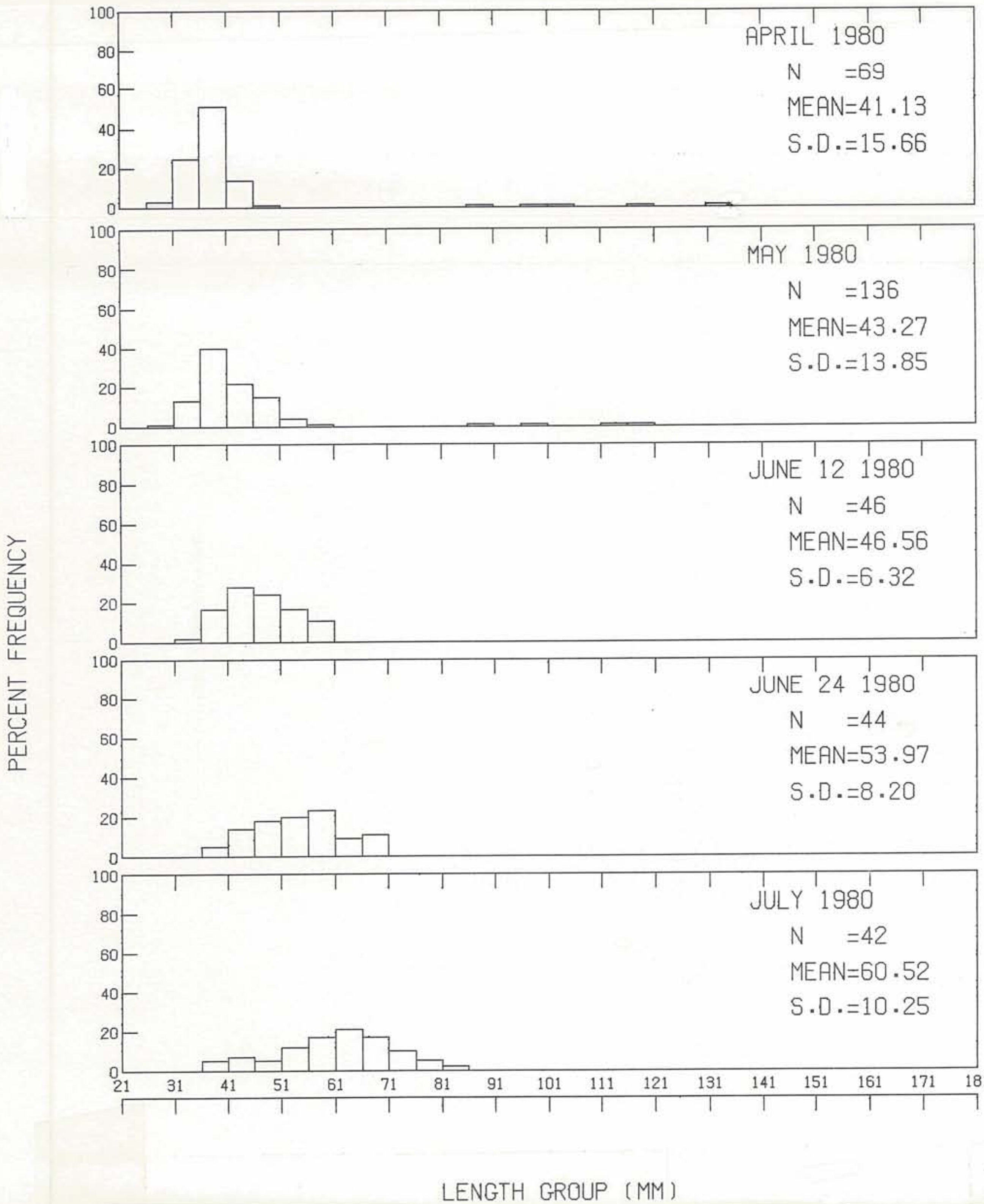

Fig. 5. Length frequency histogram of subsampled electrofisher catch of juvenile coho.

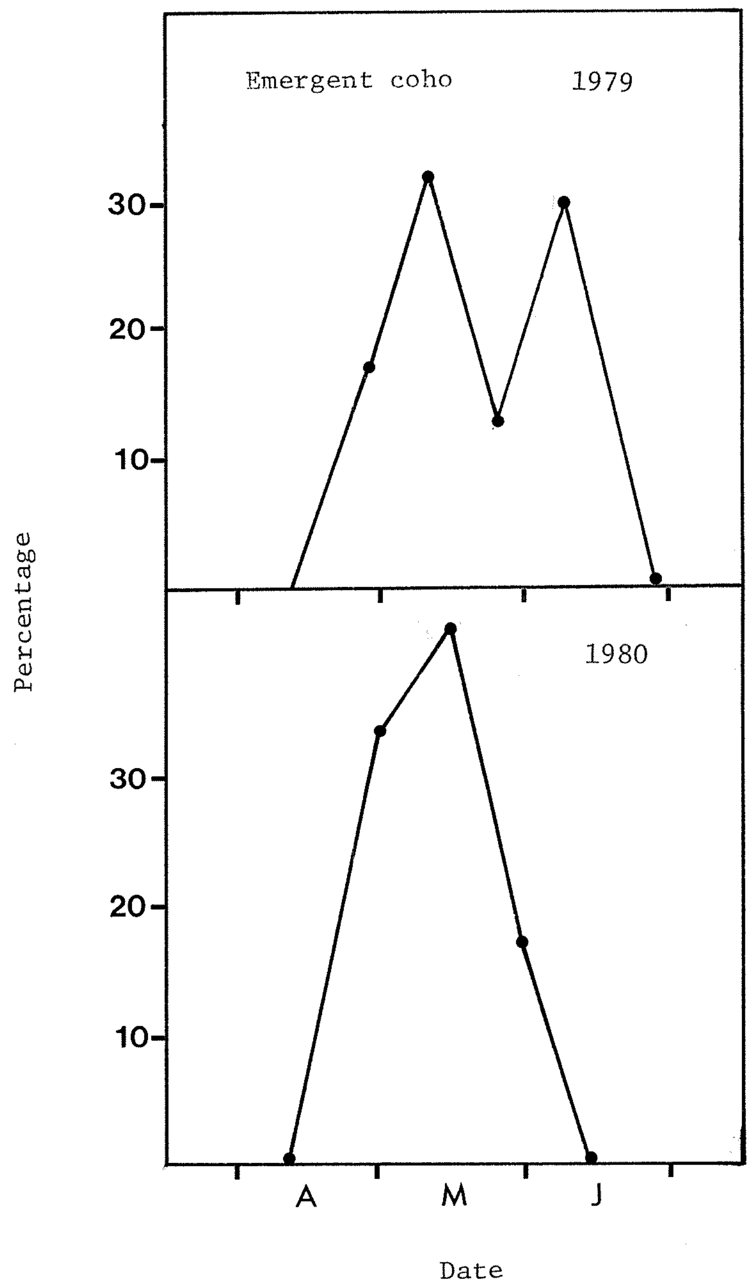

Fig. 6. Percentage of total sampled emergent coho fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches.

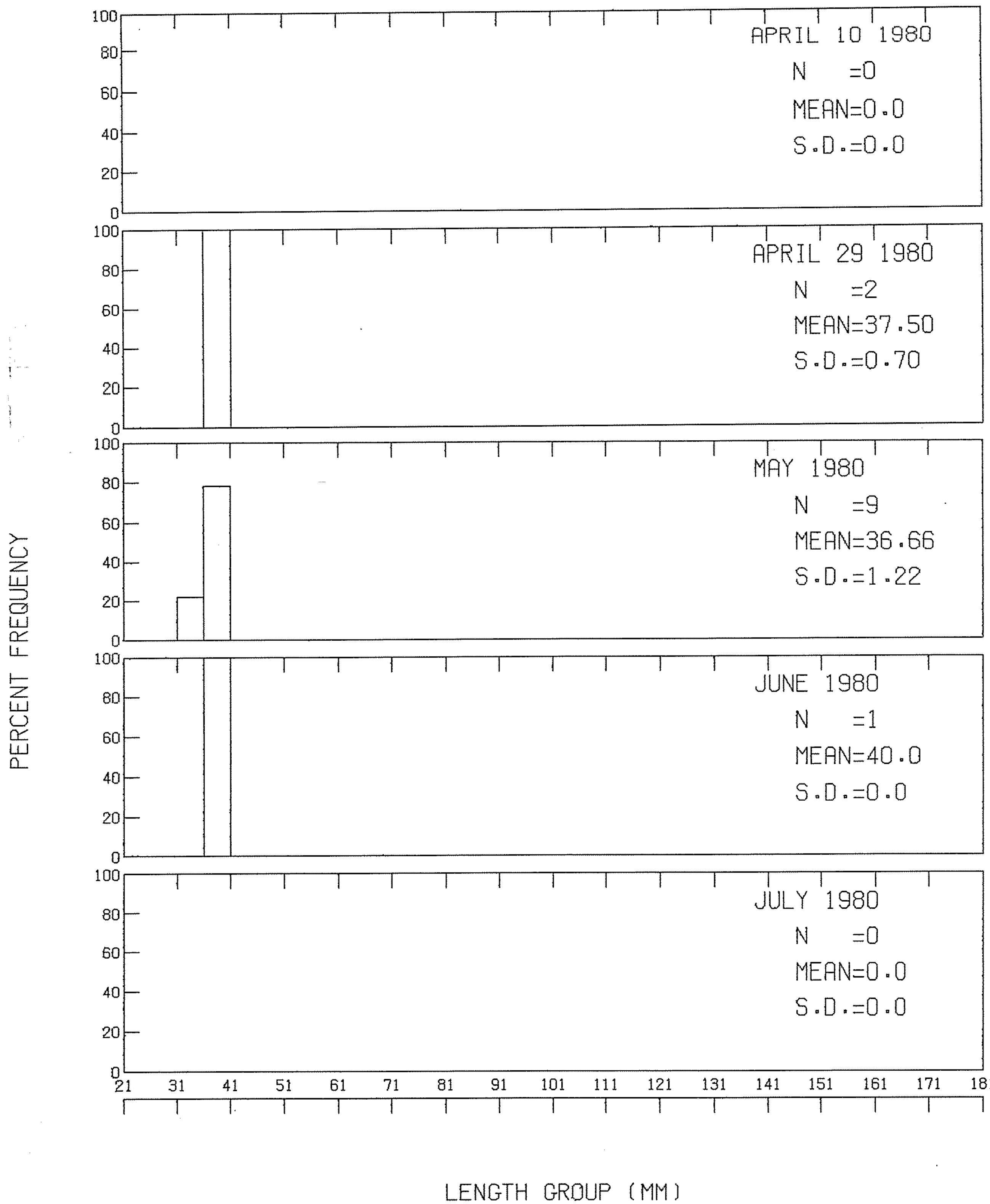

Fig. 7. Length frequency histogram of subsampled electrofisher catch of chum fry.

The general trend in abundance of newly emerged chum in 1979 and 1980 is very similar (Fig. 8), with a peak occurring in late May in each year. Final emergence date for chum in 1979 was estimated as June 21 (Tyler 1980).

Emergent-sized rainbow-steelhead (<31 mm) first appeared in the May 28 sample and were present until sampling terminated on July 25 (Fig 9). The estimated initial emergence date of May 21 is approximately one month later than that found by Tyler in 1979. Peak abundance of emergent-sized rainbow-steelhead occurred in early July in both 1979 and 1980 (Fig. 10). Final emergence in 1979 was estimated as August 9.

Temporal Abundance of Juvenile Salmonids

The electrofisher catches, pooled over all sites, of age 0 and I+ salmonids are shown in Figs. 11 and 12, respectively. Beach seine catches during this period are also plotted for comparative purposes.

Precise information on the outmigration period of juvenile salmonids was not provided by sampling with the electrofisher or by beach seining. Improved estimates of both the timing and abundance of outmigrants may soon be available due to the installation of an inclined plane trap on the lower river by Nisqually tribal biologists.

Chinook

Electrofisher catches of age 0 chinook (Fig. 11) were greatest during the initial sampling session when 98 were captured. Later catches declined steadily until July 25, when no age 0 chinook were captured. However, beach seine catches during both 1979 (Tyler 1980) and 1980 indicate that during mid-summer, at least a portion of the chinook fry have moved offshore and not out of the river.

Age I chinook (Fig. 12) were captured in small numbers on the April 10 and April 29 surveys. No age I chinook were captured by the electrofisher after this date, but beach seine data show that many fish were still present in the deeper portions of the river on May 23. From this it may be inferred that Age I chinook outmigration continues well into June.

Sampling conducted near the confluence of the Nisqually River and Puget Sound (referred to as the Nisqually Reach) during 1977 and 1978 (Fresh et al. 1979) substantiates this conclusion. Few chinook smolts were captured before mid-May, and peak catches did not occur until mid-late June. Average length of the chinook smolts captured was 124 mm.

