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ORE-AQUA COHO SCALE ANALYSIS

AGE COMPOSITION AND AGE/LENGTH KEY FOR THE 1981 COHO SALMON RUN

by

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CONTRACT COMPLETION REPORT

to

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This report summarizes the results of age composition and age/length studies of the 1981 coho return to OAF at Yaquina Bay. Analyses of the 1981 coho data followed those reported in Crawford et al. (1981) for the 1980 coho return to OAF-Yaquina Bay. Replication of the 1980 age/length analysis was particularly desireable from the standpoint of measuring between-year variation in age-at-length relationships. The model presented in Crawford et al. (1981) for segregating "jacks" (precocious juveniles) from adults in the length interval 400-510 mm was based on data from the 1980 coho return only. We were therefore interested in testing predictions from the model against the observed relative proportions of jacks and adults in each 10-mm length increment between 400 and 510 mm in 1981 samples. Furthermore, if these age-at-length relations were reasonably consistent between years, then an average age/length key could be proposed to reliably segregate jacks and adults within the group of fish smaller than 51 cm.

Another important aspect of the project was the estimation of an age composition statistic for the 1981 return of adults not implanted with coded wire tags. Previous results indicated that at least five age groups, including a possible aberrant life history type (Crawford et al. 1981), could be represented in samples collected during the coho run. For purposes of calculating survival of yearling and age0 smolts released in 1979, 1980, and 1981, it was necessary to accurately evaluate the contribution of each release to the 1981 return. The first step was to segregate the run by age group, in terms of the absolute number of fish of each age in the return.

The results reported herein are specific to the following objectives:

1. Calculate an age composition for the 1981 coho run by week of return and a statistic for the total run.

2. Model the transition from primarily jacks to primarily adults as a function of fish length in the 1981 return.

3. Evaluate the accuracy of an average (1980 and 1981) age/length curve for separating jacks and adults among fish less than 51 cm in length.

METHODS

Length and weight data for fish from which scales were sampled during harvest were received with the appropriate gum cards from the Oregon Dep. Fish and Wildlife at approximately weekly intervals. Acetate replicas of scales were produced in the standard fashion and projected 43X to the screen of a microfiche reader for age interpretation. A total of

1367 coho scales were obtained from ODF&W and 1124 (82.2%) of these produced acetate replicas of sufficient clarity for pattern analysis.

As in the analysis of scales from coho returning in 1980, a variety of patterns was noted in the pre-release portion of scales from the 1981 return. Given the artificial conditions under which these fish are reared, it is difficult to postulate a biological significance for the variety of patterns observed. However, it is probable that much of the pattern variability displayed by scales from adult fish derives from differential handling regimes (e.g., vaccination, grading) and release schedules of juveniles. To ensure that subjective interpretation of scale patterns was minimized, we formulated a set of decision rules governing pattern analysis. The criteria established for initial analysis of scale samples were as follows:

1. Spacing of adjacent circuli. Widely-spaced circuli implied accelerated growth typical of age0 juveniles.

2. Presence of an identifiable annulus in the pre-release zone of the scale. Presence would identify the scale as belonging to a yearling fish.

This set of decision rules was soon found to be deficient because the presence or absence of a winter check on scales was difficult to verify in many cases. On the advice of two readers experienced with Ore-Aqua coho scales, a third criterion was included in the decision set:

1. Number of circuli in the pre-release scale growth zone. Age 0 fish consistently show substantially fewer circuli in the pre-release zone because they are reared in freshwater for much less time than are yearling fish.

The pre-release zone of adult scales was identified using the method of Parker et al. (1981).

A separate age composition statistic was computed for scale samples taken from unmarked adults which were not harvested. These fish were transported to the Springfield hatchery and spawned. Since no accurate date of return was available for spawned coho, samples taken on 10/29, 11/20, 12/2, and 12/8 were consolidated into an average age composition estimate.

