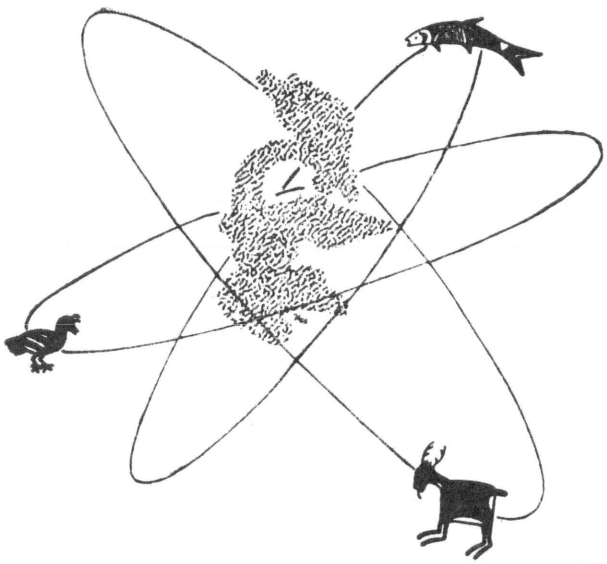
FEDERAL AID PROGRESS REPORTS
FISHERIES
1978



RESEARCH AND DEVELOPMENT SECTION

Oregon Department of Fish and Wildlife

Fish Division

Willamette River Spring Chinook

ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: Improving Survival of Spring Chinook Hatchery Smolts in the Willamette River

PROJECT NUMBER: 88E25045

CONTRACT NUMBER: 03-08-M02-43

PROJECT PERIOD: October 1, 1977 to September 30, 1978

Prepared by: Eugene M. Smith
Ronald H. Williams
Jeffrey C. Zakel
Research Section

Oregon Department of Fish and Wildlife
506 S. W. Mill Street
P. O. Box 3503
Portland, Oregon 97208

This project was financed in part with Columbia River Fishery Development funds through the National Marine Fisheries Service, a branch of the National Oceanic and Atmospheric Administration.

Footnote notation [b] also applies to 1974 brood Carson stock.

ERRATA

Table 3, Page 5: Footnote [a] applies to Carson RV.

Table 7, Page 23: Table heading notation "Game/fish" should be "Grams/fish".

Footnote notation [b] also applies to 1974 brood Carson stock.

CONTENTS

TABLES

Table no.

FIGURES

Figure no.

APPENDIX TABLES

Table no.

APPENDIX FIGURES

Figure no.

ABSTRACT

We released comparable groups of 1975 and 1976 brood spring chinook smolts at Foster Dam on the South Santiam River and below Willamette Falls to define the effects of fish size and time and location of releases of hatchery smolts on survival. The first tagged fish, seven 3-year-old jacks, returned to South Santiam Hatchery in 1978. They resulted from fall released smolts and included six jacks from the release at Foster Dam and one from the release below Willamette Falls.

We compared growth, ATPase activity and scale characteristics of juveniles during residence in the hatcheries and at release with similar data collected post-release from active emigrants in the lower Willamette and Columbia rivers. Smolts smaller than about 140 mm do not appear to emigrate quickly. We could not relate ATPase activities to success of emigration, and we found several factors could influence activity. Emigration of spring chinook smolts released in the spring appear similar for 1975 and 1976 broods; movement peaked in the lower Willamette River about 3 wk post-release.

We continued to collect adult return information from comparable groups of Carson and Willamette spring chinook returning to Fall Creek Dam. Carson chinook continued to predominate in the returns to the fish trap at Fall Creek, while preliminary fishery contribution estimates favored the Willamette stock.

INTRODUCTION

This study is entering its third year of investigating methods for improving returns of spring chinook salmon to the Willamette River. We are using data from recaptures of coded wire tagged juvenile and adult salmon to aid in promoting emigration, fishery contribution and adult returns of hatchery-reared spring chinook salmon. We continued to collect adult return data at Fall Creek Dam to help evaluate the survival and contribution of an exotic stock of spring chinook salmon in the Willamette River.

Long-term benefits of this study will include improved definition of life history of juvenile and adult spring chinook of Willamette River origin, and an accurate estimate of mortality of juveniles passing Willamette Falls for several years. This study will also estimate the magnitude and locations of catches of Willamette River spring chinook in the various ocean and freshwater fisheries. Results obtained will aid in developing effective operating criteria for the spring chinook production facilities on the Willamette River.

METHODS

The 1975 and 1976 broods of spring chinook were reared and coded wire tagged at South Santiam Hatchery. We released comparable groups of each brood into the South Santiam River and below Willamette Falls during the spring and fall (Table 1).

Table 1. Tagged spring chinook smolts of the 1975 and 1976 broods released at South Santiam Hatchery and below Willamette Falls.

Brood	Number released	Date of release	CWT codes	Release location	Remarks
1975	97,640	11/15/76	09-5/07	At Foster	Fall release
1975	103,040	11/15/76	09-5/08	Below falls	Fall release
1975	93,912	03/18/77	09-5/09	At Foster	Spring release
1975	86,953	03/17/77	09-5/10	Below falls	Spring release
1976	85,014[a]	11/07/77	09-16/27, 28,29	At Foster	Fall release
1976	84,578[a]	11/08/77	09-16/30, 31,32	Below Falls	Fall release
1976	69,457[a]	03/09/78	09-16/21, 22,26	At Foster	Spring release
1976	64,933[a]	08/09-10/78	09-16/23, 24,25	Below falls	Spring release

[a] *Releases divided into three distinctly tagged replicate groups.*

We collected growth and ATPase data and scales from the groups of tagged smolts during residence in the hatchery and at time of release. Emigration data were obtained from tagged juveniles as they migrated past the Portland General Electric Company's (PGE) Sullivan Plant at Willamette Falls and from the National Marine Fisheries Service (NMFS) seining crews on the lower Columbia River. Initial information on returns of the 1975 brood was collected from jacks returning to Foster Dam in 1978.

We compared ATPase data from this study with that from a separate but complementary study comparing Carson and Willamette stocks of spring chinook reared at Marion Forks Hatchery. Because of a unique opportunity afforded by simultaneous sampling for ATPase activity by personnel from the Oregon Department of Fish and Wildlife (ODFW) and NMFS at Marion Forks Hatchery, we compared two assay methods.

We continued to evaluate returns of marked Carson and Willamette spring chinook returning to Fall Creek Dam. Although this study is no longer funded under the Columbia River Fisheries Development Program (CRFDP), it is being completed under state funds and results are included in this report.

The tests described in Table 1 will be repeated using spring chinook smolts of the 1977 brood. These fish will be released in late 1978 and early 1979 (Table 2).

A permanent employee was hired for analysis of salmonid scales. This person will work part-time on scales from Willamette spring chinook to aid in describing life history information.

Table 2. Spring chinook smolts of the 1977 brood tagged for release in November 1978 and March 1979.

Hatchery	Number tagged	CWT codes[a]	Scheduled release Date	Scheduled release Location	Purpose
S. Santiam	103,000	07-19/26,27,28	11/78	Foster	Time x location release
S. Santiam	68,000	07-19/29,30	11/78	Below Will. Falls	"
Willamette	112,000	07-19/19,20,21	03/79	Foster	"
Willamette	113,000	07-19/22,23,24	03/79	Below Will. Falls	"

[a] *Releases divided into distinctly tagged replicate groups.*

RESULTS

Smolt Size as a Factor in Emigration

River freshets in fall 1977 affected our ability to sample emigration at Willamette Falls of tagged 1976 brood smolts released in early November. We were able to collect emigrants only during the first half of November. However, limited sampling indicated that those smolts emigrating soon after release were generally only the larger fish (125-210 mm in fork length) in the release group. Generally, smolts smaller than 135 mm did not emigrate quickly after release (Fig. 1).

Closure of the PGE plant at Willamette Falls from March 13 to 30, 1978, for smolt protection, precluded sampling the early segment of the spring downstream migration of tagged chinook. Fish were released from hatcheries in mid March, and we began sampling 2 to 3 wk post-release. Few of the largest emigrants were recovered in this delayed sampling effort, and we believe this resulted from passage of these fish during plant closure. As a result, mean lengths of recaptured fish were smaller or only slightly larger than the corresponding mean lengths of the groups at release (Table 3). Comparison of size ranges between released and recaptured smolts appears to confirm our earlier observations (Smith 1977) that the smallest fish released (80-115 mm) in the spring did not emigrate quickly.

Emigration

The PGE plant closure during spring 1978 affected analyses of emigration rates of tagged chinook smolts. By comparing patterns of emigration for similar time periods, post-release, for the 1975 and 1976 broods, we found similarities in emigration (Fig. 2). We believe the majority of emigrants passed Willamette Falls during the period of plant closure in 1978; thus the closure was effective in protecting the majority of hatchery-released spring chinook smolts from turbine-incurred injury.