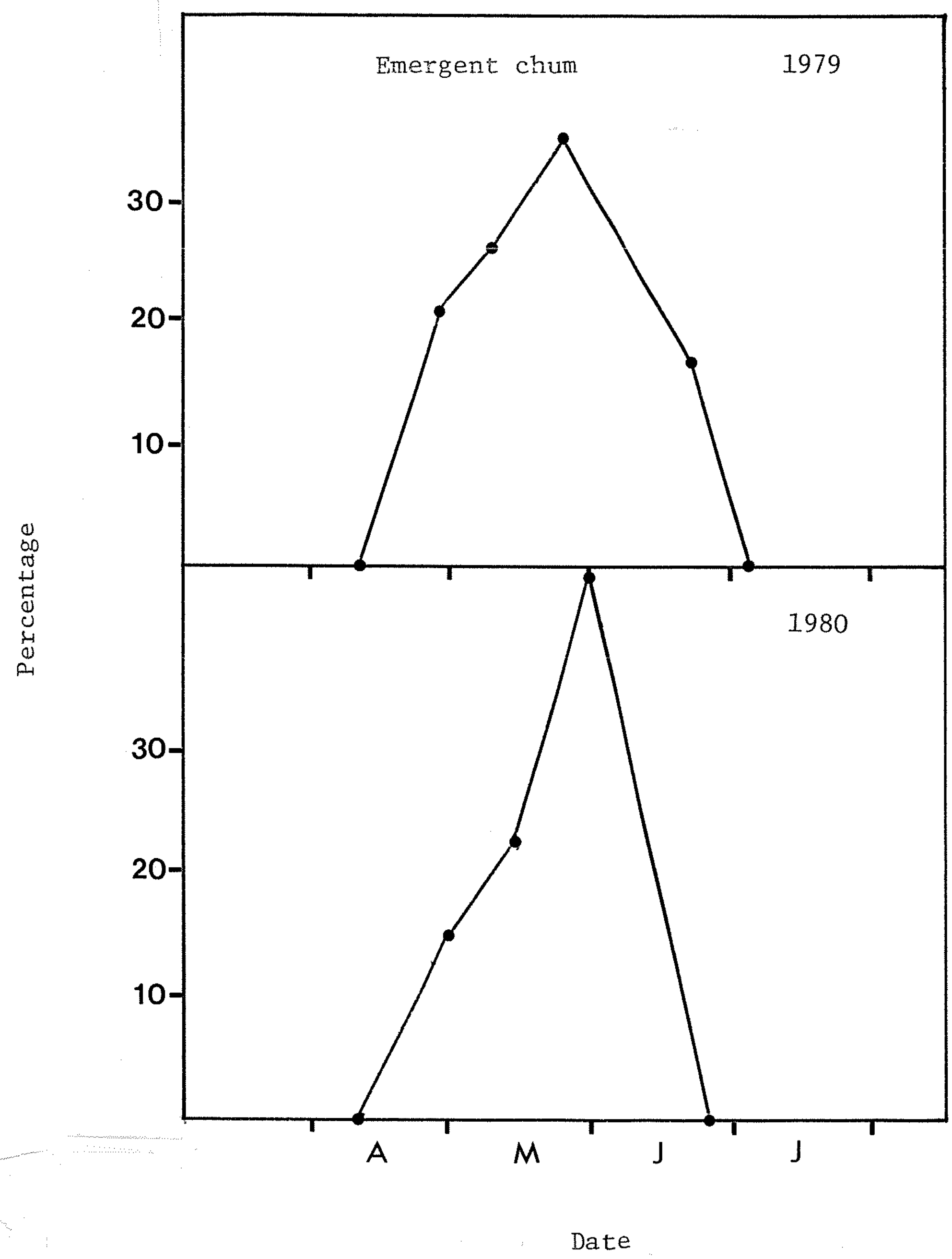

Fig. 8. Percentage of total sampled emergent chum fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches.

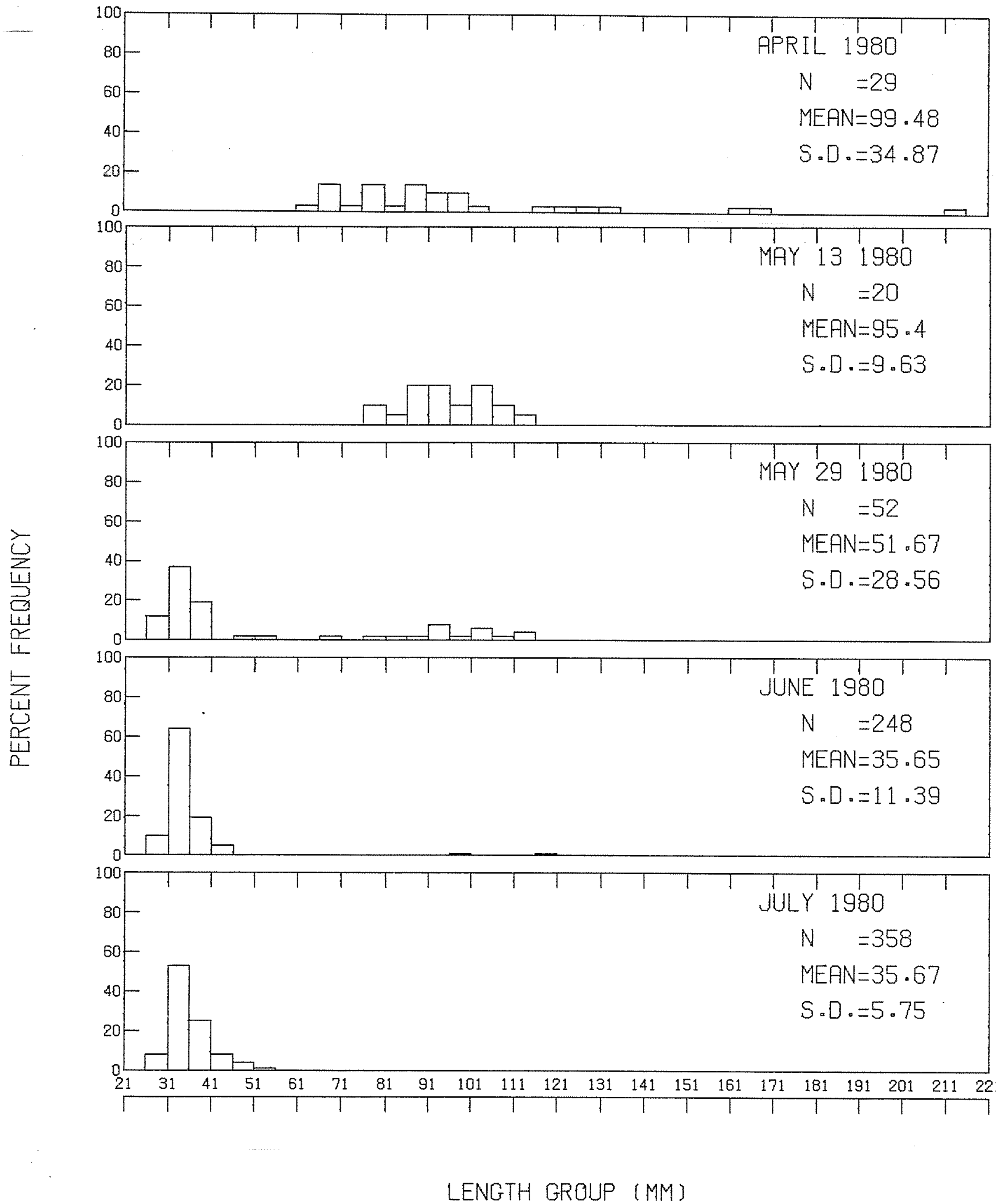

Fig. 9. Length frequency histogram of subsampled electrofisher catch of juvenile rainbow-steelhead.

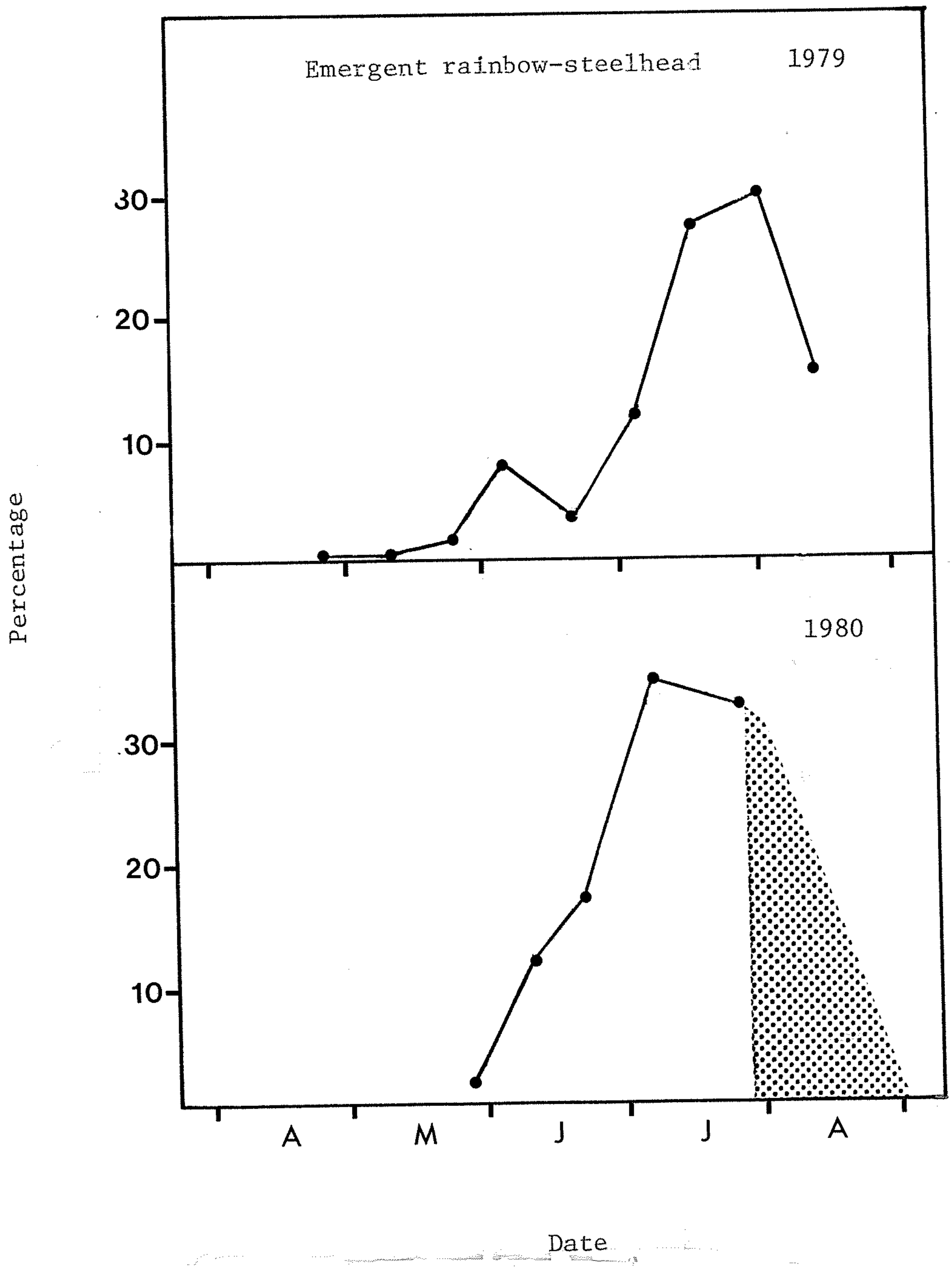

Fig. 10. Percentage of total sampled emergent rainbow-steelhead fry captured on each survey date in 1979 and 1980, as estimated from electrofisher catches. Shaded area indicates time period in which emergent fry may be present though sampling was not conducted.