Age-at-length was modelled by a logistic curve of form

$$p = \frac{1}{1+e^{-(a+b\ell)}} \qquad (1)$$

where:

p = proportion of adult fish of length ℓ (1-p = proportion of jacks)
e = base of Naperian system of logarithms

a = constant
b = constant
ℓ = fish length

The constants "a" and "b" were estimated from the linearized form of equation 1:

$$-\ln\left(\frac{1-p}{p}\right) = a + b\ell \qquad (2)$$

Proportions of adults (ages 0.1 and 1.1) in each 10-mm increment of fish length in the interval 400-510 mm were $\log_e$-transformed by equation 2 and regressed against length to obtain estimates of "a" and "b". These values inserted into equation 1 provided a least squares fit of the observed data to the curve generated by equation 1.

RESULTS

Table 1 indicates that four age groups were present in the 1981 coho return to OAF-Yaquina Bay. Over 91% of the total return was composed of 1-ocean adults, of which about 65% were 0.1's and about 27% were 1.1's. No scales indicating aberrant life history types were noted.

Table 1. Age composition of the 1981 coho return to OAF-Yaquina Bay.

	Age group				
	0.0	1.0	0.1	1.1	Total
Number	3	63	514	215	795
Percent	0.38	7.92	64.65	27.05	100.00

Age composition by week of return is given in Appendix Table 1 and presented graphically in Figure 1. Age 0.1 adults predominated in samples taken early in the run and gradually were replaced by age 1.1 adults in samples taken on 19 October and 26 October. The last sample reported here showed that age 0.1 adults were again predominant. Age 1.0 jacks never reached 15% of any sample.

Scale analysis of the samples from spawned coho adults indicates that 65.4% were age 0.1 and 34.6% were age 1.1. All fish taken for eggs were larger than 51 cm in length, hence no age breakdown by length is given. Age composition by sample is included in Appendix Table 2.

Length frequency distribution for jacks (Fig. 2a) and adults (Fig. 2b) show considerable overlap. The mean length of jacks was 425.5 mm, and adults averaged 580.5 mm. Length distributions for 0.1 and 1.1 adults were essentially identical, hence these ages were grouped together