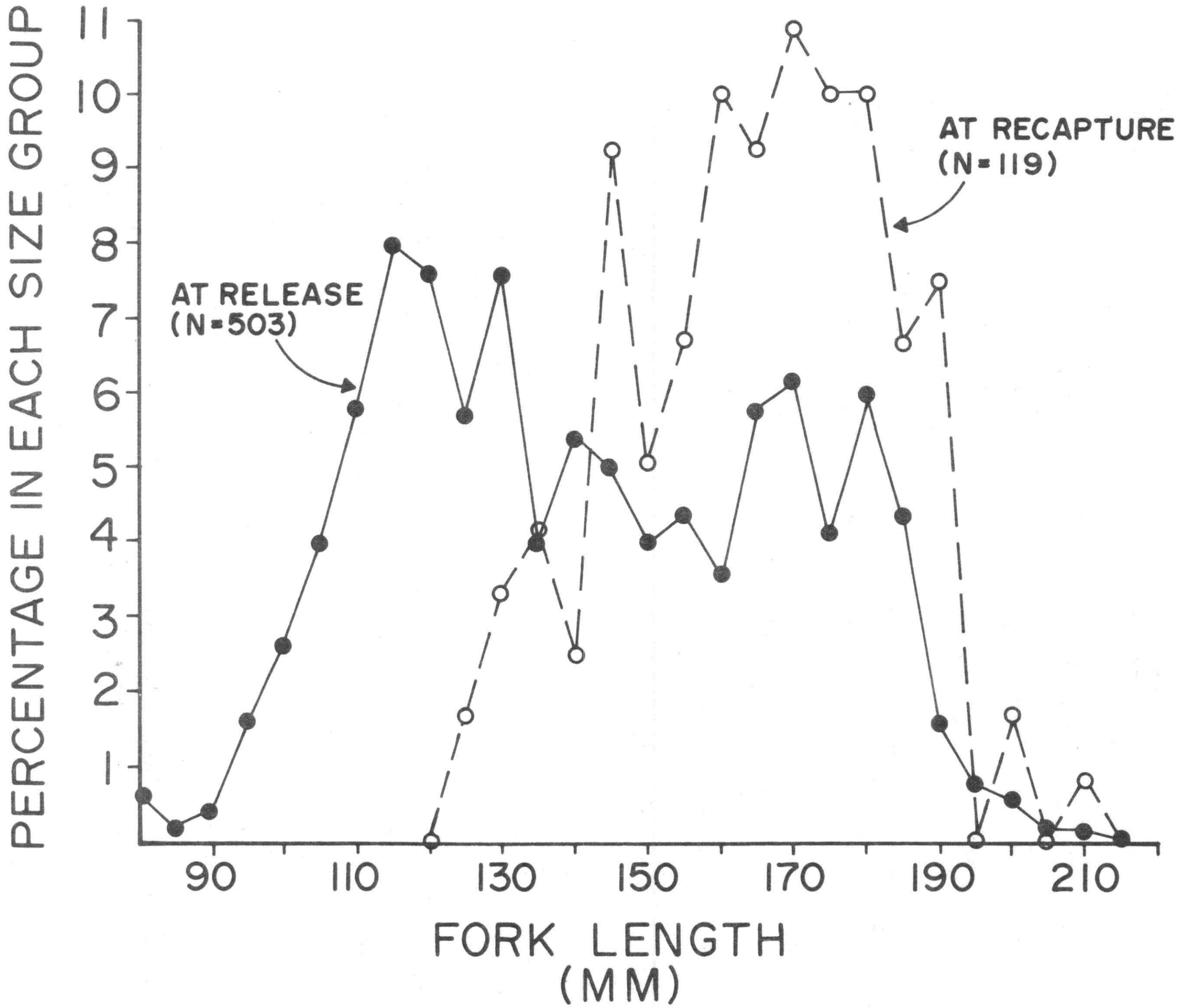


Fig. 1. Comparison of length frequencies between populations of tagged spring chinook smolts released from South Santiam Hatchery on November 7 and migrants recaptured at the Sullivan Plant sampler from November 9-14, 1977

Table 3. Comparison of lengths of tagged spring chinook released at Willamette River hatcheries in spring 1978, and subsequently recovered at the Sullivan Plant sampler.

Hatchery	Stock and mark	Release data				Recovery data				
		Date	$\bar{x}$ mm	Range	n	Dates	$\bar{x}$ mm	Range	n	Change
S. Santiam	Will. CWT	3/9/78	162.5	85-255	552	4/5-5/10	151.8	115-215	39	-10.7 mm
Marion Fk.	Will. CWT	3/13-15/78	141.2	80-220	600	3/31-4/28	149.3	105-215	311	+ 8.1 mm
Marion Fk.	Carson CWT	3/13-15/78	130.4	80-220	696	3/31-4/28	134.6	115-185	160	+ 4.2 mm
Marion Fk.	Carson RV	3/13-15/78	129.2	80-200	239	4/5-5/10	136.9	120-160	133	+ 7.7 mm

[a] *Excess Carson stock released from Marion Forks Hatchery were marked RV to prevent confusion with Willamette stocks as returning adults.*

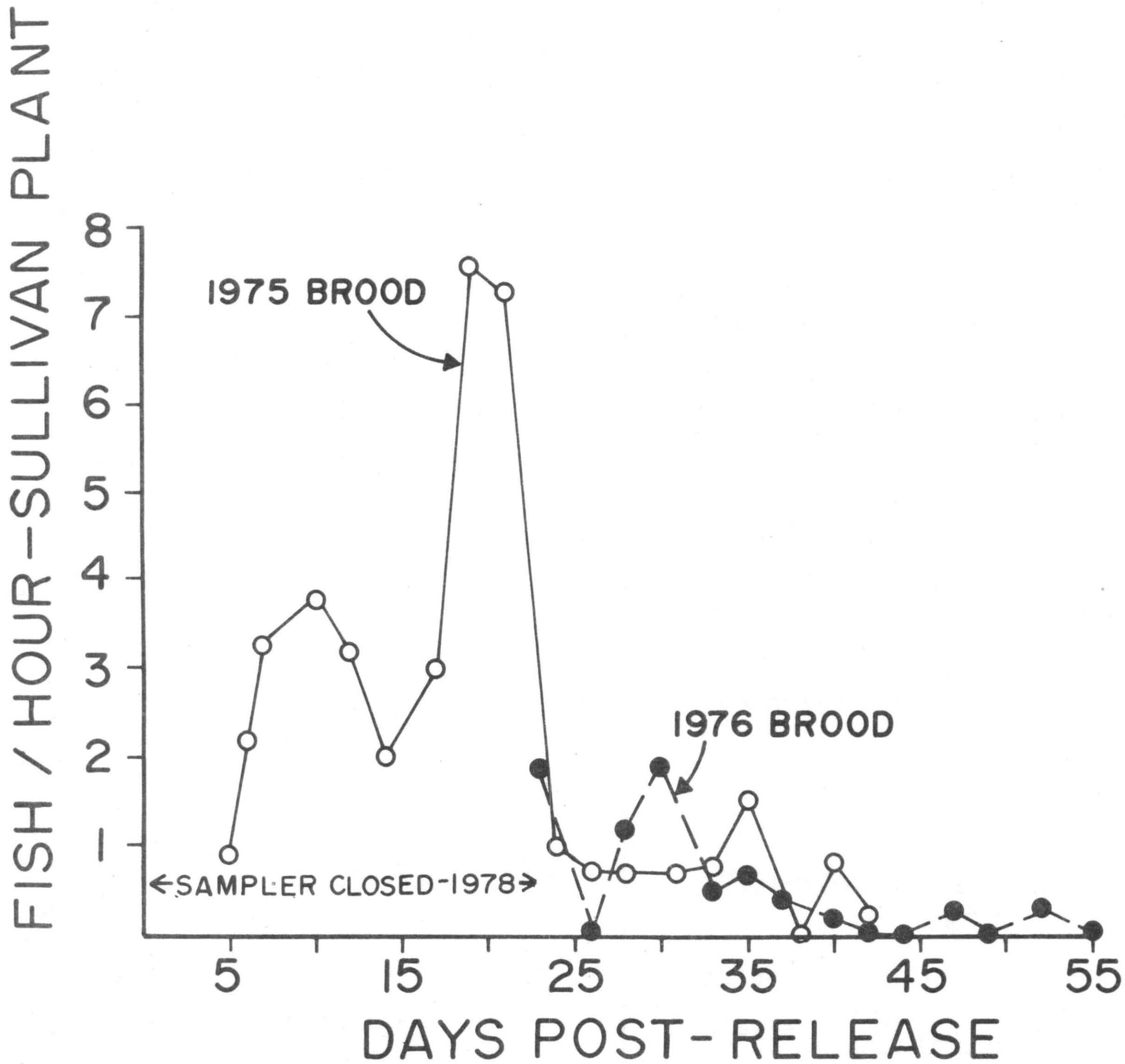


Fig. 2. Catch of 1975 and 1976 brood spring chinook released at South Santiam Hatchery and recaptured at the Sullivan Plant sampler in spring 1977 and 1978, respectively.

Recently, NMFS data became available which displays the pattern of passage in the Columbia River of tagged 1975 brood smolts released from South Santiam Hatchery. Seining began at Jones Beach on April 14, 1977, apparently in time to sample the peak emigration of these smolts through the Columbia River. Smolts released into the South Santiam River peaked at Willamette Falls 19 days post-release and in the lower Columbia River 31 days post-release (Fig. 3).

None of the 1976 brood smolts released at South Santiam Hatchery in March 1978 were collected at the Sullivan Plant after May 1, and emigration of Willamette spring chinook smolts appeared minimal after that date. These data support observations on the 1975 brood (Smith 1977).

Collection of wild and hatchery chinook at the Sullivan Plant in 1978 indicated that wild smolts began passing through the lower Willamette in substantial numbers by early March (Fig. 4). We usually released our hatchery smolts about mid March in most years. However, it appears on the basis of wild smolt movement that we may be able to release the larger hatchery fish about March 1 and reduce hatchery operating costs while still obtaining rapid emigration. An earlier release might also benefit the slower emigrants by permitting them more time to leave the river before water temperatures rise to the point that disease organisms become infective.

Effects of Time and Location of Release

Few jacks of the 1975 brood returned in 1978. Of seven tags recovered from jacks returning to Foster Dam in 1978, six were from smolts released in the fall at Foster and only one was from the group released in the fall below Willamette Falls. Because of the preliminary nature of the data, we will not speculate on the ability of the fish released below the falls to home to the hatchery. The high incidence of fall-released fish in these initial returns, however, coincides well with data we obtained from complementary studies at Dexter.

ATPase Activity in Relation to Emigration

We collected (Na + K-activated) gill ATPase activity data from four treatments of 1976 brood spring chinook smolts released from South Santiam Hatchery in fall 1977 and spring 1978. For analysis, we denoted these as groups 1 and 2, which were released in the fall, and groups 3 and 4, which were liberated in the spring. We retained small samples of groups 2 and 3 in tanks at the hatchery for ATPase progression data.

We saw three periods of elevated ATPase activity in the fall-released fish (groups 1 and 2): an initial increase in late June, when the fish were approximately 80 to 90 mm, followed by a small rise in November and substantial peak the following spring for those retained in the hatchery (Fig. 5). These smolts, reared at South Santaim Hatchery where temperatures are relatively constant, due to in-reservoir water intakes, displayed lowest condition factor (KFL) in December 1977, about $1\frac{1}{2}$ months post-release (Fig. 6).