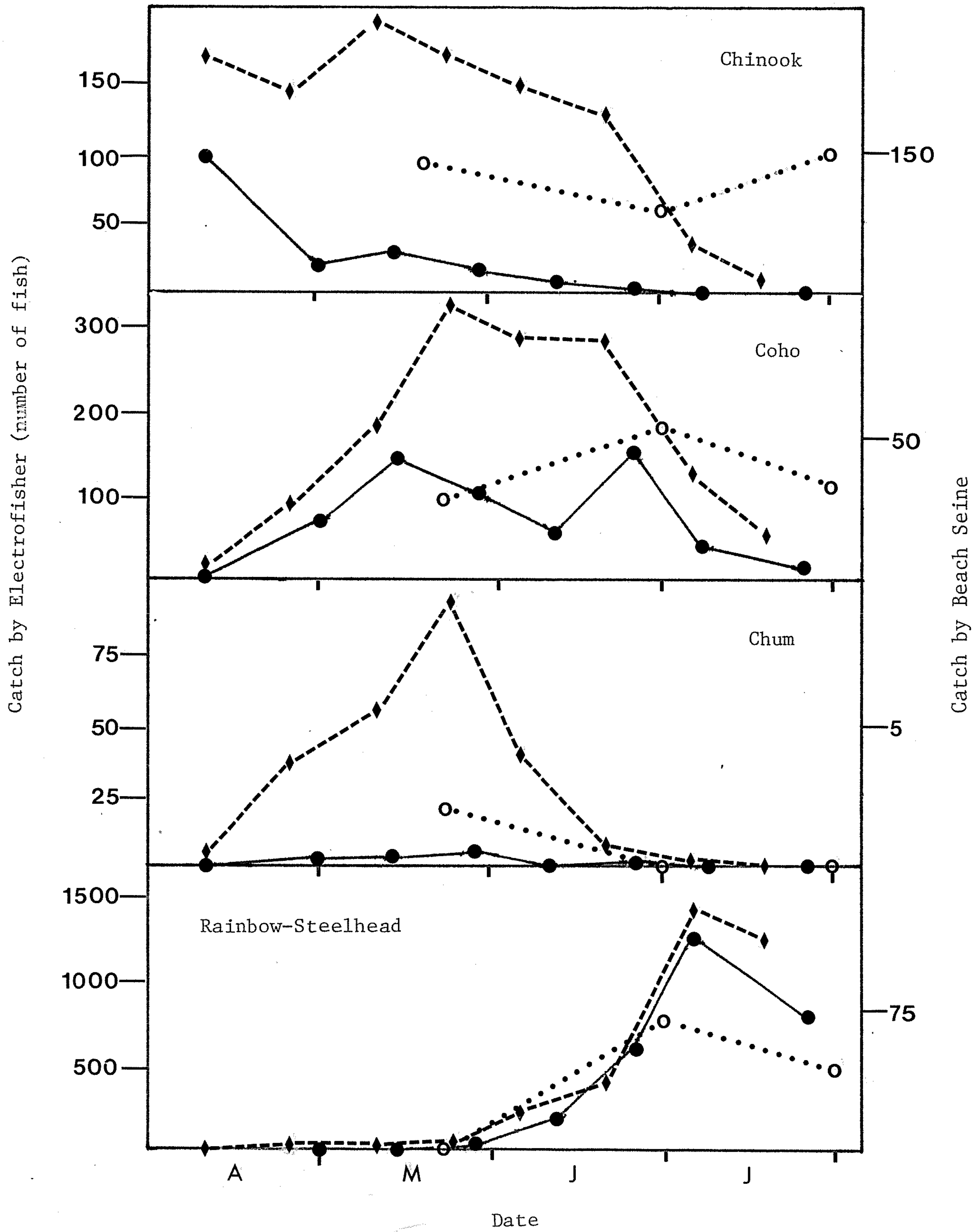

Fig. 11. Electrofisher catch combined over all sites in 1979 and 1980 and total of beach seine catches at sites 1 and 4 of age 0 chinook, coho, chum, and rainbow-steelhead. ♦----♦ 1979; ●——● 1980; O• • •O beach seine 1980.

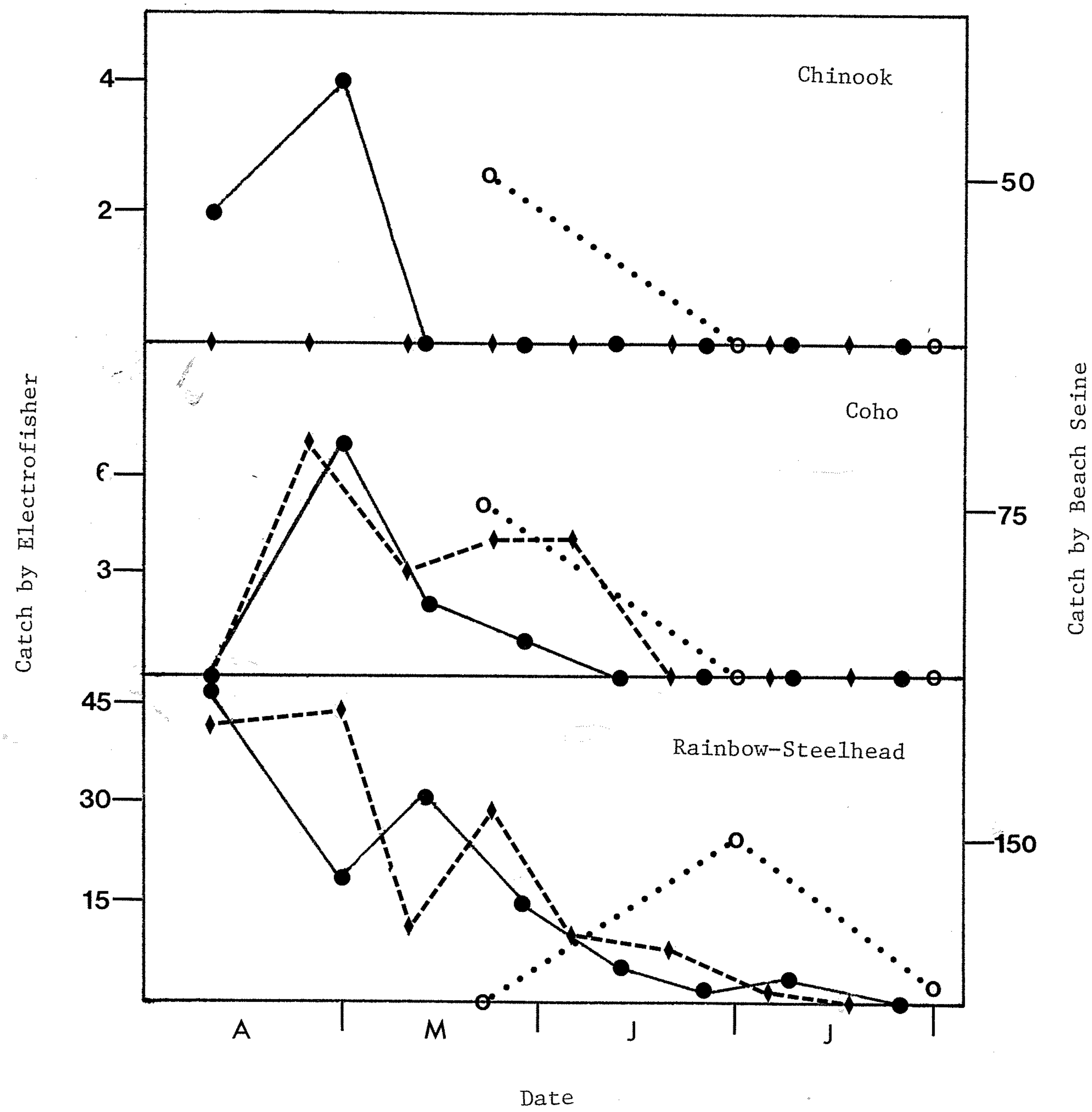

Fig. 12. Electrofisher catch combined over all sites in 1979 and 1980 and total of beach seine catches at sites 1 and 4 of age I chinook, coho, chum, and rainbow-steelhead. ♦----♦ 1979; ●——● 1980; O • • • O beach seine 1980.

Coho

The distribution of age 0 coho electrofisher catches was distinctly bimodal (Fig. 11), with peak catches of 134 and 154 fish occurring on May 13 and June 25, respectively. The second pulse of coho may have originated from one or more of the following sources: 1) heightened emergence; 2) hatchery plants; 3) flow-induced onshore migration; 4) emigration of fry from tributary streams to the mainstem Nisqually.

It is unlikely that sources 1-3 were causal factors in the development of the second peak. The number of emergent sized coho was declining through this period (Fig. 6) and the last of the hatchery plants had been made more than one month before. Further evidence that hatchery fish were not the cause of the second peak is that release locations for those plants were below site 4, which itself showed a distinct bimodality in the distribution of age 0 coho catches (Fig. 16). River flow is unlikely to have affected electrofisher catches as it was stable throughout June (Fig. 13).

The catch of age 0 coho in beach seines also peaked during late June, but this may be due to factors other than those affecting electrofisher catches.

Age I coho (Fig. 12) were not captured by the electrofisher on the initial survey date, but the maximum catch occurred slightly more than two weeks later (April 29). High flows at that time may have forced fish onshore in search of refuge from the high current velocities which were observed in the main channel. Catch of age I coho declined steadily from April 29 until the June 23 survey, when none were captured. It is likely that outmigration is essentially complete by the end of June, as a beach seine conducted on June 30 also captured no age I coho.

In 1977, coho smolts were first captured in the Nisqually Reach on May 3, while in 1978, they were present as early as April 10 (Fresh et al. 1979). Peak catches (and presumably peak outmigration) occurred during mid-May in each year.

Chum

Chum were the least abundant of the age 0 salmonids captured by the electrofisher. Catches rose from 0 fish on the initial sampling date to a peak of 6 on May 28 (Fig. 11). No chum were captured after the June 25 survey. Although the estimated chum escapement to the Nisqually River was greater than that of any other salmon (Table 4) in 1979-1980, the small catches were not unexpected, as the relatively direct downstream migration of chum fry immediately after emergence restricts their availability to the electrofisher. Beach seining was also ineffective; a total of two chum were captured, both during the May 23 survey.

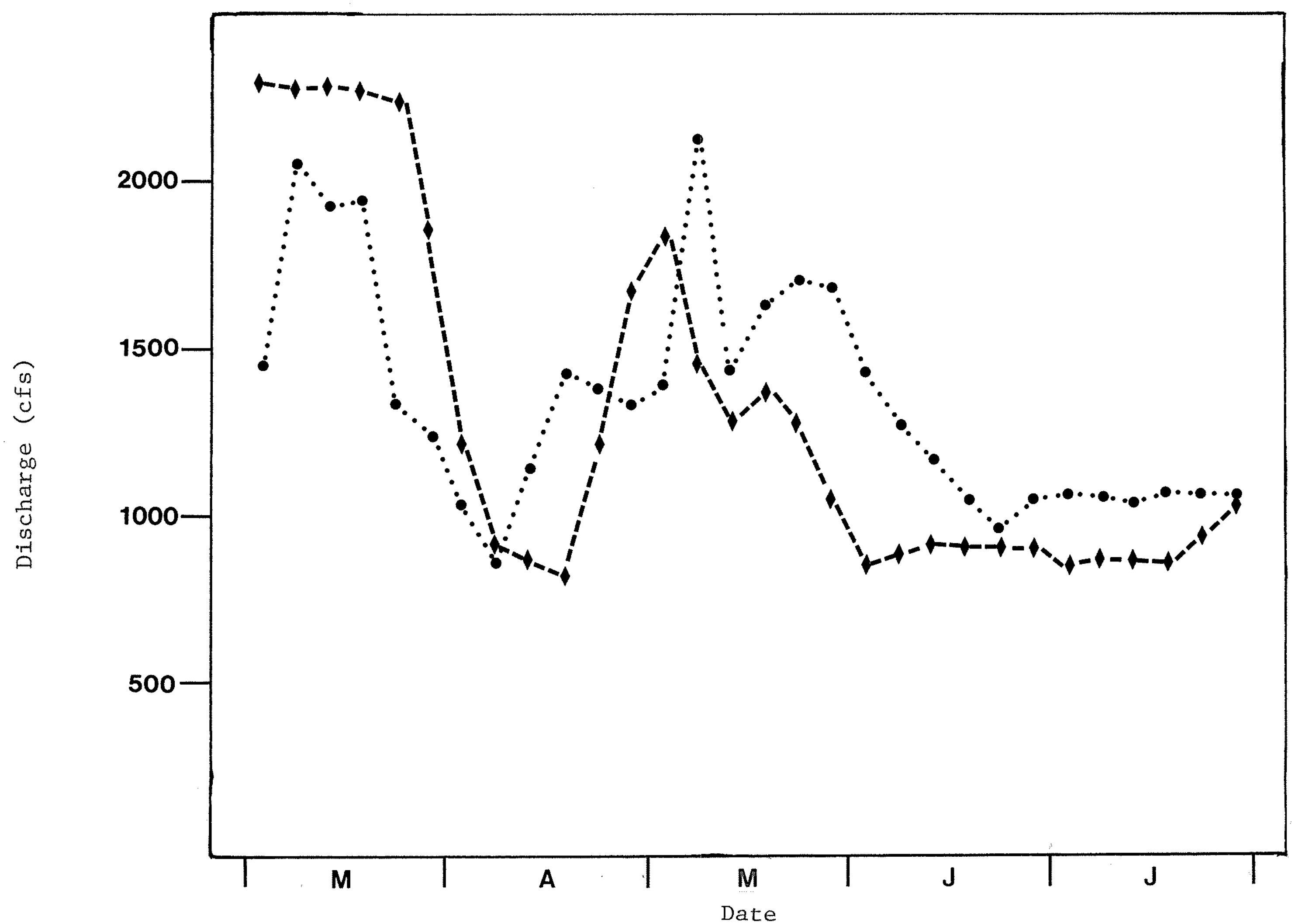

Fig. 13. Average discharge at La Grande for 5-day intervals in 1979 and 1980. ●······● 1979; ♦----♦ 1980. (Source: U.S. Geological Survey)

Table 4. Salmonid escapement and tribal harvest for the years 1978-79 and 1979-80.[1]

	1978-79		1979-80	
	Estimated escapement	Tribal harvest	Estimated escapement	Tribal harvest
Chinook	200[2]	57	100	1,454
Coho	3,000[3]	1,363	14,700	13,574
Chum	30,296[4]	24,049	21,000	3,226
Pink	--	--	1,300[5]	268
Steelhead	--	2,603	1,255[6]	1,318

[1]Source: Nisqually tribal biologists Paul Svoboda and Bill Harrington-Tweit.