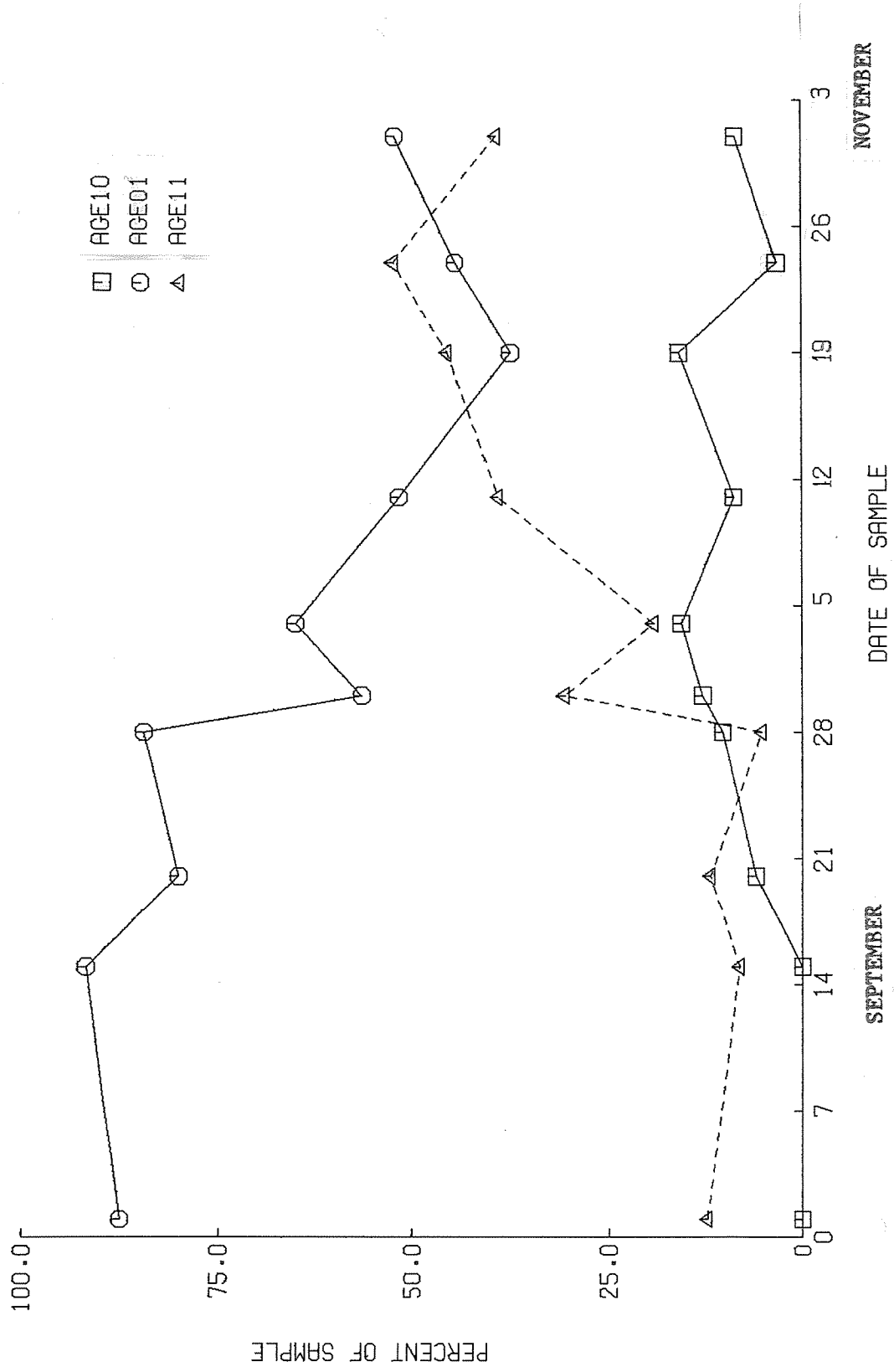

Fig. 1. Age composition of the 1981 coho return expressed as relative percentages.