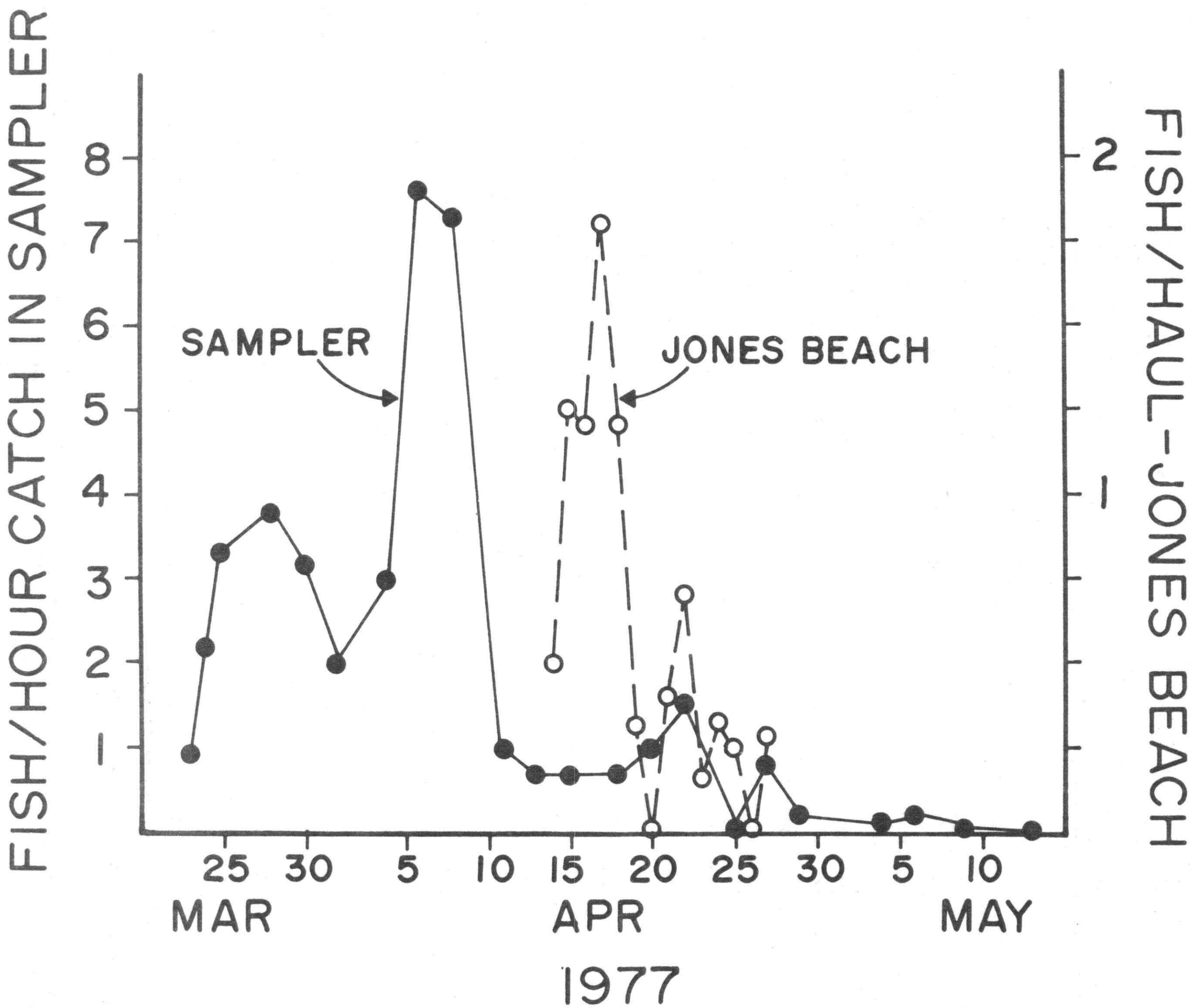


Fig. 3. Catch of coded wire tagged 1975 brood spring chinook smolts released at South Santiam Hatchery on March 18, 1977

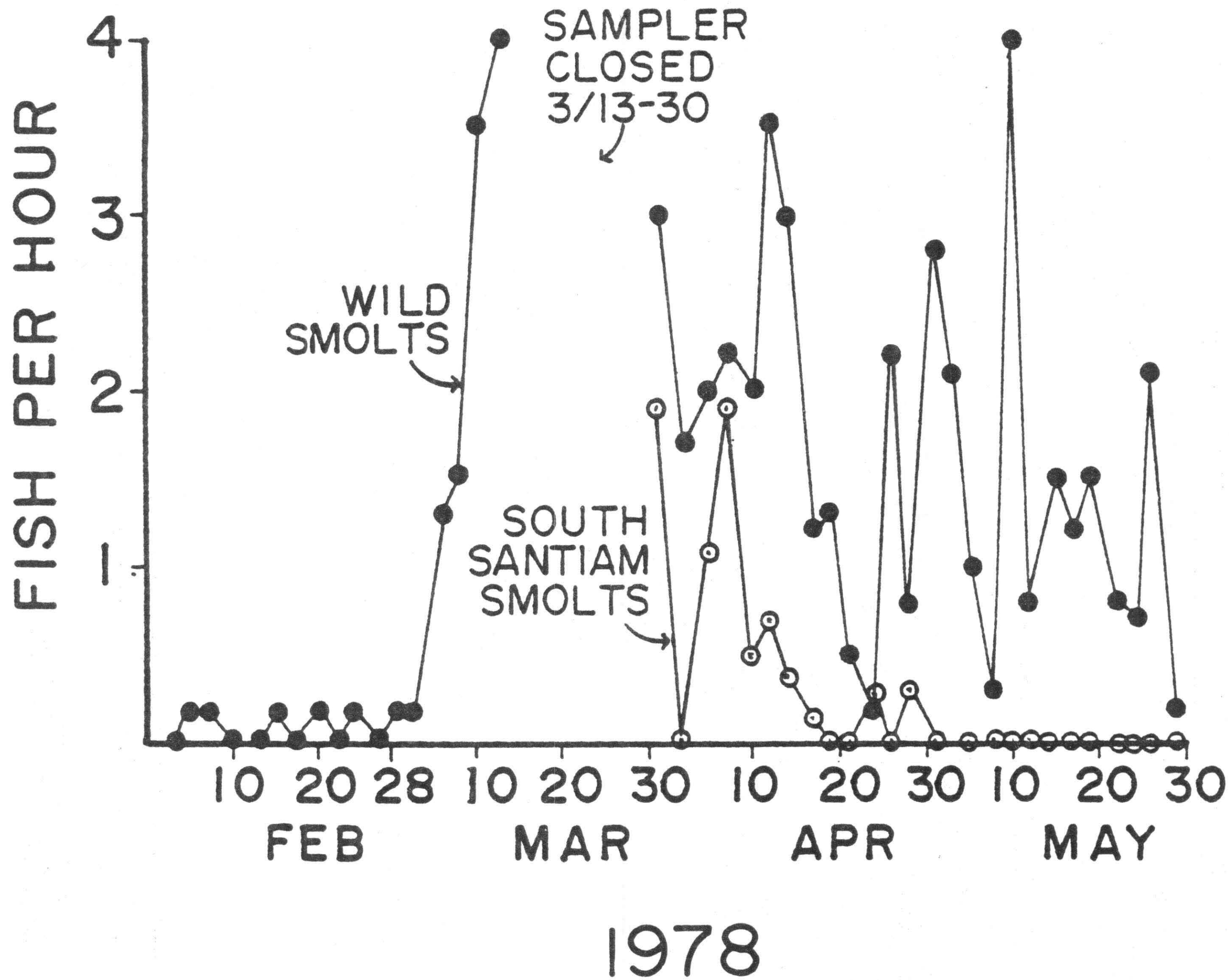


Fig. 4. Catch of non-hatchery and South Santiam Hatchery spring chinook smolts at the Sullivan Plant sampler, spring 1978.

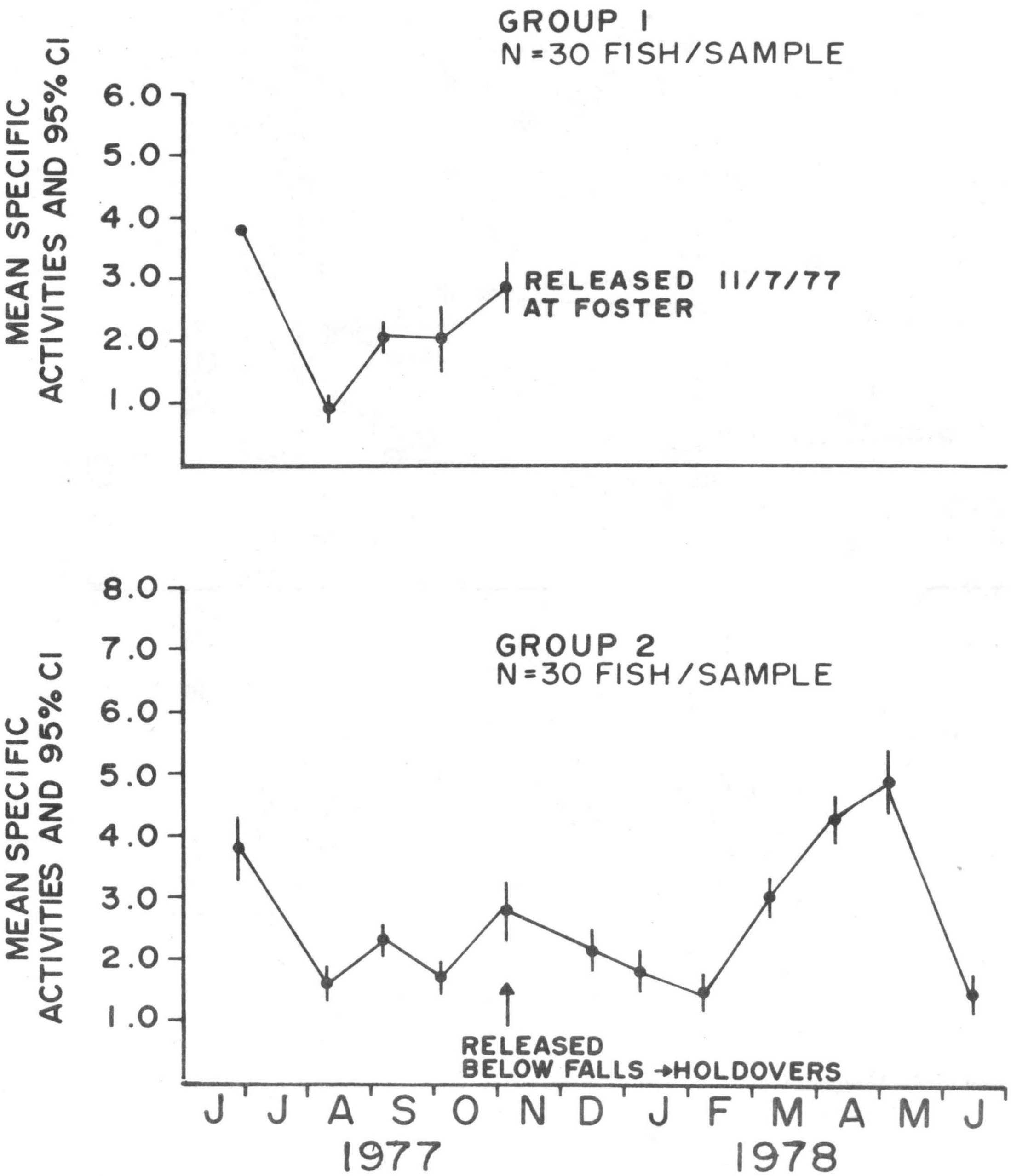


Fig. 5. Progression of mean (Na + K-activated) ATPase for two groups of Willamette stock spring chinook reared at South Santiam Hatchery.