[2]Estimated by WDF from out-of-basin index counts (Coulter, Rockey, and Burley Creeks).

[3]Estimated by WDF from index counts on 25-mile Creek.

[4]Estimated from tagging studies conducted by U.S. Fish and Wildlife Service and Nisqually Indian Tribe.

[5]Estimated by WDF from index counts on the Mashel River.

[6]Estimated number of redds from aerial surveys conducted by the Nisqually Indian Tribe.

Sampling in the Nisqually Reach during 1977 and 1978 (Fresh et al. 1979) indicated that peak outmigration occurred from mid-May to mid-June, though chum fry were captured in a period extending from early March to early July.

Pink

Although pink escapement to the Nisqually River was estimated by the WDF to be 1,300 (personal communication, Harrington-Tweit) (Table 4) in 1979, no fry were captured by either the beach seine or the electrofisher in the spring of 1980. The absence of pink fry in the catch may result both from low abundance and their immediate outmigration after emergence.

Rainbow-Steelhead

Age 0 rainbow-steelhead were captured by the electrofisher in greater numbers than any other salmonid. After the initial observation of rainbow-steelhead fry in the May 28 sample (Fig. 11), abundance increased markedly to a peak of 1,473 on July 8. The catch on the final sampling date dropped considerably to 973 fish. Beach seine results show a similar temporal pattern; age 0 rainbow-steelhead were absent in the May 23 catch, reached a peak on June 30, and declined on July 29.

Throughout the entire sampling period, age I+ rainbow-steelhead were captured in greater numbers than any other salmonid of similar age. A peak catch of 49 fish occurred in the initial survey (Fig. 12). Age I+ rainbow-steelhead were first absent from the electrofisher catch in late July.

Beach seine catch data for this species is unusual in that no fish were captured on May 23, but approximately 1 month later, a comparatively large catch of 157 fish was recorded.

The age I+ rainbow-steelhead outmigration period is difficult to define due to the number of juveniles which inhabit freshwater for two or more years and the ability of these fish to avoid the sampling gear employed. The outmigration of steelhead smolts from four other streams in western Washington (Gobar Creek, Kalama River, Chehalis River, and Minter Creek) has been found to generally commence in mid-late March, peak in early May, and continue at a reduced level into early June (Crawford et al. 1979; Brix and Seiler 1977; Salo and Bayliff 1958).

Comparative Abundance of Juvenile Salmonids in 1979 and 1980

Direct comparison of electrofisher catches in 1979 and 1980 as an indication of the relative juvenile salmonid abundance in each year should be done with some caution. The relationship between fry abundance and catch in each year is likely to have varied due to factors which include river conditions, site locations and lengths, and effort expended electroshocking.

The temporal pattern of river flow (as measured at LaGrande) was similar in 1979 and 1980 (Fig. 13), though 5-day average discharges for a similar period in each year differed by as much as 820 cfs. Discharge was greater in 1980 from March 1 to mid-April, and greater in 1979 from early May through July.

The locations of site 3 bank and 4 bar were altered from those used in April through June 1979. The relocation of site 4 bar should have had little effect on electrofisher catches, as the habitat sampled in each case was very similar. However, the relocation of site 3 bank undoubtedly reduced catches. At the original location, good cover was provided by instream and overhead vegetation. Cover at the new location was poor, consisting of occasional logs and roots in the water.

The average length of river electroshocked at each site in 1979 and the corresponding length in 1980 are shown in Table 5. The lengths of site 1 and 4 banks differed very little between the two years, while other sites, with the exception of 3 bank and 4 bar, were enlarged in 1980.

Electrofisher timer readings were recorded to facilitate a comparison of the effort expended in each year. Unfortunately, the timer does not always provide an accurate assessment of effective effort. Both the abundance of fish and the techniques of the electrofisher operator may alter the relationship between effective effort and timer total. Time per meter of each site shocked (Table 5) shows no yearly trend, though average effort expended obviously changed at the individual sites.

In light of these considerations, and the absence of any clear difference in the methodologies used each year, some general statements on comparative juvenile salmonid abundance may be possible.

Chinook

Age 0 chinook electrofisher catches in April-July 1980, were significantly lower than those for a similar period in 1979 (Fig. 11). Other evidence that age 0 chinook were less abundant in 1980 is the size of beach seine catches in each year; 489 age 0 chinook were captured in 1979 on August 15, while in 1980, only 149 were captured on July 29.

The temporal pattern of electrofisher catches of age 0 chinook was similar in each year; catches dropped in late April, then rebounded in mid-May before beginning a steady decline, reaching 0 by late July.

Age I chinook were not captured in 1979. (The abundance of age I chinook in 1980 was discussed in an earlier section.)

Table 5. Average length of site sampled in 1979, length of site sampled in 1980, and average electrofisher timer units expended per meter of site sampled in 1979 and 1980.

Site	$\overline{L}_{1979}$(meters)	L_{1980}(meters)	$\overline{T}$/meter$_{1979}$	$\overline{T}$/meter$_{1980}$
Site 1 bank	165	165	5.15	2.88
bar	69	95	4.71	4.61
Site 2 bank	74	119	6.40	7.43
bar	62	90*	6.31	10.02
Site 3 bank	117	90	4.82	4.54
bar	77	90	4.90	7.50
Site 4 bank	101	103	7.15	10.45
bar	103	68	7.00	5.50

*Maximum length sampled; length of site sampled at higher flows was not measured.

Coho

Age 0 coho were less abundant in the electrofisher catches of 1980 than in 1979 (Fig. 11). However, their relative abundance in each year is difficult to ascertain, as beach seine data show roughly equivalent catches of age 0 coho in mid-August 1979, and late July 1980 (39 and 33 fish, respectively).

Both years show similar temporal trends in the electrofisher catches. Of particular interest is the repetition in each year of the bimodal pattern of abundance, though this was not as pronounced in 1979 as in 1980. Age I coho also showed similar distributional patterns in 1979 and 1980 (Fig. 12). A peak catch of 7 fish occurred during both years in late April, and in both cases, fish of this species were first absent from the catch by mid-June.

Chum

Among salmonids, the electrofisher catches of chum in 1980 exhibited the greatest decline from 1979 levels (Fig. 11). The peak catch of 92 fish in 1979 was more than 7 times the total number captured during the entire 1980 sampling season. In contrast, escapement, as estimated by the U.S. Fish and Wildlife Service from a mark-recapture program, and Nisqually Tribal harvest figures (personal communication, P. Svoboda and B. Harrington-Tweit) indicate that there were nearly three times more chum spawners in 1980 than in 1979 (Table 4).

The distribution of chum fry catches in each year was similar. Peak catches occurred in mid- to late May and no chum were captured after late June.

Rainbow-Steelhead

Both the abundance, as estimated by electrofisher catches, and the temporal distribution of age 0 rainbow-steelhead were very similar in 1979 and 1980 (Fig. 11). Catches in both years rapidly increased after mid-May, reaching a maximum of nearly 1,500 fish in early June.

The abundance and temporal distribution of age I+ rainbow-steelhead catches was also very similar in the two years (Fig. 12). The catch on the April 10 sampling date of each year differed by only 7 fish, and both years showed a similar decline thereafter. Age I+ rainbow-steelhead were first absent from electrofisher catches on the second sample survey in July of each year.

Density of Juvenile Salmonids by Site

As the various bank and bar sampling locations differed in length, an index was computed to standardize catches and facilitate comparisons among stations. For each sampling date, site, and salmonid species, the number of fish per 100 linear meters of bank or bar habitat was computed. The average of these was then used as an index of abundance at each site.

Chinook

The catch of age 0 chinook varied from a density of 23.3 fish/100 m at site 2 on April 10 to a low density of 0 fish/100 m during the last survey at all sites (Fig. 14). Age 0 chinook were caught in greatest densities at site 2 on four out of the five sampling dates when chinook were reasonably abundant (through June 12). At site 1, catch densities were consistently lower than those of other sites. Site habitat characteristics (Table 1) appear to influence catch densities much more strongly than any upstream-downstream effects, as chinook were generally more abundant at site 2 than at site 3.

Age I chinook catch densities were greatest at site 2 (Fig. 15), where they reached a peak of 2.5 fish/100 m on April 29. Site 3 was the only location in which no age I chinook were caught.

Coho

Catch densities of age 0 coho ranged from a high of 39.2 fish/100 m at site 2 on June 25 to a low of 0 fish/100 m at site 1 on July 7 and July 25 (Fig. 16). Site 4 catch densities were higher than those of other sites on all dates with the exception of June 25, while catch densities at site 1 were always less than or equal to those of other sites. The peak on June 25 is interesting in that it occurred during a period when age 0 coho catches were generally declining and that it is not reflected in catches from either site 1 or 3.

A peak catch density of 1.67 age I coho/100 m occurred on April 29 at site 3 (Fig. 17). Catch densities at other sites never exceeded 1 fish/100 m.

Chum

Chum were the only salmonid species to show a definite upstream-downstream distributional pattern. Chum were not captured at either site 3 or 4, and only on one occasion at site 2. Catch densities, in contrast to those of all other species, were greatest at site 1 (Fig. 18), where a peak catch of 1.85 fish/100 m occurred on May 28.

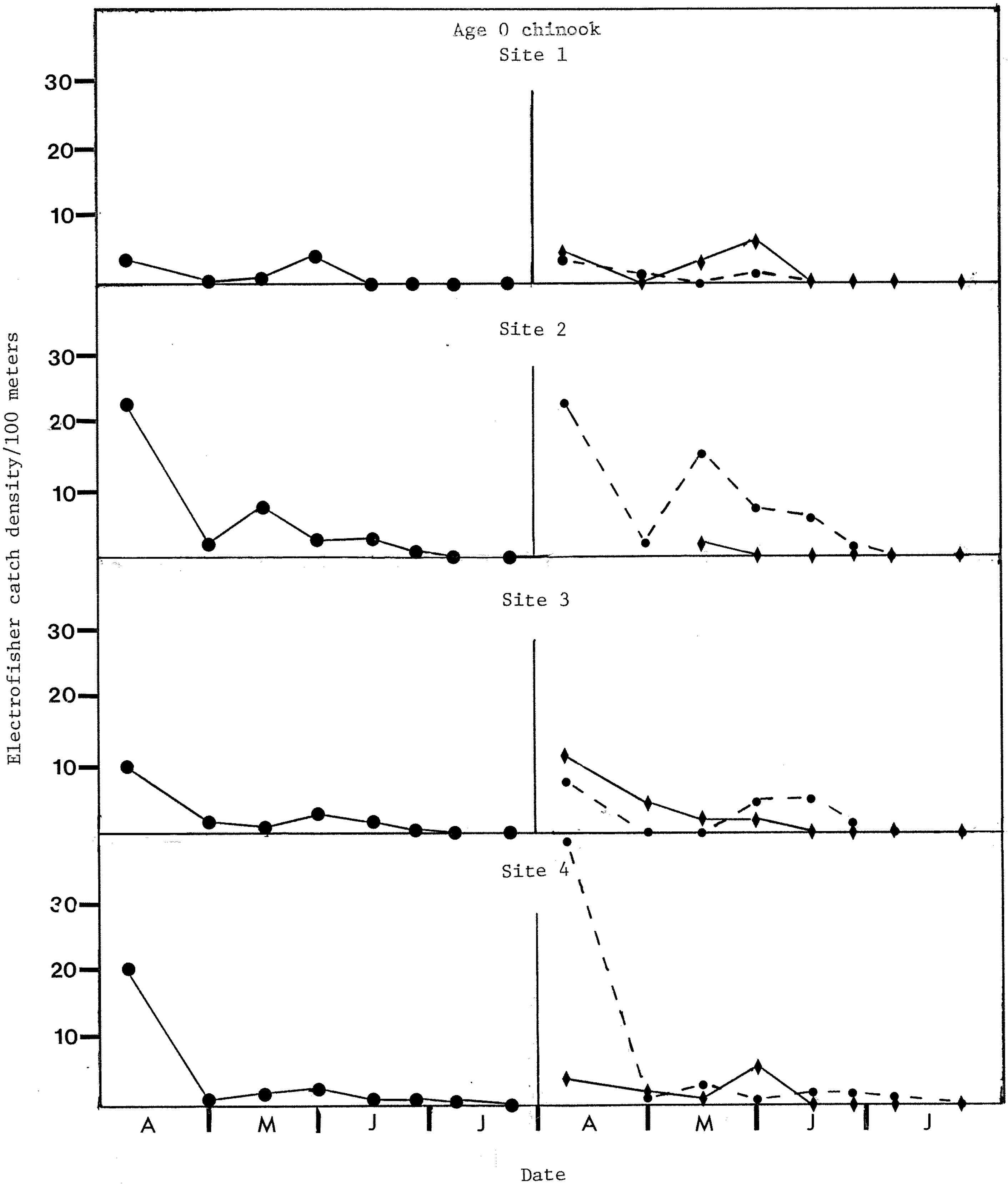

Fig. 14. Electrofisher catch density of age 0 chinook by habitat type and site. ●——● average; •- - -• Bank; ♦——♦ Bar.