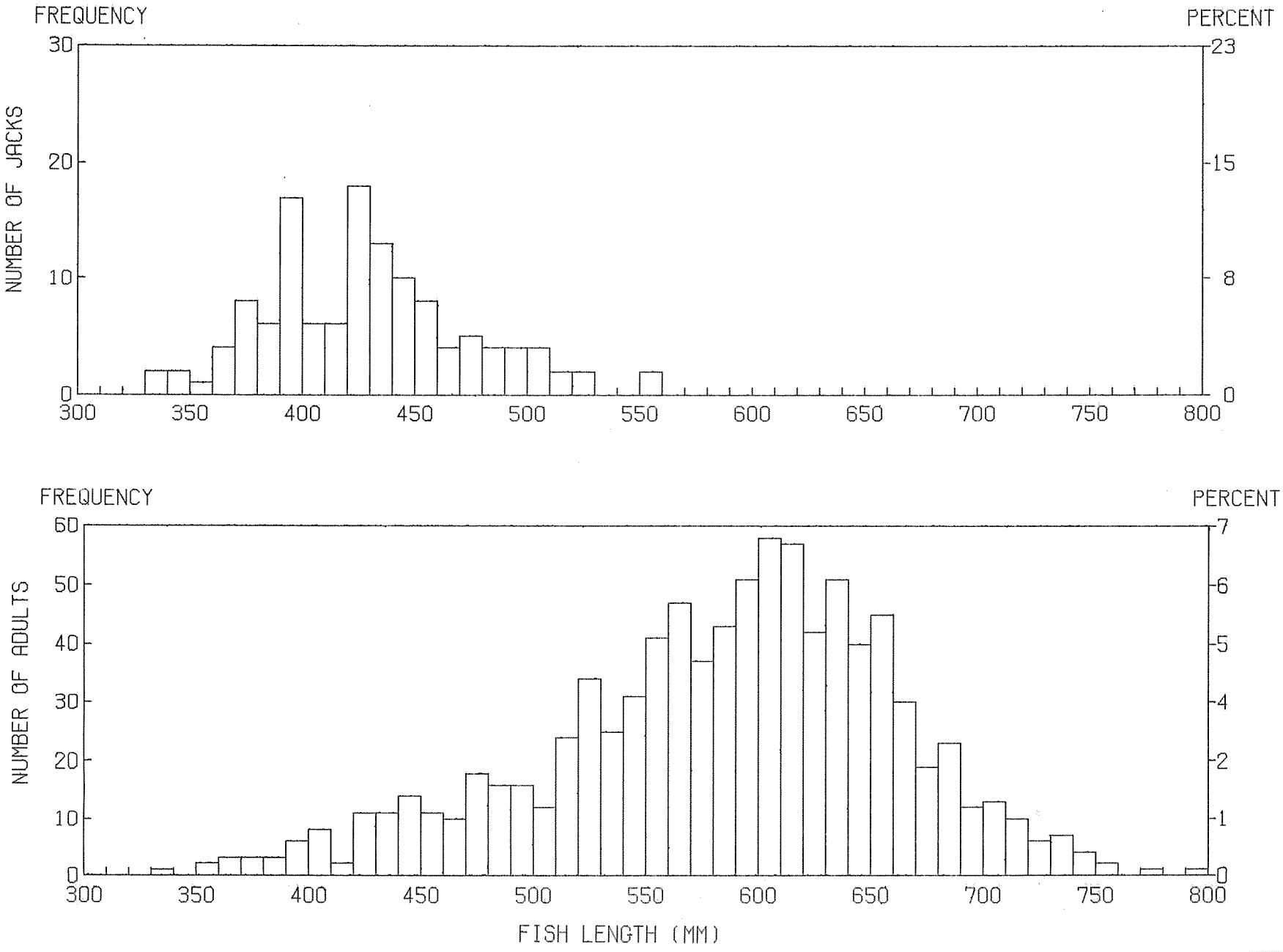

Fig. 2. (A) Length-frequency distribution of 0-ocean age coho in 1981 samples;
(B) Length-frequency distribution of 1-ocean age coho in 1981 samples.

for the purpose of developing an age/length key. The range of lengths exhibited by adults includes some age 0.1 fish which returned as unusually small adults. Patterns on the scales of these fish suggested two life history types: 1) age0 juveniles released in spring or early summer which achieved excellent growth in the first ocean year (1980) but very poor growth in the summer prior to return; 2) age0 juveniles released in the late fall (1980) which grew very little before the winter season but experienced normal spring/summer growth prior to returning to Yaquina Bay. Scales of the first type were noted only in the earliest samples received.

Figure 3 models the transition in relative proportions of jacks and adults with increasing fish length. The fit of the 1981 data is particularly good above 420 mm; the departure of observed data from predicted values below 420 mm is a product of small sample sizes and the very small age 0.1 adults discussed above. A summary of the curve-fitting procedure is given in Table 2, and the linear regression of $\log_e$-transformed proportional estimates is shown in Fig. 4. The results presented in Table 3 indicate that 1) the age/length curve is a reasonably precise model of the age-at-length relationship for coho salmon returning to Yaquina Bay; and 2) 51 cm is a very conservative lower limit for designation as adults. It is, however, an effective boundary for minimizing the probability that jacks will be included among fish selected as adults on the basis of length only.

Age-at-length data from the 1980 coho return to Yaquina Bay was combined with the 1981 data for an average age/length curve (Fig. 5). The performance of this curve in allocating fish less than 51 cm in length is shown in Table 4.

Table 4. Comparison of observation with the predicted numbers of jacks and adults in each 10-mm length increment, 1980 and 1981 combined.

	Observed		Predicted	
	jacks	adults	jacks	adults
Numbers	275	227	264	238
Percent	54.8	45.2	52.6	47.4

We feel that the precision of the average age/length curve warrants its consideration as an alternative to scale pattern age interpretation in situations where positive ages of individuals are not required. It is clearly more desirable than classifying as jacks all fish smaller than 51 cm. Table 3 shows that nearly half of the 502 fish sampled in 1980 and 1981 which would have been classified as jacks actually were small adults. We therefore propose the following table for estimating the numbers of jacks and adults in each 10-mm increment of overlap in their length distributions:

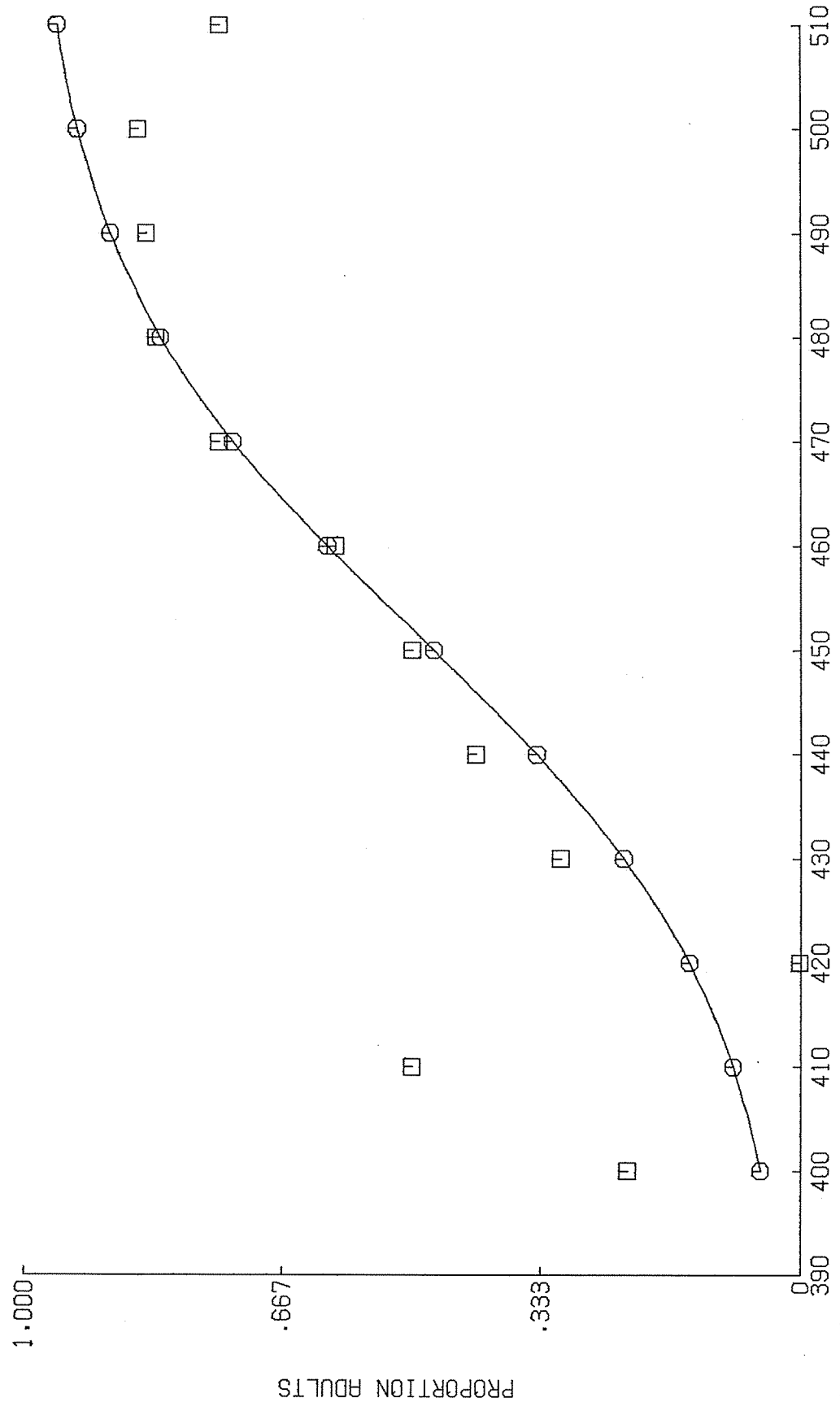

Fig. 3. Logistic curve modelling the transition from primarily jacks to primarily adults as a function of fish length. ⊡ = observed proportion of adults in each 10 mm increment over the length interval 400-510 mm.

Table 2. Summary of the procedure for fitting the logistic curve to observed proportions of jacks and adults by 10 mm length increment in the 1981 samples.