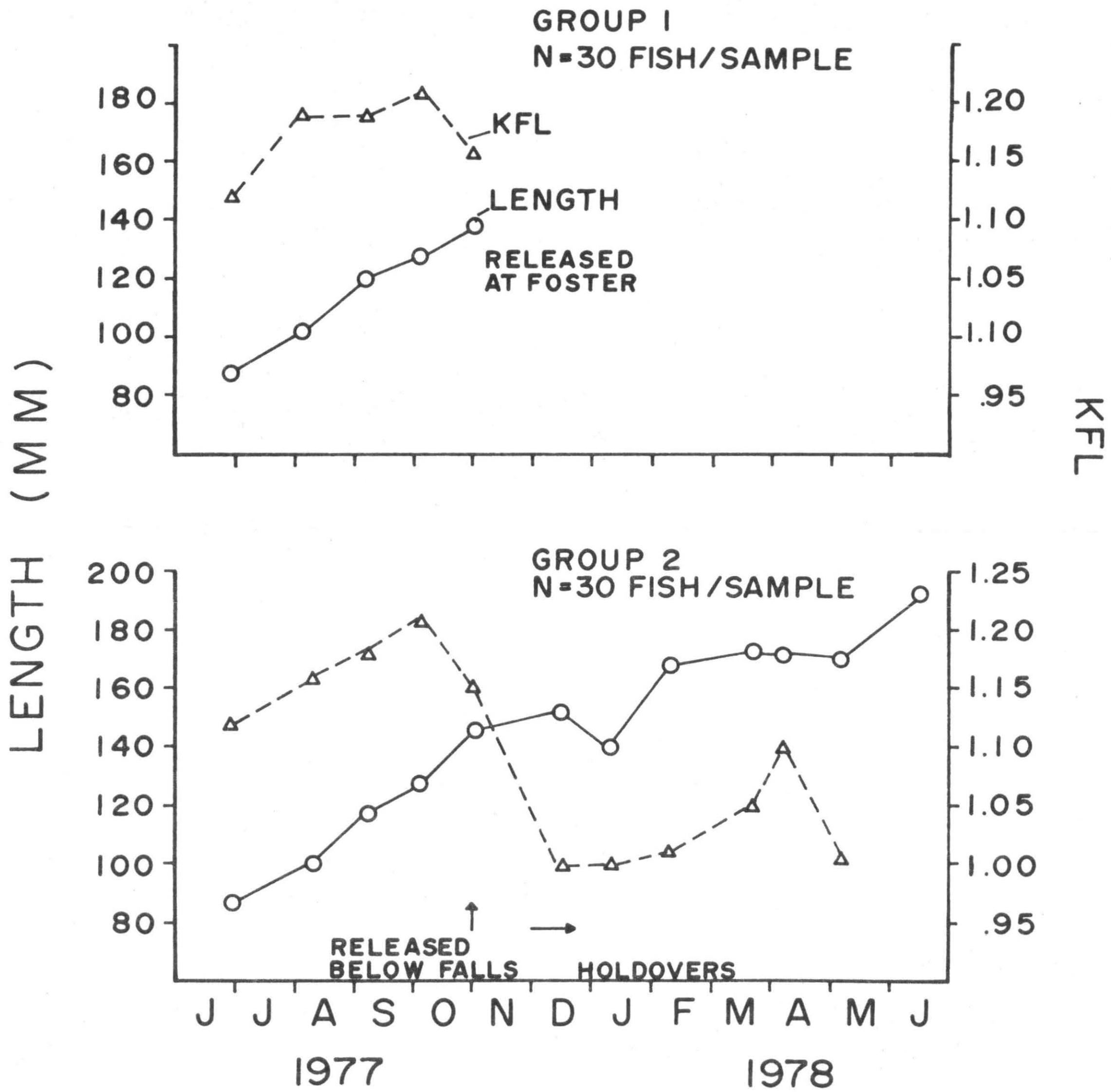


Fig. 6. Progression of mean fork length and condition factor (KFL) for two groups of Willamette stock spring chinook reared at South Santiam Hatchery.

We initially reared the spring-released fish (groups 3 and 4) at Oakridge Hatchery where water temperatures vary more. We transported these fish to South Santiam Hatchery in January 1978, for rearing and imprinting prior to release. The ATPase cycles for these spring-released groups followed the same general trend observed for the fall-released groups, but with some unique variations (Fig. 7). We observed no rise in activity in June, and the autumnal peak was more pronounced and about 1 month later than the corresponding fall peak seen in groups 1 and 2. Again, the largest increase occurred in the spring 1978, when the fish were yearlings, approximately at time of release. KFL declined in December 1977, and was still declining in group 4 at time of release (Fig. 8).

We captured emigrants from release groups 1-4 at locations in the lower Willamette River, at Willamette Falls and in the Columbia River at Jones Beach. ATPase activities from these samples were similar to those observed in the respective groups at release (Table 4), but small sample size and use of anaesthetic prior to killing the fish render the Jones Beach data questionable.

Table 4. Length, emigration rate and ATPase information collected from downstream migrant spring chinook in 1978.

Capture		No.	Av. miles/	Fish[a]	Specific activity[a]	
Date	Place	fish	day	length (cm)	Release	Capture
3/23-24/78	Canby & Sellwood Bridge	10	8-10	17.1 (14.5-19.6)	5.8	5.9 (3.5-8.2)
3/24/78[b]	Sellwood Bridge	13	0.6	15.4 (14.4-16.4)	5.1	4.8 (4.4-5.3)
4/3/78	Will. Falls	3	5.5	18.1 (16.2-20.0)	5.8	5.9
4/3/78[c]	Will. Falls	1	0.9	15.0	2.9	3.7
4/20/78[c]	Jones Bch.	1	0.5	13.5	2.8	3.8
4/20/78[d]	Jones Bch.	4	2-5	15.7	5.1-5.8	5.1

a Mean plus 95% confidence intervals where n > 5.
b Released below falls and are not necessarily migrants.
c Fall release groups 1 and 2.
d Fish from release above and below falls.

As part of a complementary study, we investigated gill ATPase activity progression of Carson and Willamette stocks of juvenile spring chinook reared at Marion Forks Hatchery, a station on the upper North Santiam River where the water is very cold most of the year. Analyses of 30 fish monthly from September until February and then bimonthly until June revealed ATPase activity peaks in both stocks in mid March which were significantly higher ($p = 0.05$) than previous levels (Fig. 9). Abrupt changes in activities

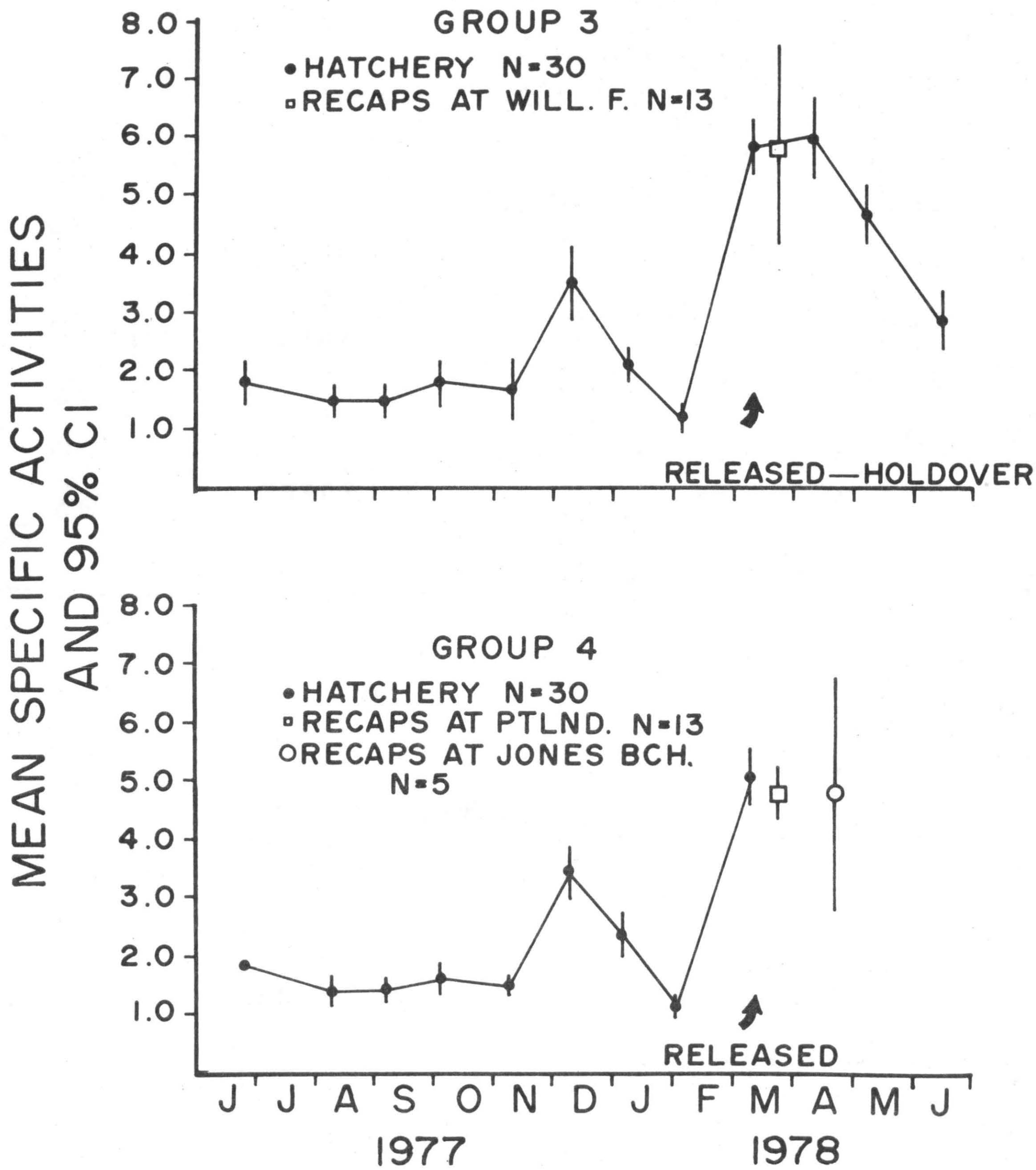


Fig. 7. Progression of mean (Na + K-activated) ATPase of two groups of Willamette stock spring chinook reared at Oakridge and South Santiam hatcheries, including data from emigrants recaptured at downstream locations.