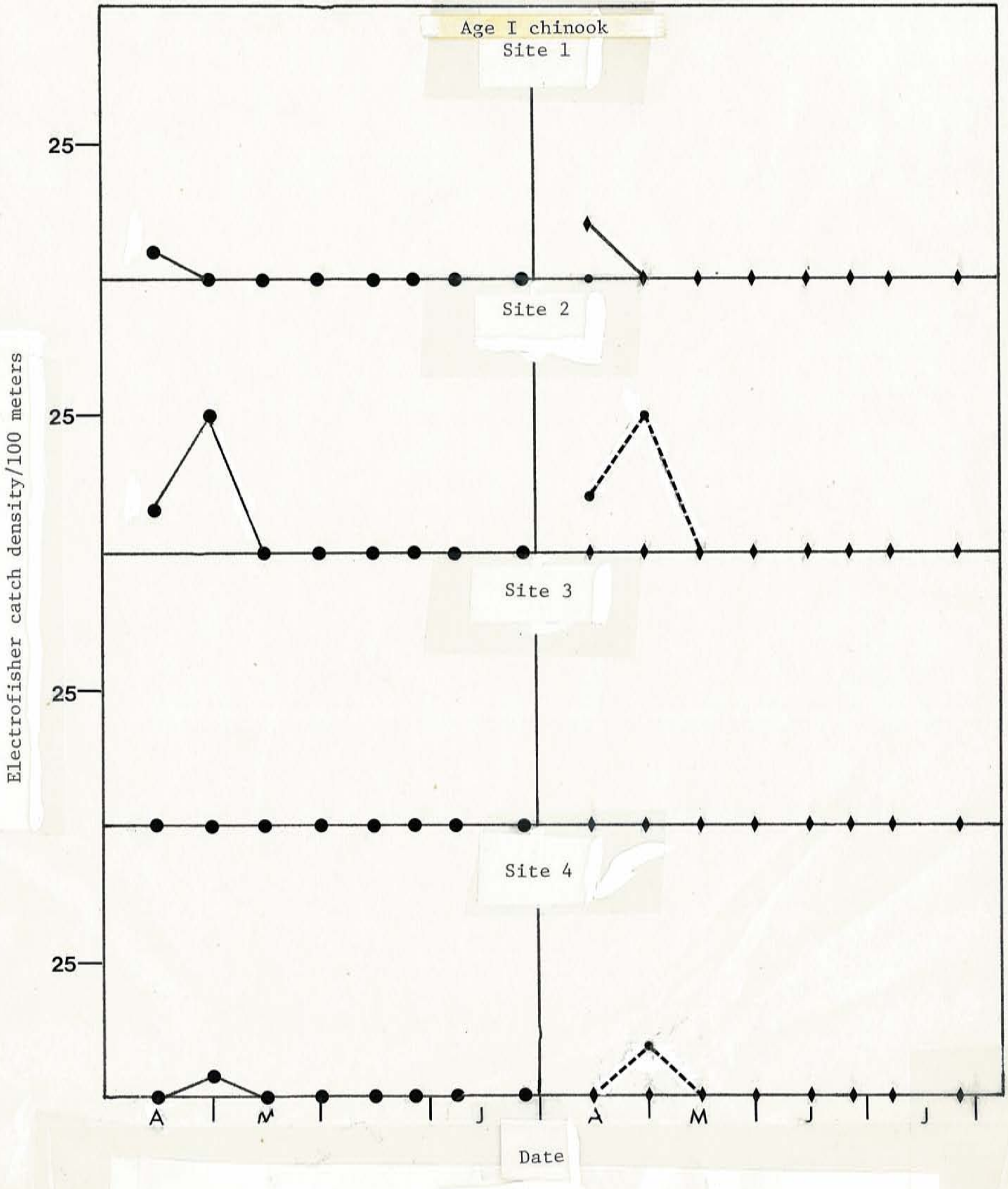

Fig. 15. Electrofisher catch density of age I chinook by habitat type and site. ●——● average; ●- - - -● Bank; ♦——♦ Bar.

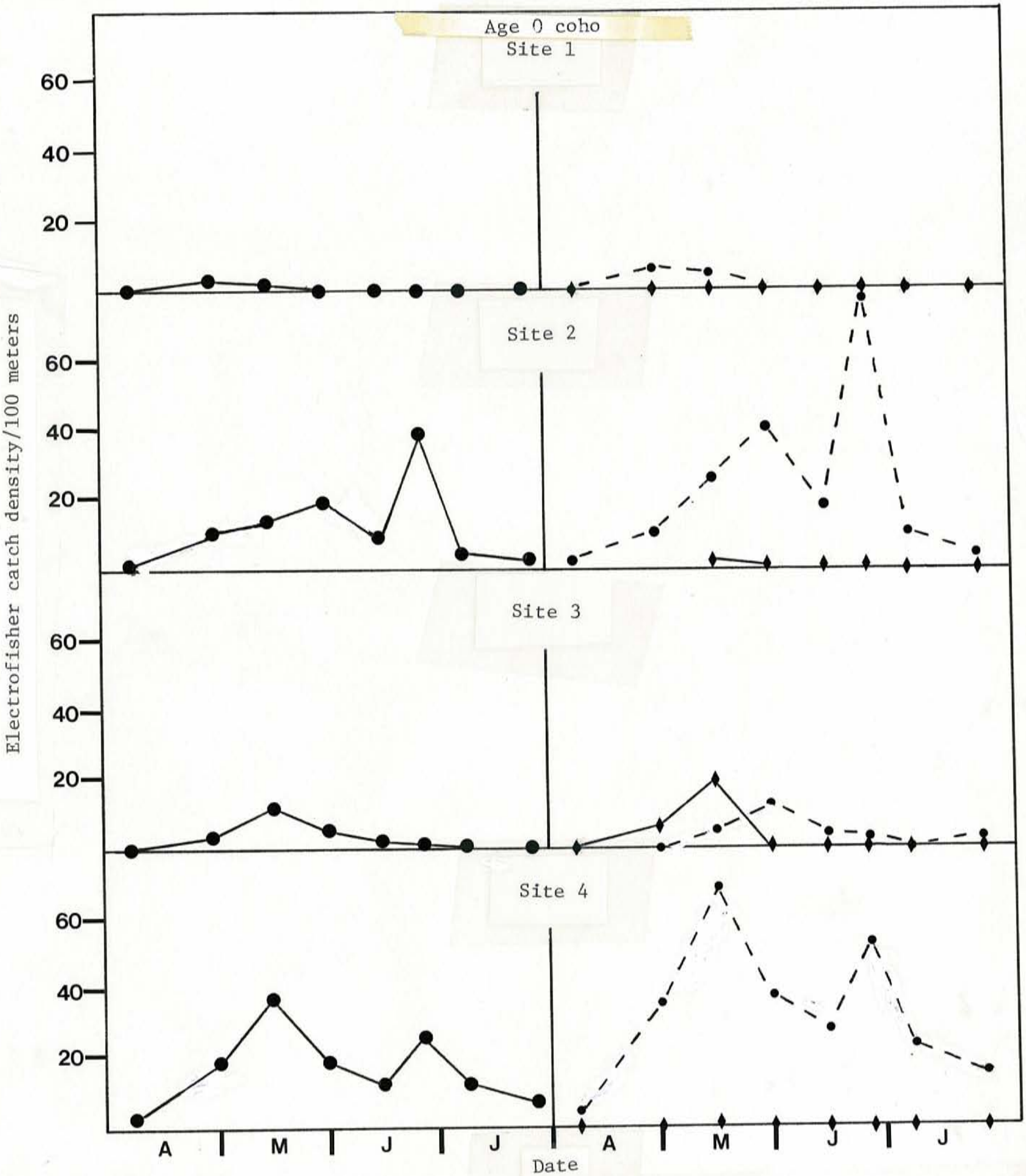

Fig. 16. Electrofisher catch density of age 0 coho by habitat type and site. ●——● average; ●- -● Bank; ♦——♦ Bar.

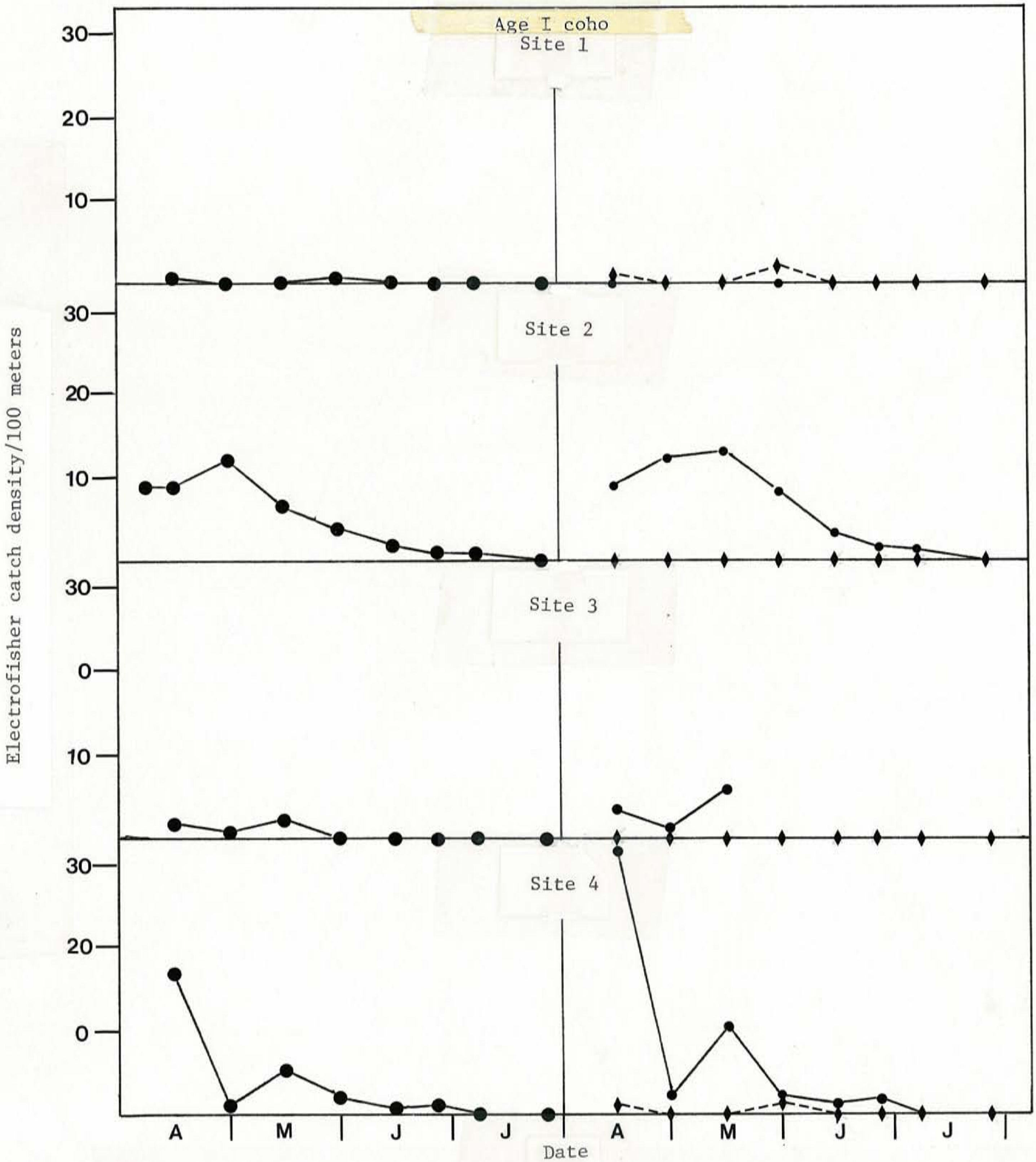

Fig. 17. Electrofisher catch density of age I coho by habitat type and site. ●——● average; ● – –● Bank; ♦——♦ Bar.