Length	Observed proportions		$-\ln\left(\frac{1-p}{p}\right)$	Adjusted proportions	
	Jacks (1-p)	Adults (p)		Jacks	Adults
< 400	.778	.222	-1.25405	.948	.052
400-409	.500	.500	0	.912	.088
410-419	.999	.001	-6.90675	.856	.144
420-429	.692	.308	- .80949	.773	.227
430-439	.583	.417	- .33510	.661	.339
440-449	.500	.500	0	.528	.472
450-459	.400	.600	.40547	.390	.610
460-469	.250	.750	1.09861	.268	.732
470-479	.167	.833	1.60704	.173	.827
480-489	.154	.846	1.70357	.107	.893
490-499	.143	.857	1.79059	.064	.936
500-509	.250	.750	1.09861	.038	.962
≥510	.001	.999	6.90675	.004	.996

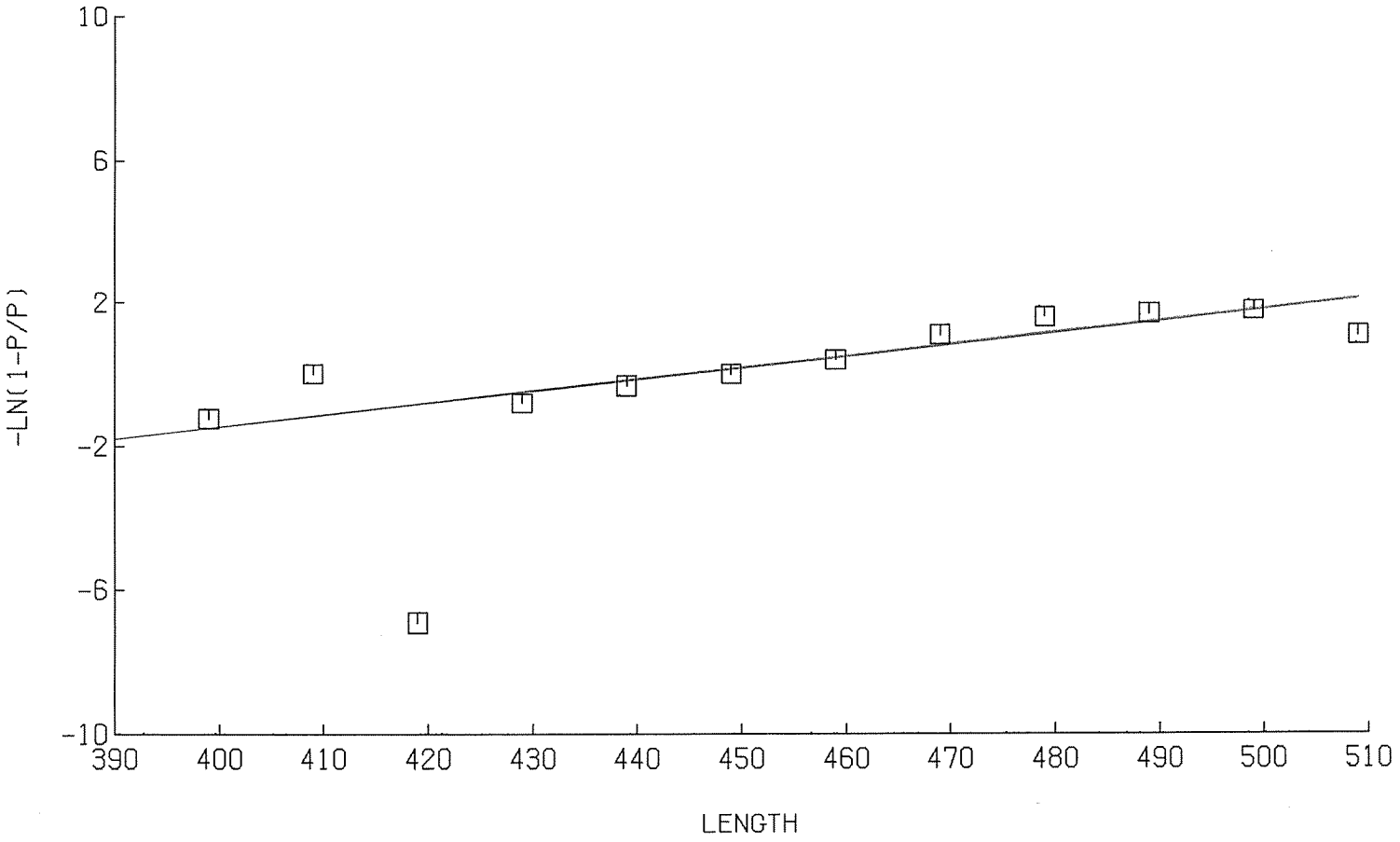

Fig. 4. Regression of transformed proportional estimates used to estimate values of "a" and "b" in the logistic equation $p = \frac{1}{1+e^{-(a+b\ell)}}$.