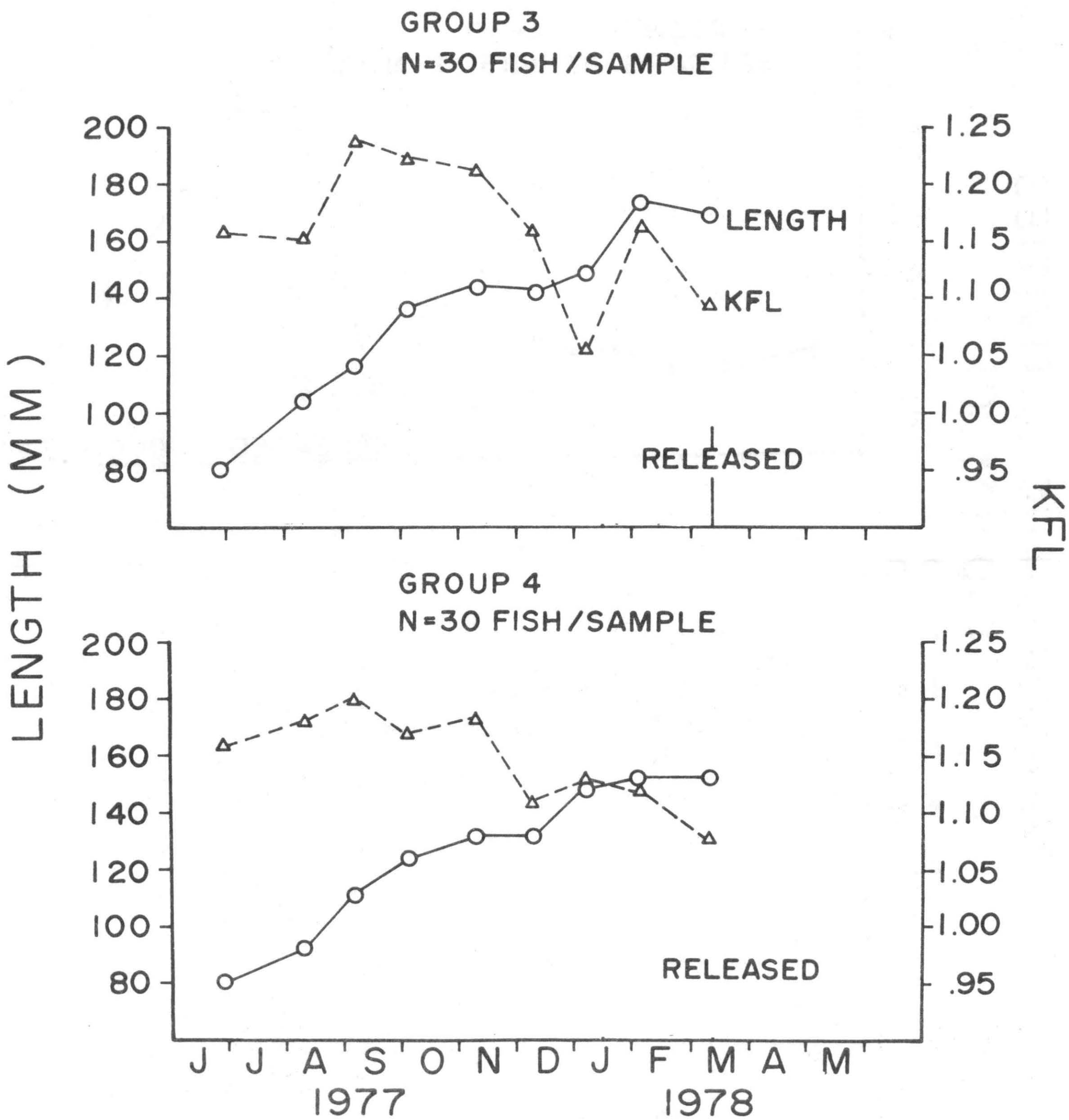


Fig. 8. Progression of mean fork length and condition factor (KFL) values of two groups of Willamette stock spring chinook reared at Oakridge and South Santiam hatcheries, including data from emigrants recaptured at downstream locations.

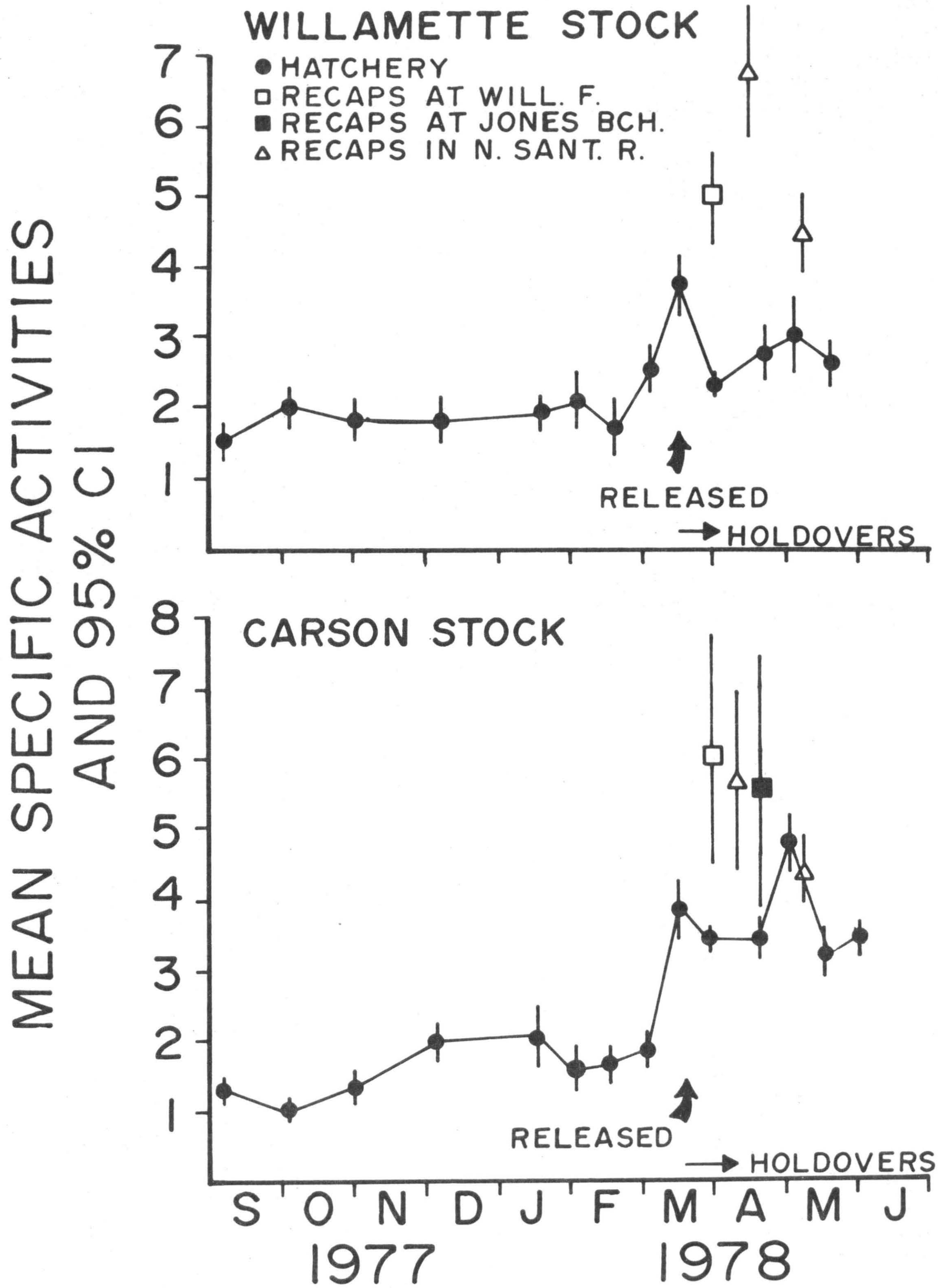


Fig. 9. Progression of mean (Na + K-activated) ATPase activity for two stocks of spring chinook reared at Marion Forks Hatchery.

for fish detained at the hatchery may have resulted from differences in handling and rearing conditions. The major peak observed in March coincided with time of release, and we are unsure of the significance of the peak activities observed in May for the Carson fish retained in the hatchery.

The Willamette stock reared at Marion Forks displayed no rise in ATPase activity in the fall (Fig. 9), while Willamette juveniles at South Santiam (Fig. 5) and Oakridge (Fig. 7) showed a rise in activity in the fall or early winter. We ascribe this to differences in rearing conditions. Although the mean size of fish reared at Marion Forks was substantially smaller than the size attained at the other two hatcheries (see Fig. 6, 8 and 10), the Willamette stock was apparently above the hypothesized minimum threshold size for initiation of ATPase cycling.

Analysis of gill ATPase activities of emigrants from Marion Forks, as sampled at downstream locations, indicated that migrants of both stocks displayed mean ATPase levels as large or larger than those observed in the respective groups at release (Table 5).

Juveniles released from Marion Forks Hatchery were also sampled by seining the North Santiam River at 1, 2 and 3 mo post-release. In the first 2 mo of sampling we caught many slow migrants, or residuals, of the Carson and Willamette stocks, in an area 35 mi below the release site. In the third month, when the water had warmed considerably, only four fish were seined from this site, and all had external signs of disease or copepod infestation.

ATPase analyses conducted on 13 slow migrants of the Willamette stock captured 1 mo post-release had a mean activity higher (significant at $p = 0.05$) than the mean found in tagged Willamette stock juveniles which migrated past the Sullivan Plant 2 wk prior on April 3, 1978 (Table 5). Nineteen slow migrants captured 2 mo post-release in the same location displayed a mean activity which was only slightly lower than the mean observed in migrants of this release group which passed the Sullivan Plant on April 3.