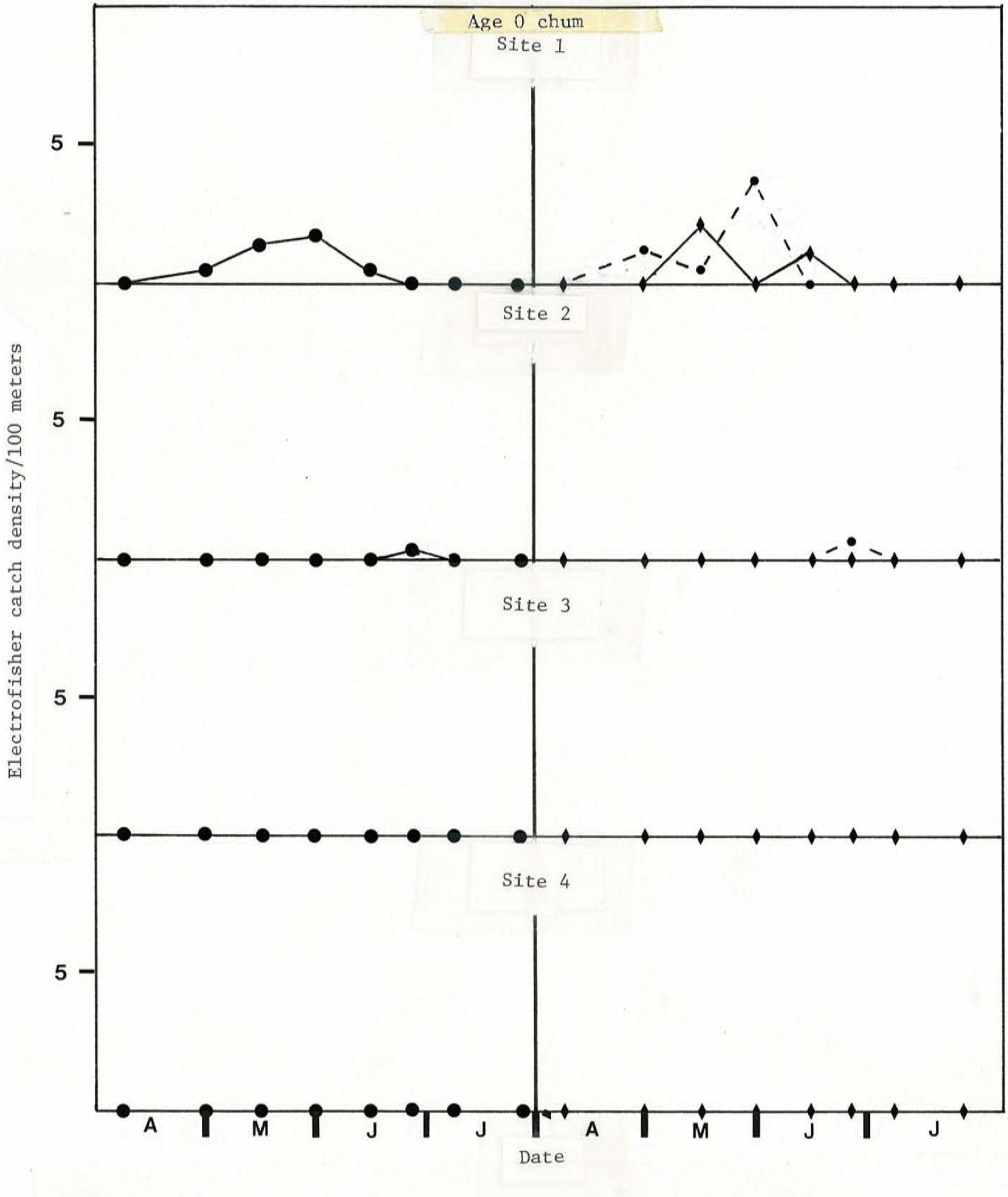

Fig. 18. Electrofisher catch density of age 0 chum by habitat type and site. ●——● average; ● – – ● Bank; ♦——♦ Bar.

Rainbow-Steelhead

Catch densities of age 0 rainbow-steelhead were greatest at site 2 (Fig. 19) on all dates with the exception of June 28, the initial date on which age 0 fry were captured. Catch densities at site 1 (9.3-47.4 fish/100 m) were generally less than 10 percent of those at other sites.

Age I+ rainbow-steelhead catch densities were greatest at site 2 (Fig. 20), where they reached a peak of 12.5 fish/100 m on April 29. Age I+ rainbow-steelhead were also present in electrofisher catches at site 2 in seven out of the eight survey dates, a significantly greater number than at sites 1 and 3 (2 and 3 dates, respectively), and a slightly greater number than at site 4 (6 dates). This is no doubt due to the excellent habitat provided by the undercut banks and overhead cover at site 2.

Preference of Juvenile Salmonids for Bank vs. Bar Habitat

As described earlier, both bar and bank type habitats were sampled at each site, thus facilitating determination of the habitat preferences of juvenile salmonids. Initial classification of a study site into bank and bar components was based on river bank slope. Bank and bar habitat differ in a number of other ways, all or some of which may be important in determining fish preferences. In general, bank habitat, in contrast to bar, is characterized by slower, deeper water (pools), with a corresponding shift to a substrate composed of finer sediments.

Visual examination of the distribution of electrofisher catches between bank and bar habitat (Figs. 14-20) indicates that there were differences among the juvenile salmonids in preferred habitat. The Wilcoxon signed rank test was used to statistically test for significant differences in the observed distributional patterns. The number of comparisons to be made (sampling dates) was often small, thus limiting the power of this test. When 5 comparisons are made, all must have similar outcomes for the result to be significant at the 90 percent level. Comparisons were not made when the sample size dropped below 5.

For the conclusions drawn from this statistical test to be valid, four important assumptions or conditions must be met. These are:

1) The number of fish available to populate each bank or bar being compared must be equal.

2) Bank/bar habitat pooled among sites must be similar to avoid confounded effects and increased variance.

3) Fish habitat preferences cannot change during the time period for which they are tested.

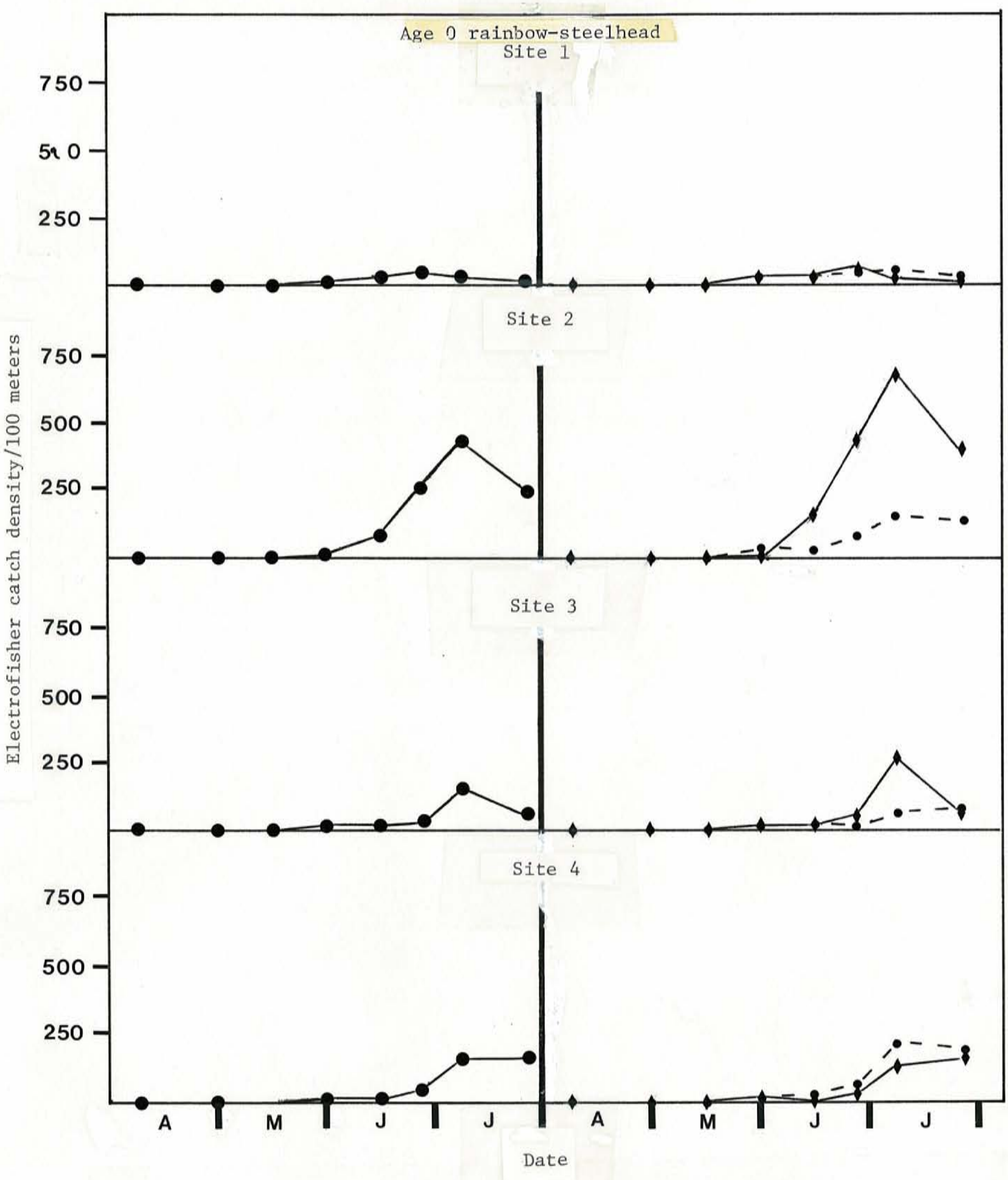

Fig. 19. Electrofisher catch density of age 0 rainbow-steelhead by habitat type and site. ●——● average; ●- -● Bank; ♦——♦ Bar.

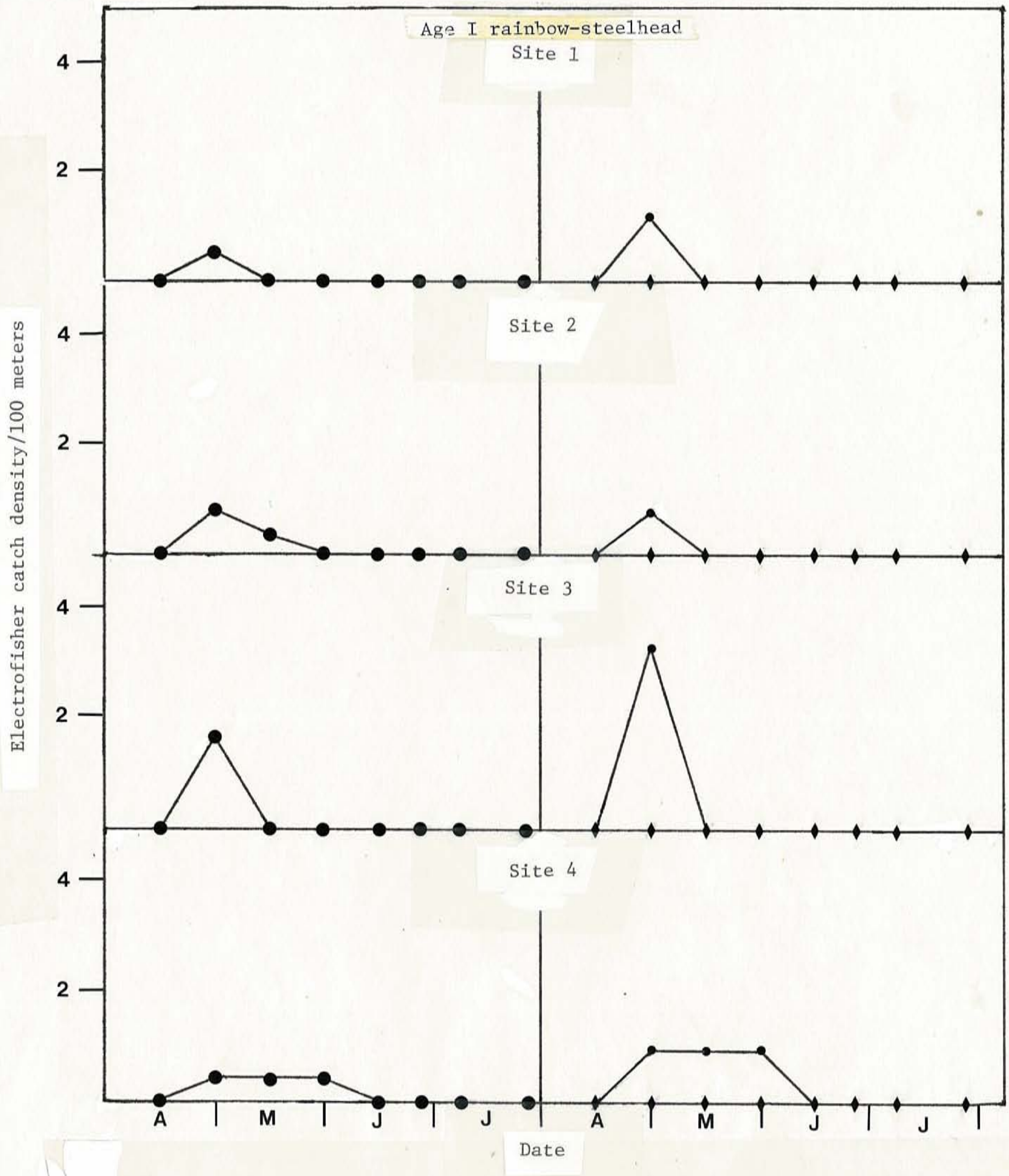

Fig. 20. Electrofisher catch density of age I rainbow-steelhead by habitat type and site. ●——● average; ●– –● Bank; ♦——♦ Bar.

4) Fish distributional patterns must reflect real habitat preferences and not an inability to select habitat because of locomotory or temporal limitations.

Assumption 4 is the most tenuous. In this analysis, catch locations were assumed to reflect preferred habitat.

The time period of this study was considered sufficiently short that no major changes would occur in the habitat preferences of either age 0 or age I fish, thus meeting the requirements of assumption 3.