Table 3. Comparison of observed numbers of jacks and adults in each 10 mm length increment with those predicted by the logistic age/length curve, 1981 only.

Length	N	Observed		Predicted	
		Jack	Adult	Jack	Adult
400	27	21	6	26	1
400-409	6	3	3	5	1
410-419	3	3	0	3	0
420-429	13	9	4	10	3
430-439	12	7	5	8	4
440-449	10	5	5	5	5
450-459	10	4	6	4	6
460-469	8	2	6	2	6
470-479	18	3	15	3	15
480-489	13	2	11	1	12
490-499	14	2	12	1	13
500-509	8	2	6	0	8
Total					
Number		63	79	68	74
Percent		44.4	55.6	47.9	52.1

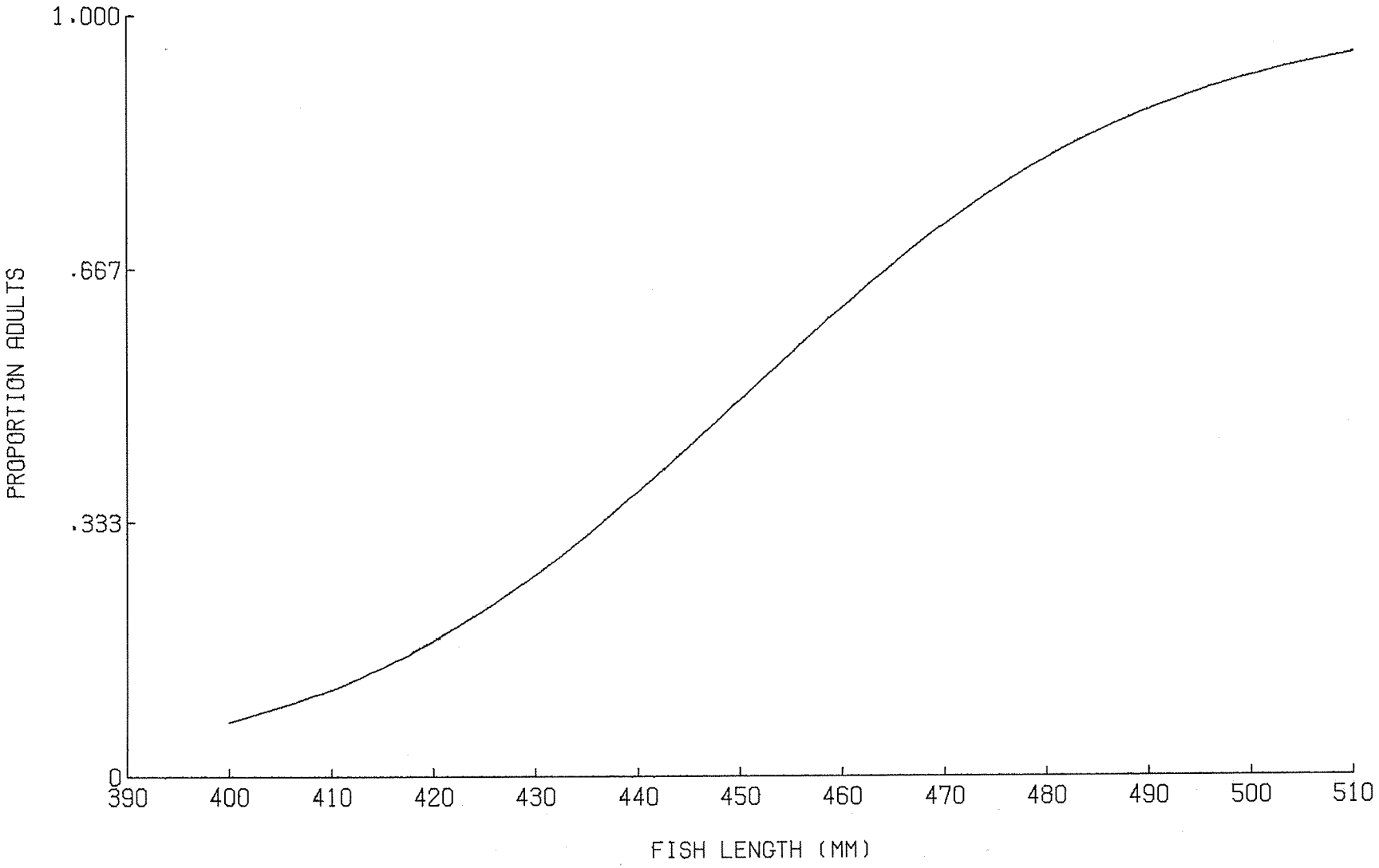

Fig. 5. Age/length curve for estimation of the relative proportions of jacks and adults in each 10 mm length increment over the interval 400-510 mm.

Fish length (mm)	Proportion jacks	Proportion adults
<400	.9257	.0743
400-409	.8832	.1168
410-419	.8211	.1789
420-429	.7358	.2642
430-439	.6282	.3718
440-449	.5062	.4938
450-459	.3835	.6165
460-469	.2740	.7260
470-479	.1864	.8136
480-489	.1220	.8780
490-499	.0778	.9222
500-509	.0487	.9513
>510	.0201	.9799

SUMMARY OF CONCLUSIONS

1. Age 0.1 coho constituted about 64.6% of the samples aged using scale pattern analysis. About 27.1% were yearling adults and about 7.9% were yearling jacks. Scales exhibiting patterns suggestive of overwintering in Yaquina Bay or Wright Creek (Crawford et al. 1981) were not seen.

2. Length frequency analysis of the 1981 data indicated that coho jacks ranged in length from 330 to 550 mm with a mean of 425.5 mm. Adults ranged from 385 to 790 mm with a mean length of 580.5. The curve developed to separate jacks and adults in the area of overlap in their length distribution proved to be quite accurate, misclassifying only 5 of 142 samples.