Marked Carson stock juveniles captured during this seining indicated that the mean gill ATPase value of 13 slow migrants captured 1 mo post-release was similar to the mean activity of migrating Carson juveniles which passed the Sullivan Plant on April 3, 1978 (Table 5). Ten marked Carson fish captured 2 mo after release had a mean activity significantly lower ($p = 0.05$) than those migrating on April 3, but approximately equal to the fish at release on March 13, 1978.

We analyzed ATPase activities using a whole gill assay technique (WG) developed by Dr. Richard Ewing (ODFW). The NMFS collected ATPase data from smolts at Marion Forks hatchery in 1978 using a microsomal assay (MA) method developed by Dr. Wallace Zaugg. To determine if a relationship exists between the two analyses the same individual fish were sampled at Marion Forks Hatchery on several occasions and at Willamette Falls once and analyzed by the two techniques. Thirty fish were sampled on each occasion. Equal portions of gill tissue homogenates of three fish were pooled into a sample for analysis by the MA method. Gill tissue homogenates from each individual fish were analyzed by the WG method.

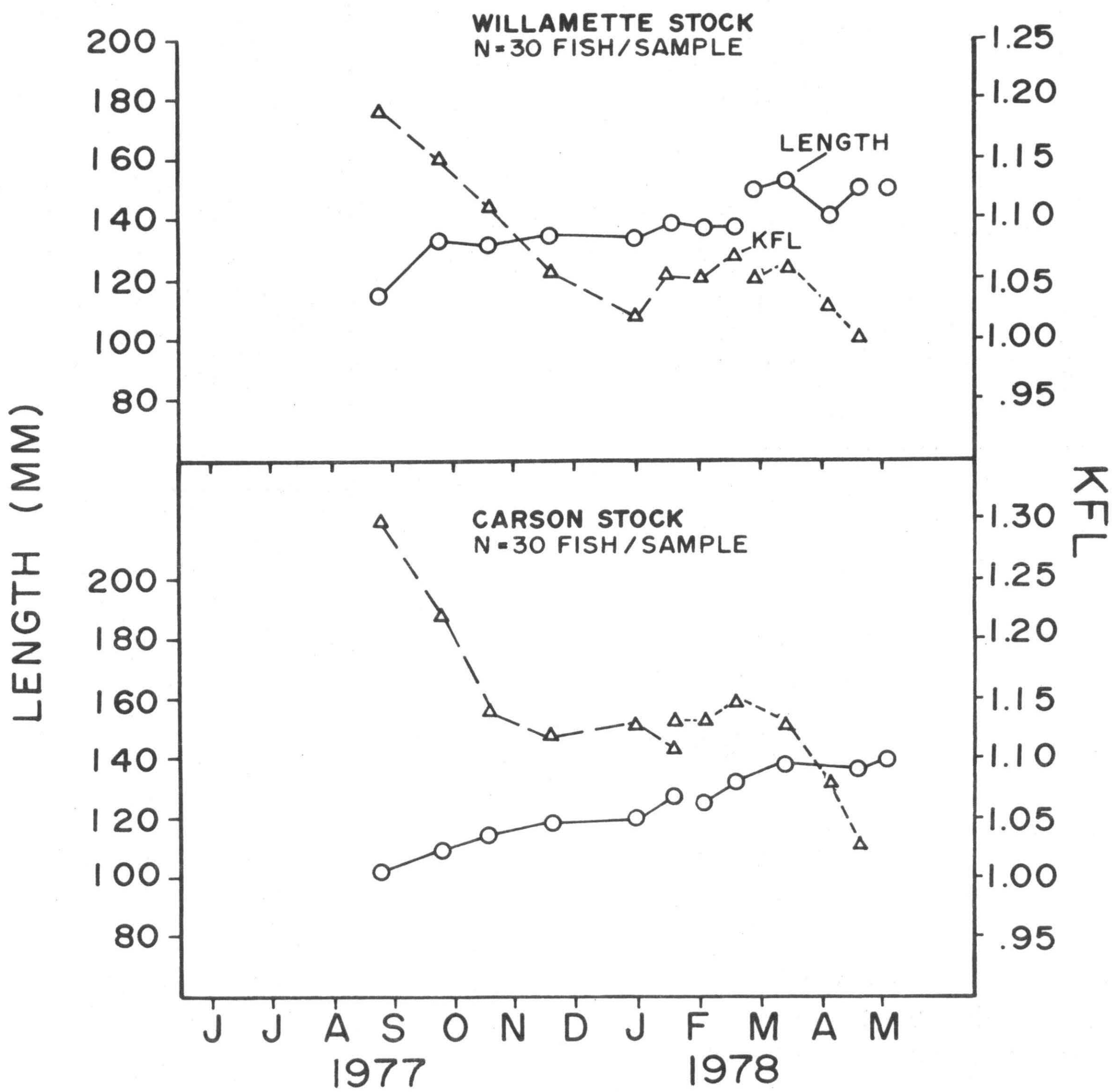


Fig. 10. Progression of mean fork length and condition factor (KFL) for two stocks of spring chinook reared at Marion Forks Hatchery.

Table 5. Length, emigration rate and ATPase information collected from downstream migrant spring chinook released from Marion Forks Hatchery in 1978.

Capture		No.	Av. mile/	Fish[a]	Specific activity[a]	
Date	Place	fish	day	length (cm)	Release	Capture
3/23/78	Canby	4	15.1	18.4	3.7 (3.2-4.2)	3.8
4/3/78	Will. Falls	16	6.8	18.1 (16.8-19.6)	3.7	5.3 (4.6-6.1)
4/17/78[b]	N. Sant. R.	13	1.5	13.7 (12.2-15.2)	3.7	6.8 (5.8-7.8)
4/20/78	Jones Bch.	3	5.7	16.5	3.7	3.5
5/8/78[b]	N. Sant. R.	19	0.7	12.9 (11.9-13.9)	3.7	4.5 (3.9-5.1)
6/8/78[b]	N. Sant. R.	2	< 0.5	17.5	3.7	6.7
Carson Stock						
3/23/78	Canby	3	14.0	14.0	3.9 (3.5-4.4)	3.8
4/3/78	Will. Falls	5	6.6	15.5 (11.9-19.1)	3.9	6.1 (4.6-7.6)
4/17/78[b]	N. Sant. R.	13	1.4	13.2 (12.8-13.7)	3.9	5.7 (4.5-6.9)
4/20/78	Jones Bch.	6	5.7	14.8 (13.7-16.0)	3.9	5.9 (3.1-8.7)
5/8/78[b]	N. Sant. R.	10	0.7	13.1 (12.2-13.9)	3.9	4.5 (4.0-5.0)
6/8/78[b]	N. Sant. R.	2	< 0.5	17.9	3.9	2.5

[a] *Mean values (95% confidence intervals where n > 5).*
[b] *Considered slow or non-migrants.*

Two comparisons were then made. By calculating a mean activity of three fish from the WG method corresponding with the same three fish used in the MA method, it was possible to determine if a relationship existed between the methods. Also, by comparing the mean specific activities on all 30 fish on each occasion, a relationship between the methods could be determined in the cyclic progression of the enzyme.

Regression analysis showed that there was no relationship in determining ATPase activity between the methods on an individual fish basis (Table 6). When comparing the progressions of mean bimonthly activities we found both the magnitude and, in the case of the Willamette stock, the timing of peak activities were different (Fig. 11).

Table 6. Coefficients of determination of two different assay techniques currently being used for ATPase analysis.

Date	No. fish	Description	r^2 values
March 13, 1978	30	Willamette stock	0.002
March 13, 1978	28	Carson stock	0.110
March 3, 1978	30	Active migrants	0.001

Our studies of annual progressions of Na + K-ATPase activity from six groups of Willamette River spring chinook found that increases were cyclic and that mean activity peaked in the autumn and again in the early spring. Studies of juvenile chinook have determined that substantial emigrations occur coincident with these periods (Mattson 1962; Smith 1977; Lichatowich 1977). We believe that some relationship exists between the two phenomena, since fish require an increase in transport enzyme to maintain osmotic homeostasis upon entry to seawater (Epstein et al. 1967; Jompol and Epstein 1970; Kamiya and Utida 1968). Reasons why these increases in ATPase occur in freshwater are highly conjectural. It would be convenient to assume a cause/effect relationship between the two phenomena, but there has not been a definitive study to show such is the case with spring chinook. We found that fast and slow emigrants had elevated mean ATPase activities. Peak migrations of smolts past Willamette Falls occur within 14-25 days after release. We do not regard juveniles remaining in the river at 1, 2 and 3 mo post-release as desirable hatchery products.

Thus far the following three situations have been documented in reference to ATPase and behavior of juvenile spring chinook salmon:

a) Function(s) → ATPase elevation → emigration → seawater entry

b) Function(s) → emigration → seawater entry and ATPase elevation

c) Function(s) → ATPase elevation → non-emigration

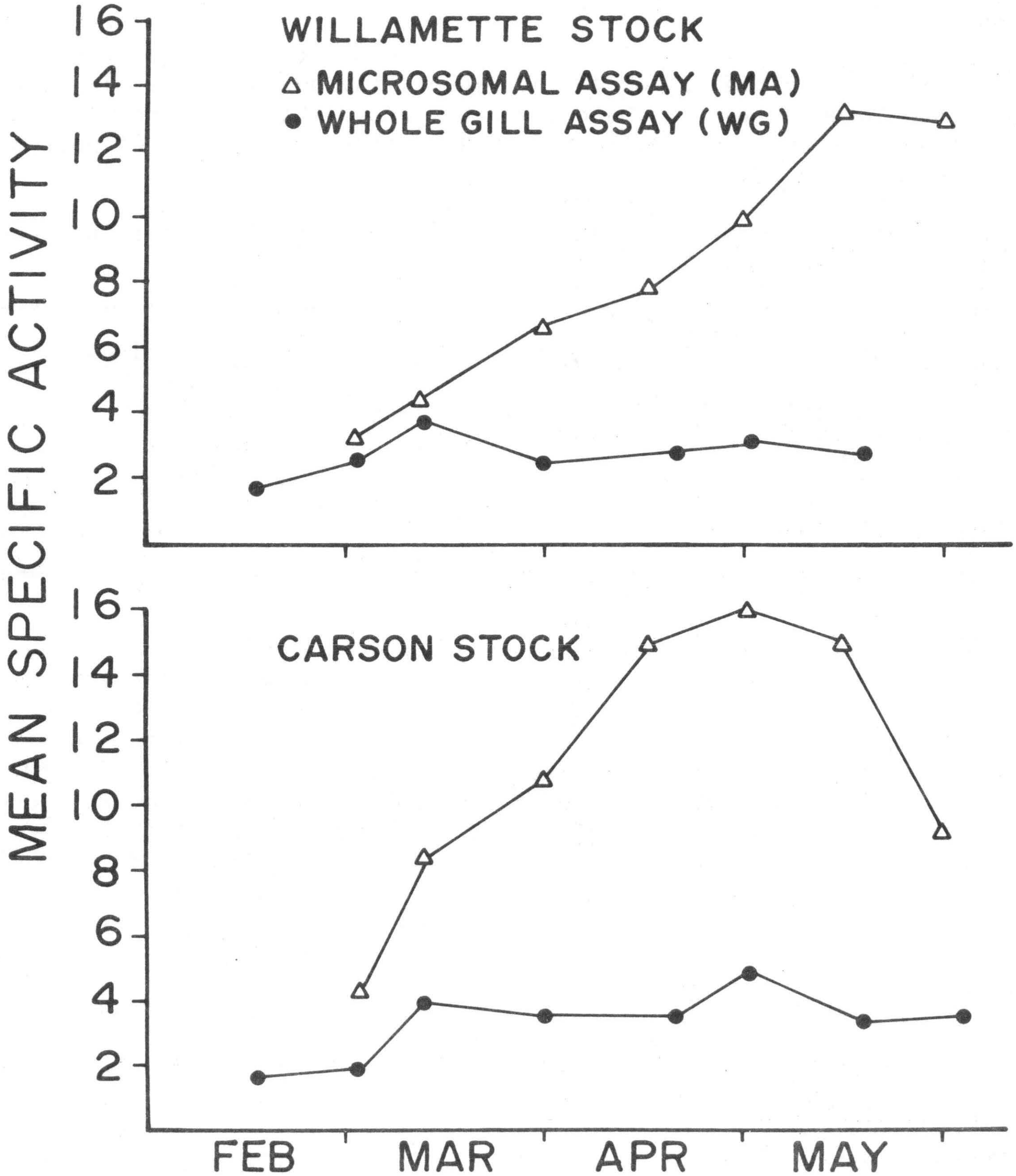


Fig. 11. A comparison of progression of mean (Na + K-activated) ATPase activities from the same fish as determined by two assay methods.

It is apparent that variations in ATPase activity are only one aspect of a complex array of physiological changes that prepare fish for seawater entry. Present data suggest that factors other than ATPase can serve as migratory stimuli. The exact role of (Na + K) ATPase as an indicator of migratory behavior is presently vague. In conjunction with other studies (scale analyses, monitoring of migration and seawater survival tests), ATPase can presently be used to define general time periods when fish are prepared to enter salt-water.

No correlation between fish length and ATPase was found in this limited study, yet we consistently see a definite relationship between size and effective emigration past Willamette Falls. Other factors noted to affect emigration include freshets, photoperiod and population density.

In addition, it appears that ATPase activities are affected primarily by rearing conditions and less by genetic differences. Marion Forks is a cold water station where salmon experience slow growth. There, the ATPase cycle of two stocks lacked a peak in the fall months, while at two other stations with conditions conducive to optimum growth, Willamette stock peaked in autumn. Studies conducted at the Corvallis Research Laboratory have shown that (Na + K) ATPase activity can be influenced by growth, photo-period variation, and crowding stress (Ewing et al. in preparation; Strange and Schreck in press). Cyclic changes in two stocks reared at the same hatchery, showed generally similar trends. Therefore it appears that specific rearing conditions have a greater effect upon the annual ATPase cycle than the genetic background of the fish.

Comparison of Carson and Willamette Stocks

We continued to collect marked Carson and Willamette adults returning to Fall Creek Dam. Substantial fishery contribution data has been collected. These returns resulted from releasing approximately equal numbers of juve-niles of the 1972 and 1974 broods. The two stocks were reared under similar conditions at Oakridge Salmon Hatchery, distinctly fin-marked and released below Fall Creek Dam in November 1973 and 1975, respectively.

From previous experience with unmarked broods of Carson spring chinook reared in Fall Creek Reservoir, we hypothesized that Carson adults were not as subject to delays in passage at Willamette Falls as were Willamette stock adults. Thus, we expected Carson fish to reach upstream production areas better than Willamette chinook after ascending the falls. However, we questioned the relative contribution rates between the two stocks, since quick passage through the lower Willamette sport fishery might reduce the proportion of Carson adults harvested.

Returning adults of the two broods faced substantially different passage conditions upon return. The 1972 brood adults were subjected to a possible delay as 4-year-old fish in 1976, when high flows prevailed. In 1977, returning 5-year-old adults from this brood experienced near-optimum passage conditions at Willamette Falls. Four-year-old fish of the 1974 brood had excellent passage conditions at Willamette Falls in 1978. Restricted discharges from Fall Creek Reservoir in the spring of 1977 and 1978, result-ing from water conservation measures, appeared to affect the return of adults to the Fall Creek fishway. We observed marked Carson and Willamette adults from the Fall Creek release in the Middle Fork Willamette River, in Dexter holding ponds and in returns to McKenzie Hatchery. We cannot determine the effects of this straying, but considering the substantial differences observed in timing of return between Carson and Willamette stocks, analysis of return information could be seriously compromised.

We have collected more Carson than Willamette adults at Fall Creek Dam (Table 7). Despite their smaller size at release, 1974 brood fish of both stocks are returning in larger numbers than the 1972 brood.

Returns for the 1972 brood are essentially complete. We accounted for 258 total Carson stock recoveries; 139 were estimated taken in downstream fisheries and 119 returned to Fall Creek. We accounted for only 149 Willamette adults of this brood, primarily from downstream fisheries. Carson fish of the 1972 brood surpassed the Willamette stock in total numbers in the fisheries and total return to the project. Low returns of 1972 brood Willamette fish to the project, possibly resulting from passage problems at Willamette Falls in 1976 and in Fall Creek in 1977, produced a contribution to return ratio of 4.1 to 1 compared to 1.1 to 1 for the Carson stock.

With 5-year-old fish destined to return in 1979, preliminary recovery data for the 1974 brood appears substantially different. A total of 338 Carson fish have been recovered; however only 33 were taken in downstream fisheries, while 305 returned to Fall Creek. We have accounted for 555 Willamette fish, 442 from the fisheries and only 113 at the project despite excellent passage conditions at Willamette Falls in 1978. Thus, Carson adults continue to predominate in the returns to Fall Creek. However, total contribution to downstream fisheries by the 1974 brood substantially favors the Willamette stock, with a contribution to return ratio of 3.9 to 1 compared to a low 0.1 to 1 for the Carson stock. The contribution rate for the 1974 brood Willamette stock was substantially enhanced by the recovery of 391 fish in the lower Willamette sport fishery in spring 1978, despite excellent passage conditions at Willamette Falls. In addition, good passage conditions in 1978 may have allowed faster than usual passage over the falls for the Carson fish thus reducing their exposure to the sport fishery.

Based on these incomplete data, it appears that Carson fish can generally be expected to return to the project of origin in greater numbers than their Willamette counterparts, particularly in years of poor passage conditions at Willamette Falls. This could be particularly significant to fish culture operations in assuring adequate egg supplies. Relative contribution data between the two stocks differed for the two broods; however, smaller proportions of the Carson fish were harvested in downstream fisheries. Better definition of the relative merits of the two stocks will be available from data collected in 1979 and from information we will obtain from a complementary study at Marion Forks Hatchery (comparison of Carson and Willamette stocks of spring chinook, 1966-1980 broods).

Table 7. Preliminary contribution and return data, Carson-Willamette comparative study at Fall Creek Dam, 1972 and 1974 broods.[a]

	Carson stock								Willamette stock							
	1972 brood				1974 brood				1972 brood				1974 brood			
No. released	175,000				190,000				170,000				197,000			
Game/fish	45.4				37.4				45.4				30.9			
Release date	11/15/78				11/05/75				11/15/73				11/05/75			
Mark	Rp-RM				RV				LP-LM				LV			
Recoveries by location	Age				Age				Age				Age[b]			
	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
Alaska	0	0	-	-	-	-	-	-	0	0	-	-	-	-	-	-
B. C.[c]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Washington																
Sport	0	4	-	-	-	-	-	-	0	46	-	-	-	-	-	-
Troll	0	0	-	-	-	-	-	-	0	14	-	-	-	-	-	-
Columbia R.																
Sport	0	0	-	-	-	-	-	-	0	0	-	-	-	-	-	-
Gill net																
Winter	0	0	0	0	0	0	6	-	0	0	0	4	0	0	36	-
Spring	-	0	-	0	0	5	-	-	-	0	-	10	0	0	0	-
Oregon ocean																
Sport	0	0	-	-	-	-	-	-	0	0	-	-	-	-	-	-
Troll	0	0	-	-	-	-	-	-	11	0	-	-	-	-	-	-
Cal. troll	0	0	-	-	-	-	-	-	0	0	-	-	-	-	-	-
Will. R. sport																
Lower	0	0	120	15	0	0	22	-	0	0	20	15	0	15	391	-
Upper[d]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Return to Fall Creek	1	4	99	15	23	51	231	-	1	0	10	18	0	4	109	-
Prelim. totals																
Contribution	139				33				120				442			
Return	119				305				29				113			
Total	258				338				149				555			

[a] *Ocean contribution data are complete for years that figures are available. Returns of 5-year-old fish for the 1974 brood will occur in 1979.*

[b] *No ocean and Columbia River sport recoveries for single fin marks.*

[c] *British Columbia did not sample fin marked fish.*

[d] *No data available from upper Willamette sport fishery.*

CONCLUSIONS

Despite restricted sampling at the Sullivan Plant downstream migrant collector in fall 1977 and spring 1978, it appears that the smaller hatchery-released smolts, generally under 140 mm in fork length, do not emigrate quickly after release. Observations of patterns of passage indicate that most of the migrating spring chinook smolts released from Willamette hatcheries about mid March completed their emigration by about May 1. Non-hatchery chinook smolts began moving through the lower Willamette River in substantial numbers in early March 1978. If earlier releases of hatchery smolts could be made in the spring while still allowing rapid emigration of released smolts, hatchery operating costs would be reduced.