To avoid violating assumption 2, sites 1 and 3 and sites 2 and 4 were pooled based on their similarity of bank characteristics (Table 1). The banks at sites 2 and 4 provide excellent cover in contrast to the small amount of cover afforded at sites 1 and 3. This further classification of bank types allows the bank slope and cover effects to be isolated.

Assumption 1 did not appear to be violated as the distance between bank and bar habitat at each site was small.

Habitat Preferences of Age 0 Salmonids

A summary of the preference of age 0 fry of each species for each type of habitat and associated significance levels are presented in Table 6.

Age 0 chinook showed no significant preference for either bar or noncover-bank habitat. However, they did show a significant preference (Pr.>.94) for bank habitat with cover as compared to bars. This suggests that cover is more important than slope in determining chinook fry distributional patterns.

Habitat preferences of age 0 coho were similar to those of chinook. A significant preference was noted for banks with cover as compared to bars (Pr.=.95), but not for noncover banks.

Due to the small sample sizes of age 0 chum only site 1 was tested for a bank/bar preference. Preferred habitat at that location was equally divided between bank and bar during the four sample dates on which chum were captured.

Age 0 rainbow-steelhead were unusual in that no habitat preference could be detected. However, in the cover-bank/bar comparison, fry were more numerous in the cover-bank habitat on all but one occasion (April 28).

Table 6. Preference of age 0 and I chinook, coho, chum, and rainbow-steelhead for different habitat types as determined by analysis of catch data.

		Preferred habitat	
Species	Age	Cover-bank/bar	Noncover-bank/bar
Chinook	0	Cover - bank Pr.> 0.94	Nonsignificant
	I	*	*
Coho	0	Cover - bank Pr.=0.95	Nonsignificant
	I	*	*
Chum	0	*	Nonsignificant
Rainbow-steelhead	0	Nonsignificant	Nonsignificant
	I+	Cover - bank Pr.> 0.98	*

*Insufficient sample size.

Tyler (1980) tested fry habitat preferences in the Nisqually River for a similar time period (April-June 1979). In that study, banks providing different degrees of cover were not distinguished, but bank habitat was still preferred by chinook and coho. Neither chum nor rainbow-steelhead were found to significantly prefer bank or bar habitat.

Habitat Preferences of Age I Salmonids

Age I+ rainbow-steelhead, in contrast to age 0, showed a very significant ($Pr. > .98$) preference for bank with cover in comparison to bar habitat.

All other species-habitat combinations had insufficient sample sizes to test for habitat preferences.

SUMMARY

A study initiated in 1979 to determine the spatial and temporal distribution of juvenile salmon in the Nisqually River was continued in 1980. Fish were sampled by a backpack electrofisher biweekly from April 10 to July 27. Sample sites were located at river miles 11.0, 19.6, 25.4, and 32.8. Two of these sites were in the Yelm Reach, where a portion of the river is diverted to the City of Centralia power plant. At each site both bank and bar habitat was sampled.

The estimated timing of juvenile chinook, coho, chum, and rainbow-steelhead freshwater life phases are summarized in Fig. 21.

The emergence of chinook fry was estimated from data collected by Tyler (1980) to begin on February 5 and end on June 5. Age 0 chinook were captured from the initial date of sampling for this study (April 10) through July 7, with peak abundance occurring during the initial survey date. Beach seining in mid-summer showed that a portion of the fry had moved offshore and not out of the river. Chinook fry were found to prefer bank habitat with cover in comparison to bar habitat. No preference could be found between noncover bank and bar habitat.

Age I chinook were captured on April 10 and April 29. Outmigration was estimated to commence in mid-May and continue well into June.

Emergence of coho was estimated to begin on April 3 and to end on June 5. The catch of age 0 coho was bimodal with peak catches occuring on May 13 and June 25. Age 0 coho preferred bank habitat with cover over bars. No preference for noncover bank over bar habitat could be determined.

Age I coho were captured in maximal abundance on April 29. Outmigration is believed to begin in mid-late April and terminate in late June, with peak outmigration occurring in mid-May.

Chum emergence was estimated to begin on April 19 and continue until June 18. Chum fry were the only salmonid species to show a definite upstream-downstream distributional pattern. They were captured at site 2 on only one occasion, and never at site 3 or 4.

Age 0 rainbow-steelhead catches peaked at a higher level than those for any other salmonids. Emergence was estimated to begin on May 20 and continue until the end of the sample season. Fry showed no significant preference for cover bank, noncover bank, or bar habitat.

Age I+ rainbow-steelhead were most abundant during the April 10 survey and declined steadily until late July, when none were captured. Bank habitat with cover was preferred by age I+ rainbow-steelhead.

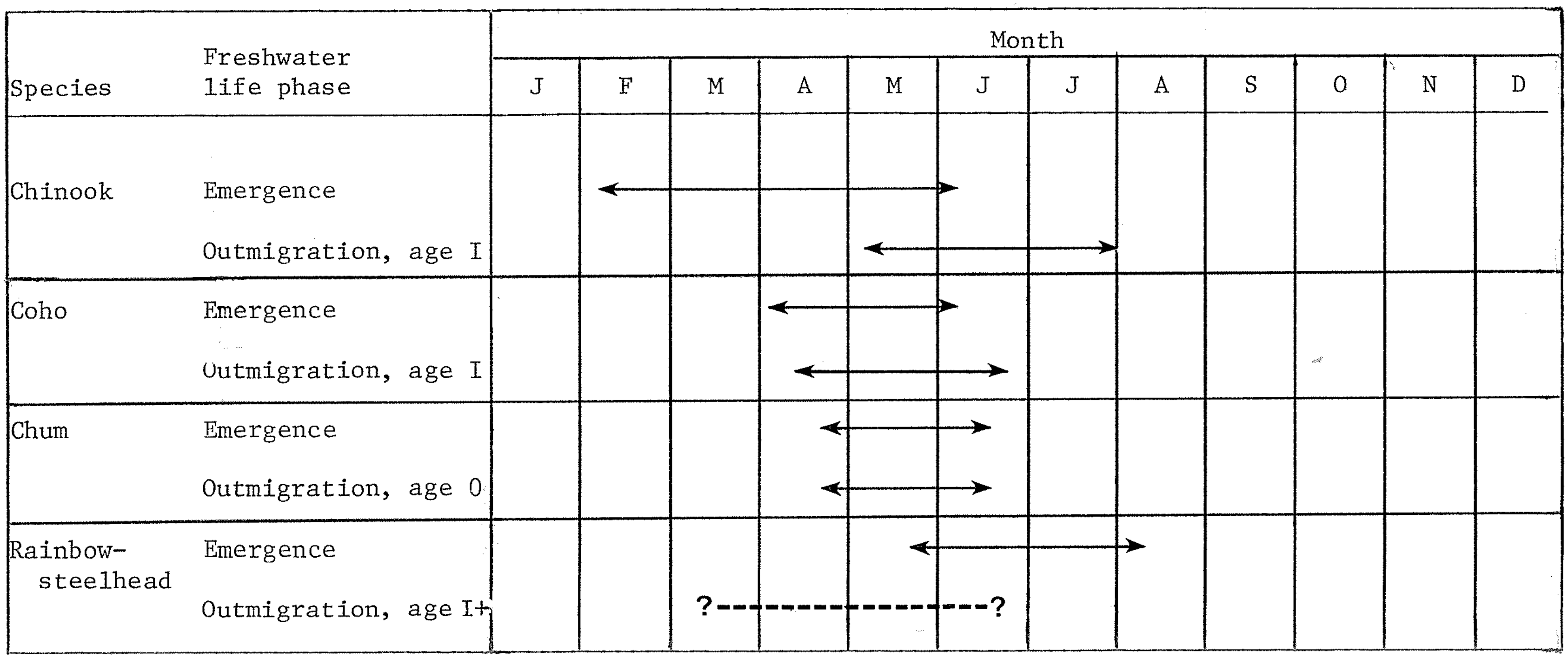

Fig. 21. Primary timing of emergence and outmigration for chinook, coho, chum, and rainbow-steelhead in the Nisqually River.

Age 0 chinook, coho, and chum catches in 1980 were smaller than those during 1979. A comparison of the abundance of fish in the two years is difficult due to differences in the sampling methods employed. Catches of age 0 rainbow-steelhead were similar in 1979 and 1980.

In contrast to sampling during 1979, a small number of age I chinook were captured by the electrofisher in 1980. Catch levels of age I coho and age I+ rainbow-steelhead were roughly equivalent in each year.

LITERATURE CITED

Brix, R., and D. Seiler. 1977. Upper Chehalis River smolt trapping study, 1976. Wash. Dep. Fish. Prog. Rep. 25. 14 pp.

Crawford, B. A., S. A. Leida, and M. W. Chilcote. 1979. Kalama River steelhead investigations, 1979. Wash. Dep. Game. 100 pp.

Fresh, K. L., D. Rabin, C. Simenstad, E. O. Salo, K. Garrison, and L. Matheson. 1979. Fish ecology studies in the Nisqually Reach area of southern Puget Sound, Washington. Univ. Washington, Fish. Res. Inst. Final Rep. FRI-UW-7904. 229 pp.

Salo, E. O., and W. H. Bayliff. 1958. Artificial and natural production of silver salmon, *Oncorhynchus kisutch*, at Minter Creek, Washington. Wash. Dep. Fish., Res. Bull. 4. 82 pp.

Tyler, R. W. 1980. Nisqually River juvenile salmonid study. Univ. Washington, Fish. Res. Inst. Final Rep. FRI-UW-8009. 39 pp.

Appendix Table 1. Salmonids caught by electrofisher.

Date	Location	Timer	Age 0				Age I		
			Chin	Coho	Chum	Rb-Sh	Chin	Coho	Rb-Sh
4-10-80	1 bank	391	6						
	bar	202	4				1		1
	2 bank	209	28	3			1		11
	bar		Not Sampled						
	3 bank	99	7						3
	bar	209	10						
	4 bank	531	39	6					33
	bar	196	4						1
4-29-80	1 bank	*	1	10	2			2	
	bar	*							
	2 bank	525	3	13			3	1	15
	bar		Not Sampled						
	3 bank	116						3	1
	bar	260	4	6					
	4 bank	*	1	38			1	1	3
	bar	*	1						
5-13-80	1 bank	289		8	1				
	bar	214	3		2				
	2 bank	604	19	31				1	16
	bar	208		2					
	3 bank	206		5					5
	bar	287	2	16					
	4 bank	964	3	71				1	11
	bar	164	1	1					
5-28-80	1 bank	717	3		6	15			
	bar	653	6			9			2
5-30-80	2 bank	2,153	9	49		10			9
	bar	339							
	3 bank	662	4	10		1			
	bar	*	2			2			

Appendix Table 1. Salmonids caught by electrofisher, continued.

			Age 0				Age I		
Date	Location	Timer	Chin	Coho	Chum	Rb-Sh	Chin	Coho	Rb-Sh
5-28-80	4 bank	1,137	1	39				1	3
	bar	91	4			1			1
6-12-80	1 bank	442		1		24			
	bar	335			1	16			
	2 bank	585	7	22		44			4
	bar	893				131			
	3 bank	309	4	4		4			
	bar	136				1			
	4 bank	*	2	28		13			1
	bar	252				4			
6-25-80	1 bank	536		2		65			
	bar	591				53			
	2 bank	632	1	94	1	104			2
	bar	*				384			
6-23-80	3 bank	207	1	3		7			
	bar	*				43			
	4 bank	703	2	55		66			
	bar	453				26			
7-7-80	1 bank	463				93			
	bar	*				21			
	2 bank	872		12		182			2
	bar	1,681				617			
7-11-80	3 bank	662		1		47			
	bar	1,729				219			
	4 bank	1,367	1	25		213			2
	bar	756				81			
7-25-80	1 bank	403				38			
	bar	396				11			
	2 bank	459		5		149			
	bar	1,389				353			

Appendix Table 1. Salmonids caught by electrofisher, continued.

Date	Location	Timer	Age 0				Age I		
			Chin	Coho	Chum	Rb-Sh	Chin	Coho	Rb-Sh
7-24-80	3 bank	*		3		71			
	bar	550				62			
	4 bank	1,209		16		178			
	bar	529				111			

*Timer malfunction.

Appendix Table 2. Salmonids caught by beach seine.

Date	Site	Age 0				Age I		
		Chin	Coho	Chum	Rb-Sh	Chin	Coho	Rb-Sh
5-23-80	1		10	2		11	15	
	4	103	19			40	61	
6-30-80	1	11	1					
	4	84	52		71			157
7-29-80	1	7			16			15
	4	142	33		26			3

Source: Puyallup tribal biologist John Kerwin.

Appendix Table 3. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of rainbow-steelhead by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35 mm, etc.)