3. The average age/length curve produced from 1980 and 1981 run data combined showed comparable accuracy in segregating jacks from adults at lengths under 51 cm. The average curve misclassified only 6 of 360 fish in samples taken from the 1980 and 1981 coho returns. We therefore recommend adoption of an average age/length curve for allocating to ocean age fish less than 51 cm.

REFERENCES

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APPENDICES

Appendix Table 1. Age composition by week of the 1981 coho salmon return to Yaquina Bay. Separate statistics are shown for groups of fish classified by OAF as jacks (< 51 cm in length) and as adults (> 51 cm). "R" indicates regenerated scales.

		<51 cm					>51 cm				
Date		0.0	1.0	0.1	1.1	R	0.0	1.0	0.1	1.1	R
8/31/81	n			30	5	3			48	6	11
	%			85.7	14.3				88.9	11.1	
9/15/81	n			5		3			72	7	7
	%			100.0					91.1	8.9	
9/20/81	n	1	2	2		3		1	38	6	7
	%	20.0	40.0	40.0				2.2	84.4	13.3	
9/28/81	n		8	10		9			58	4	11
	%		44.4	55.6					93.5	6.5	
9/30/81	n		3			2			13	7	1
	%		100.0						65.0	35.0	
10/4/81	n		13	4	1	6			50	15	11
	%		72.2	22.2	5.6				76.9	23.1	
10/11/81	n	1	16	10	3	27		2	96	76	26
	%	3.3	53.4	33.3	10.0			1.1	55.2	43.7	
10/19/81	n	1	11	4	2	11		1	24	33	13
	%	5.6	61.1	22.2	11.1			1.7	41.4	56.9	
10/26/81	n		2	1		2			27	33	11
	%		66.7	33.3					45.0	55.0	
11/2/81	n		4	1		2			23	18	6
	%		80.0	20.0					56.1	43.9	

Appendix Table 2. Age composition of unmarked adults held for spawning. All fish sampled were larger than 51 cm in length.

Date		0.1	1.1	R	Total
10/29	n	54	17	29	100
	%	76.1	23.9		
	N = 71				
11/20	n	37	30	8	75
	%	55.2	44.8		
	N = 67				
12/2	n	80	47	23	150
	%	63.0	37.0		
	N = 127				
12/8	n	43	21	11	75
	%	67.2	32.8		
	N = 64				
	Mean	65.4	34.6		