Analyses of gill (Na + K) ATPase activity progressions in populations of juvenile spring chinook salmon reared at three Willamette Basin hatcheries indicated an annual cyclic pattern, with peaks in enzymatic activity generally occurring in the fall and spring. Environmental conditions appear to alter this cycle. We did not find high levels of ATPase activity to be an exclusive characteristic of migrating yearling spring chinook. The type of assay method used can significantly alter the ATPase values obtained. We do not believe that it is feasible to use ATPase values exclusively in determining when to release spring chinook smolts.

More Carson than Willamette adults have returned to Fall Creek Dam, but preliminary catch data indicated higher contributions of Willamette fish to the various fisheries. Low transport flows in 1977 and 1978 apparently resulted in straying of some of the marked adults destined for Fall Creek..

LITERATURE CITED

Epstein, F. H., A. J. Katz and G. E. Pickford. 1967. Sodium and potassium activated adenosine triphosphatase of gills: role and adaptation of teleosts to sea water. Science. 156:1245-1247.

Jampol, L. M. and F. H. Epstein. 1970. Sodium and potassium activated adenosine triphosphatase and osmotic regulation by fishes. Am. J. Physiol. 218(2):607-611.

Kamiya, M. and S. Utida. 1968. Changes in activity of sodium and potassium activated adenosine triphosphatase in gills during adaptation of the Japanese eel to sea water. Comp. Biolchem. Physiol. 26:675-685

Lichatowich, J. A. 1977. Rogue Basin Evaluation Program. Progress Report, Research Section, Oregon Department of Fish and Wildlife. 86 pp.

Mattson, C. R. 1962. Early life history of Willamette River spring chinook salmon. Progress Report. Fish Commission of Oregon. 39 pp.

Smith, E. M. 1977. Improving survival of spring chinook hatchery smolts in the Willamette River. Progress Report. Research Section, Oregon Department of Fish and Wildlife. 22 pp.

APPENDIX

The text does not refer to the tables and figures included in this appendix. Data in the appendix provide some background relating to the Willamette River spring chinook runs.

Appendix Table 1. Juvenile spring chinook released from upper Willamette River hatcheries, 1965 through 1976 broods.

Brood	Marion Forks	McKenzie[a]	South Santiam	Willamette & Dexter	Total[b]
1965	3.21	0.81	0.15	4.94	9.11 (2.41)
1966	1.78	0.65	0.15	3.28	5.86 (0.56)
1967	3.98	0.88	0.77	2.67	8.30 (3.02)
1968	1.62	0.71	0.58	3.51	6.42 (2.36)
1969	5.42	0.85	0.99	3.00	10.26 (6.17)
1970	1.10	0.55	1.71	4.20	7.56 (4.11)
1971	1.01	0.53	1.26	5.57	8.37[c] (5.67)
1972	1.03	0.53	0.34	2.74	7.06[d] (4.02)
1973	1.30	0.17	3.46	2.54	7.47 (3.86)
1974	1.38	0.41	0.33	4.27	8.72[e] (4.15)
1975	1.16	0.90	0.41	3.32	5.80 (1.69)
1976	0.59	2.22	0.35	1.28	4.44 (1.90)

[a] *Includes Leaburg releases.*

[b] *Fry and fingerlings included and shown separately in parentheses.*

[c] *Includes 0.58 million from Oxbow.*

[d] *Includes 2.42 million from Metolius.*

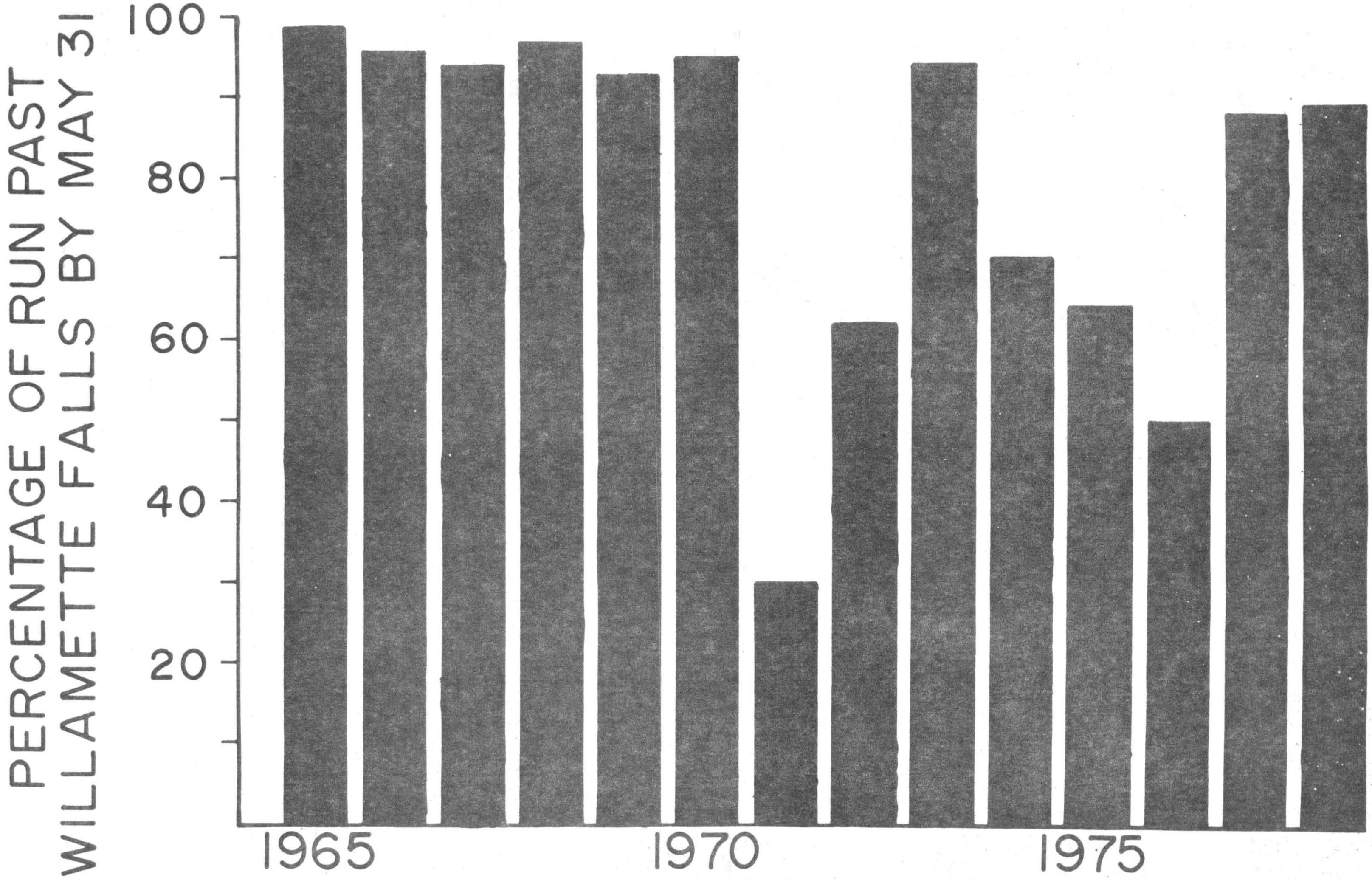
[e] *Includes 2.33 million from Aumsville.*

Appendix Table 2. Estimated number of adult spring chinook entering the Willamette River, 1955 through 1978.

	Numbers in thousands			
Year	Lower Willamette R. sport catch	Falls count	Estimated Clackamas R. run	Estimated number entering Willamette R.
1955	9.0	22.0	1.5	32.5
1956	16.0	58.6	3.0	77.6
1957	11.5	39.3	2.0	52.8
1958	15.5	45.2	2.1	62.8
1959	18.5	31.9	3.0	53.4
1960	8.0	14.4	1.8	24.2
1961	6.4	18.9	2.2	27.5
1962	9.1	26.0	3.0	38.2
1963	13.6	30.3	4.0	48.1
1964	18.6	36.3	3.5	58.4
1965	9.0	29.1	3.0	41.1
1966	12.8	28.2	3.0	44.0
1967	15.2	56.2	3.0	74.4
1968	13.5	31.5	2.0	47.5
1969	16.3	33.7	2.5	52.6
1970	17.9	34.2	1.5	53.6
1971	20.2	44.6	2.0	67.4
1972	18.7	26.2	2.0	47.1
1973	10.2	42.0	2.0	54.5
1974	25.2	44.5	2.0	71.8
1975	12.5	19.1	1.0	32.6
1976	16.4	22.2	2.0	40.7
1977	15.0	40.0	3.0	58.0
1978	20.2	47.5	2.5	70.2
Mean	14.6	34.2	2.4	51.2

Appendix Table 3. Returns of Willamette River spring chinook to upper river projects, 1956 through 1978.

Year	Hatchery returns: Falls count (1,000's)	Hatchery returns: Fish (1,000's)	Hatchery returns: % of falls count	Reservoir returns: Fish (1,000's)	Reservoir returns: % of falls count	Total return as percentage of falls count
1956	58.6	4.3	7	--	--	7.0
1957	39.3	5.2	13	--	--	13.0
1958	45.2	.9	15	--	--	15.0
1959	31.9	5.0	16	--	--	16.0
1960	14.4	2.0	14	--	--	14.0
1961	18.9	1.8	10	--	--	10.0
1962	26.0	4.3	16	--	--	16.0
1963	30.3	9.2	30	--	--	30.0
1964	36.3	8.2	23	--	--	23.0
1965	29.1	8.6	29	--	--	29.0
1966	28.2	6.1	22	--	--	22.0
1967	56.2	13.2	23	--	--	23.0
1968	31.5	13.0	41	0.1	0.3	41.3
1969	33.7	12.4	37	4.7	13.9	50.9
1970	34.2	10.8	31	1.9	5.5	36.5
1971	44.6	8.0	18	6.6	14.7	32.7
1972	26.2	5.0	19	1.8	6.9	25.9
1973	42.0	7.2	17	2.9	6.8	23.8
1974	44.5	14.0	31	3.1	7.0	38.0
1975	19.1	4.3	23	1.7	9.0	32.0
1976	22.2	4.3	19	2.5	11.0	30.0
1977	40.0	9.1	23	4.3	11.0	34.0
1978	47.5	incomplete	--	incomplete	--	--



Appendix Fig. 1. Percentage of the Willamette spring chinook run passing Willamette Falls by May 31, 1965 through 1978, illustrating delays.