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
4-10-80	26	0	0	0	0
	31	0	0	0	0
	36	0	0	0	0
	41	0	0	0	0
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	1	62.0	2.46	1.03
	66	4	68.3	3.39	1.07
	71	0	0	0	0
	76	4	78.0	4.21	.89
	81	1	81.0	5.96	1.12
	86	3	88.7	5.59	.80
	91	1	95.0	8.51	.99
	96	1	96.0	8.62	.97
	101	0	0	0	0
	106	0	0	0	0
	111	0	0	0	0
	116	1	116.0	N	0
	121	1	124.0	N	0
	126	0	0	0	0
	131	0	0	0	0
	136	0	0	0	0
	141	0	0	0	0
	146	0	0	0	0
	151	0	0	0	0
	156	0	0	0	0
	161	1	164.0	N	0
	166	1	170.0	N	0
	171	0	0	0	0
	176	0	0	0	0
	181	0	0	0	0
	186	0	0	0	0
	191	0	0	0	0
	196	0	0	0	0
	201	0	0	0	0
	206	0	0	0	0
	211	1	215.0	N	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
4-29-80	26	0	0	0	0
	31	0	0	0	0
	36	0	0	0	0
	41	0	0	0	0
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	1	74.0	N	0
	76	0	0	0	0
	81	0	0	0	0
	86	1	88.0	7.55	1.11
	91	2	95.0	9.71	1.13
	96	2	96.5	10.83	1.21
	101	1	105.0	15.10	1.30
	106	0	0	0	0
	111	0	0	0	0
	116	0	0	0	0
	121	0	0	0	0
	126	1	128.0	N	0
	131	1	133.0	N	0
	136	0	0	0	0
	141	0	0	0	0
	146	0	0	0	0
	151	0	0	0	0
	156	0	0	0	0
	161	0	0	0	0
	166	0	0	0	0
	171	0	0	0	0
	176	0	0	0	0
	181	0	0	0	0
	186	0	0	0	0
	191	0	0	0	0
	196	0	0	0	0
	201	0	0	0	0
	206	0	0	0	0
	211	0	0	0	0

Appendix Table 3. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of rainbow-steelhead by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35 mm, etc.) Continued.

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR	DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
5-13-80	26	0	0	0	0	5-28-80	26	6	28.8	.20	.82
	31	0	0	0	0		31	19	32.9	.27	.76
	36	0	0	0	0		36	10	37.1	.43	.84
	41	0	0	0	0		41	0	0	0	0
	46	0	0	0	0		46	1	50.0	1.30	1.04
	51	0	0	0	0		51	1	51.0	1.48	1.12
	56	0	0	0	0		56	0	0	0	0
	61	0	0	0	0		61	0	0	0	0
	66	0	0	0	0		66	1	68.0	3.48	1.11
	71	0	0	0	0		71	O	0	O	0
	76	2	78.0	5.42	1.14		76	1	76.0	N	0
	81	1	82.0	6.79	1.23		81	1	84.0	7.67	1.29
	86	4	88.8	8.84	1.26		86	1	86.0	8.39	1.32
	91	4	93.5	10.30	1.26		91	4	92.3	8.82	1.12
	96	2	100.0	11.04	1.10		96	1	98.0	N	0
	101	4	102.0	9.42	.89		101	3	102.3	13.31	1.24
	106	2	107.0	15.75	1.29		106	1	106.0	N	0
	111	1	112.0	16.38	1.17		111	2	111.5	N	0

Appendix Table 3. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of rainbow-steelhead by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35 mm, etc.) Continued.

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-12-80	26	14	29.0	.20	.81
	31	61	32.7	.28	.79
	36	18	37.7	.43	.80
	41	1	44.0	.71	.83
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	1	74.0	N	0
	76	0	0	0	0
	81	0	0	0	0
	86	1	87.0	N	0
	91	1	94.0	N	0
	96	1	96.0	N	0
	101	0	0	0	0
	106	0	0	0	0
	111	0	0	0	0
	116	1	116.0	N	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-23-80	26	10	29.8	.24	.90
	31	98	32.9	.31	.87
	36	28	37.3	.45	.87
	41	11	42.4	.84	1.10
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0
	76	0	0	0	0
	81	0	0	0	0
	86	0	0	0	0
	91	0	0	0	0
	96	1	99.0	N	0
	101	0	0	0	0
	106	0	0	0	0
	111	0	0	0	0
	116	1	120.0	N	0

Appendix Table 3. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of rainbow-steelhead by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35 mm, etc.) Continued.

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
7- 7-80	26	13	29.7	.21	.78
	31	109	33.0	.30	.83
	36	44	37.5	.51	.96
	41	15	42.8	.75	.96
	46	3	48.3	1.16	1.03
	51	1	52.0	1.51	1.07
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0
	76	0	0	0	0
	81	0	0	0	0
	86	0	0	0	0
	91	1	92.0	13.34	1.71

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
7-24-80	26	17	29.5	.20	.79
	31	79	32.8	.30	.85
	36	47	37.8	.50	.93
	41	15	42.7	.80	1.03
	46	10	47.7	1.17	1.08
	51	3	51.7	1.41	1.02
	56	0	0	0	0
	61	1	61.0	2.79	1.23
	66	0	0	0	0
	71	0	0	0	0
	76	0	0	0	0
	81	0	0	0	0
	86	0	0	0	0
	91	0	0	0	0

N = Weight not measured.

Appendix Table 4. Length frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of chinook by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35 mm, etc.)

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR	DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
4-10-80	26	0	0	0	0	4-29-80	26	0	0	0	0
	31	0	0	0	0		31	0	0	0	0
	36	6	38.8	.46	.78		36	0	0	0	0
	41	29	42.8	.66	.84		41	0	0	0	0
	46	7	47.3	.92	.87		46	5	48.0	1.13	1.03
	51	4	51.8	1.22	.88		51	5	52.8	1.47	1.00
	56	3	58.0	2.03	1.04		56	0	0	0	0
	61	1	61.0	2.13	.94		61	0	0	0	0
	66	2	67.5	2.80	.91		66	0	0	0	0
	71	0	0	0	0		71	0	0	0	0
	76	0	0	0	0		76	0	0	0	0
	81	1	83.0	N	0		81	0	0	0	0
	86	0	0	0	0		86	0	0	0	0
	91	0	0	0	0		91	0	0	0	0
	96	0	0	0	0		96	0	0	0	0
	101	0	0	0	0		101	0	0	0	0
	106	1	110.0	N	0		106	0	0	0	0
	111	0	0	0	0		111	0	0	0	0
	116	0	0	0	0		116	0	0	0	0
	121	0	0	0	0		121	1	124.0	N	0
	126	0	0	0	0		126	0	0	0	0
	131	0	0	0	0		131	0	0	0	0
	136	0	0	0	0		136	1	140.0	N	0
	141	0	0	0	0		141	1	144.0	N	0

Appendix Table 4. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of chinook by sampling date. (Length group 26 = 26–30 mm, length group 31 = 31–35 mm, etc.) Continued.

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
5-13-80	26	0	0	0	0
	31	0	0	0	0
	36	1	38.0	.42	.77
	41	2	42.5	.79	1.02
	46	6	48.2	1.13	1.01
	51	6	52.5	1.46	1.01
	56	3	57.3	1.97	1.05
	61	5	63.4	2.76	1.08
	66	0	0	0	0
	71	1	75.0	4.34	1.03
	76	0	0	0	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
5-28-80	26	0	0	0	0
	31	1	35.0	.26	.61
	36	10	38.6	.47	.82
	41	11	42.6	.67	.87
	46	2	47.0	1.03	.99
	51	2	53.5	1.77	1.16
	56	0	0	0	0
	61	1	62.0	2.66	1.12
	66	0	0	0	0
	71	0	0	0	0
	76	1	78.0	5.92	1.25

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-12-80	26	0	0	0	0
	31	0	0	0	0
	36	6	39.5	.47	.77
	41	5	42.8	.65	.83
	46	3	47.7	1.10	1.02
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0
	76	0	0	0	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-23-80	26	0	0	0	0
	31	0	0	0	0
	36	0	0	0	0
	41	2	41.0	.57	.83

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
7- 8-80	26	0	0	0	0
	31	0	0	0	0
	36	0	0	0	0
	41	1	42.0	.69	.93

N — Weight not measured.

Appendix Table 5. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of coho by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35, etc.)

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
4-10-80	26	0	0	0	0
	31	3	34.7	.31	.74
	36	4	38.8	.47	.81
	41	2	42.0	.59	.80
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0
	76	0	0	0	0
	81	0	0	0	0
	86	0	0	0	0
	91	0	0	0	0
	96	0	0	0	0
	101	0	0	0	0
	106	0	0	0	0
	111	0	0	0	0
	116	0	0	0	0
	121	0	0	0	0
	126	0	0	0	0
	131	0	0	0	0

DATE	LENGTH GROUP	FREQ	ME=N LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
4-29-80	26	2	29.5	.20	.78
	31	14	33.5	.31	.82
	36	31	37.9	.47	.86
	41	8	42.4	.64	.84
	46	1	49.0	1.16	.99
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0
	76	0	0	0	0
	81	0	0	0	0
	86	1	87.0	8.42	1.28
	91	0	0	0	0
	96	1	99.0	11.69	1.20
	101	1	101.0	10.55	1.02
	106	0	0	0	0
	111	0	0	0	0
	116	3	118.3	16.52	.99
	121	0	0	0	0
	126	0	0	0	0
	131	1	131.0	N	0

Appendix Table 5. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of coho by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35, etc.) Continued.

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR	DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
5-13-80	26	1	29.0	.26	1.07	5-28-80	26	0	0	0	0
	31	13	33.8	.33	.86		31	5	34.2	.35	.88
	36	34	37.9	.47	.86		36	20	38.0	.56	1.03
	41	19	42.6	.76	.98		41	11	43.5	.91	1.10
	46	11	48.3	1.23	1.09		46	10	47.0	1.17	1.13
	51	2	52.5	1.55	1.07		51	4	53.0	1.76	1.18
	56	0	0	0	0		56	1	58.0	2.34	1.20
	61	0	0	0	0		61	0	0	0	0
	66	0	0	0	0		66	0	0	0	0
	71	0	0	0	0		71	0	0	0	0
	76	0	0	0	0		76	0	0	0	0
	81	0	0	0	0		81	0	0	0	0
	86	1	90.0	N	0		86	0	0	0	0
	91	0	0	0	0		91	0	0	0	0
	96	1	99.0	13.04	1.34		96	0	0	0	0
	101	0	0	0	0		101	0	0	0	0
	106	0	0	0	0		106	0	0	0	0
	111	0	0	0	0		111	1	113.0	14.12	.98
	116	2	117.5	16.81	1.04		116	0	0	0	0

Appendix Table 5. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of coho by sampling date. (Length group 26 = 26–30 mm, length group 31 = 31–35, etc.) Continued.

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-12-80	26	0	0	0	0
	31	1	35.0	.32	.75
	36	8	38.6	.59	1.02
	41	13	39.8	.94	1.49
	46	11	48.1	1.39	1.25
	51	8	52.6	1.94	1.33
	56	5	57.6	2.52	1.32

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
7- 7-80	26	0	0	0	0
	31	0	0	0	0
	36	2	39.5	.64	1.05
	41	3	43.0	1.00	1.26
	46	1	49.0	1.43	1.22
	51	3	53.7	1.77	1.15
	56	3	58.3	2.57	1.29
	61	8	63.0	2.96	1.18
	66	4	67.8	3.74	1.20

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-23-80	26	0	0	0	0
	31	0	0	0	0
	36	2	38.5	.61	1.06
	41	6	44.5	1.03	1.17
	46	8	48.0	1.36	1.23
	51	9	52.9	1.95	1.32
	56	10	57.5	2.50	1.32
	61	4	63.5	3.47	1.36
	66	5	68.4	4.11	1.28

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
7-24-80	26	0	0	0	0
	31	0	0	0	0
	36	0	0	0	0
	41	0	0	0	0
	46	1	50.0	1.78	1.42
	51	2	53.0	1.97	1.32
	56	4	58.0	2.22	1.14
	61	3	65.0	3.24	1.18
	66	1	66.0	3.27	1.14
	71	4	72.3	4.72	1.25
	76	2	77.5	6.13	1.32
	81	1	81.0	7.16	1.35

N – Weight not measured.

Appendix Table 6. Length-frequency, mean length, mean weight, and condition factor of subsampled electrofisher catch of chum by sampling date. (Length group 26 = 26-30 mm, length group 31 = 31-35, etc.)

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
4-29-80	26	0	0	0	0
	31	0	0	0	0
	36	2	37.5	.35	.65
	41	0	0	0	0
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
5-28-80	26	0	0	0	0
	31	1	35.0	.27	.63
	36	5	37.0	.32	.62
	41	0	0	0	0
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
5-13-80	26	0	0	0	0
	31	1	35.0	.33	.77
	36	2	37.5	.43	.81
	41	0	0	0	0
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0

DATE	LENGTH GROUP	FREQ	MEAN LENGTH (MM)	MEAN WEIGHT (G)	CONDITION FACTOR
6-25-80	26	0	0	0	0
	31	0	0	0	0
	36	1	40.0	.48	.75
	41	0	0	0	0
	46	0	0	0	0
	51	0	0	0	0
	56	0	0	0	0
	61	0	0	0	0
	66	0	0	0	0
	71	0	0	0	0

N – Weight not measured.