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ORE-AQUA COHO SCALE ANALYSIS
Proj. 1980A: Age Composition and Age/Length Key

by

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CONTRACT COMPLETION REPORT

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Efficient management of exploited animal populations is promoted by an accurate perception of the population age structure. Age analysis provides the data for calculations of brood production and population growth rate, which in turn indicate the level at which a natural population can be safely harvested. Age structure information is no less important in managing populations of artificially propagated species. Where artificial selection determines the genetic composition of a population, genotypes exhibiting greatest brood production (e.g., as biomass) may be heavily selected for. This certainly is the case of commercial aquaculture facilities, where success or failure is a function of biomass produced for market.

The concept of ocean ranching by definition requires that the harvested stock spend a significant proportion of its life cycle at liberty from the hatchery. Pacific salmon are reared to some appropriate size for release into saltwater (see Parker et al. 1981), and thereafter they follow an intuitive migration through oceanic pastures which terminates as the adult salmon return to the point of release as smolts. Since the adult returns may be comprised of a number of age groups, an accurate understanding of brood production requires information on the number of fish of each age in the returns. This is essential for evaluating the contributions of specific genetic stocks to total biomass produced.

The 1980 return of adult coho salmon to the Oregon Aqua Foods (OAF) saltwater facility at Yaquina Bay, Oregon caused the research staff to

question 1) the number of age groups thought to be present in the return; and 2) the accuracy of the age/length relationship used during harvest to separate early-maturing "jacks" (less than one full year in the ocean) from normal 1-ocean adults. Evidence presented in Myers et al. (1981) and elsewhere suggested that some coho smolts released in late summer and early fall could overwinter in either or both of two hypothesized locations; 1) Yaquina Bay estuary, or 2) Wright Creek, upstream of the estuary. Concern that this might be occurring was centered on 1) the error produced in brood year production tables by the presence of aberrant life history types in adult returns; and 2) the possibility that OAF postsmolts overwintering in Wright Creek could stray as returning adults to spawning grounds in Wright Creek.

The objectives of this study thus were to:

1) Determine the age composition of the 1980 coho return to OAF-Yaquina Bay by scale analysis, with special attention to the incidence of aberrant life history types.

2) Describe the size distribution of the adult return and develop an age/length key from length frequency distributions of each age group.

3) Recommend a sample size for weekly scale collections from the 1981 coho return which ensures acceptable accuracy in the age composition statistic.

METHODS AND MATERIALS

Scale samples were obtained from OAF as scale smears enclosed in gummed envelopes. A subsample of three scales from each smear was removed, cleaned, and affixed to gummed scale cards from which acetate replicas of the sculptured surface were prepared. Acetate replicas were then projected 100x to the screen of a microfiche reader for pattern analysis. A total of 835 coho scale samples were obtained from OAF and processed in the above fashion. Of these, 773 were judged readable and were included in the analysis.

As there appeared to be a wide array of scale patterns within age groups, it was important to identify and adhere to strict rules governing pattern analysis. This type of pattern variability was generally found within the first annulus of the scale or that portion of the scale representing pre-release growth. The biological basis for this type of pattern variability is difficult to assess with the information presently available. For this analysis, those guidelines outlined by Parker et al. (1981) were adopted for interpretation of OAF adult coho scale patterns.

The transition from primarily 1.0 age jacks at smaller fish lengths to primarily 0.1 age adults at larger fish lengths was modelled by a logistic curve of the form

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

where:

p = proportion of 0.1 age fish

e = base of the Naperian system of logarithms

a = intercept in the linearized form

b = slope in the linearized form

ℓ = fish length.

The linearized form of equation 1 is:

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

Raw proportions of 0.1 fish in each 10 mm increment in the interval 380-510 mm were linearized using equation 2. The slope and intercept obtained were used to adjust raw proportions, which were then transformed to the logistic form by equation 1.

RESULTS

The results shown in Table 1 indicate that two major age groups comprised the coho population returning to the OAF facility at Yaquina Bay. Roughly 73% of the scales analyzed had been removed from fish

Table 1. Age composition of the 1980 coho return to OAF-Yaquina Bay.

	Age group						
	0.0	0.1	0.2	1.0	1.1	1.2	Total
Number	0	556	10	205	2	0	773
Percent	0	71.9	1.3	26.5	0.3	0	100.0

which spent less than one full year in freshwater and at least one full year in the ocean. The remaining 27% appeared to have been held in freshwater for one year prior to release. Over 99% of yearling smolts spent less than one year at sea. Of the 773 examined, 10 scales indicated aberrant life histories. These 0.2 cohos presumably are those which are thought to overwinter within Yaquina Bay estuary or further upstream, though no supportive data (such as release date from coded wire tags) are available to substantiate this conclusion.

Figure 1 shows the length frequency distributions of the two major age groups. Fish in the 0.1 age group averaged 550 mm in length. These were the largest fish returning as they had experienced accelerated ocean growth over a longer period of time. This group also exhibited the greatest range of lengths, possibly as a result of staggered smolt releases over several months. Fish of the 1.0 age group averaged 400 mm in length. Patterns on the scales of these fish suggested that they were released in early spring as fairly large smolts. These fish apparently were able to mature on one summer's accelerated ocean growth, returning as sexually mature adults in the fall of the year.

Figure 2 illustrates the transition from primarily 1.0 age jacks to 0.1 age adults as a function of fish length. The smoothed curve in Fig. 2 is a product of the constants "a" and "b" obtained from the regression of $-\ln\left(\frac{1-p}{p}\right)$ on fish length (Fig. 3) substituted into equation 1. We feel that this curve represents the best method for estimating relative proportions of each age group in the total return of fish in the length

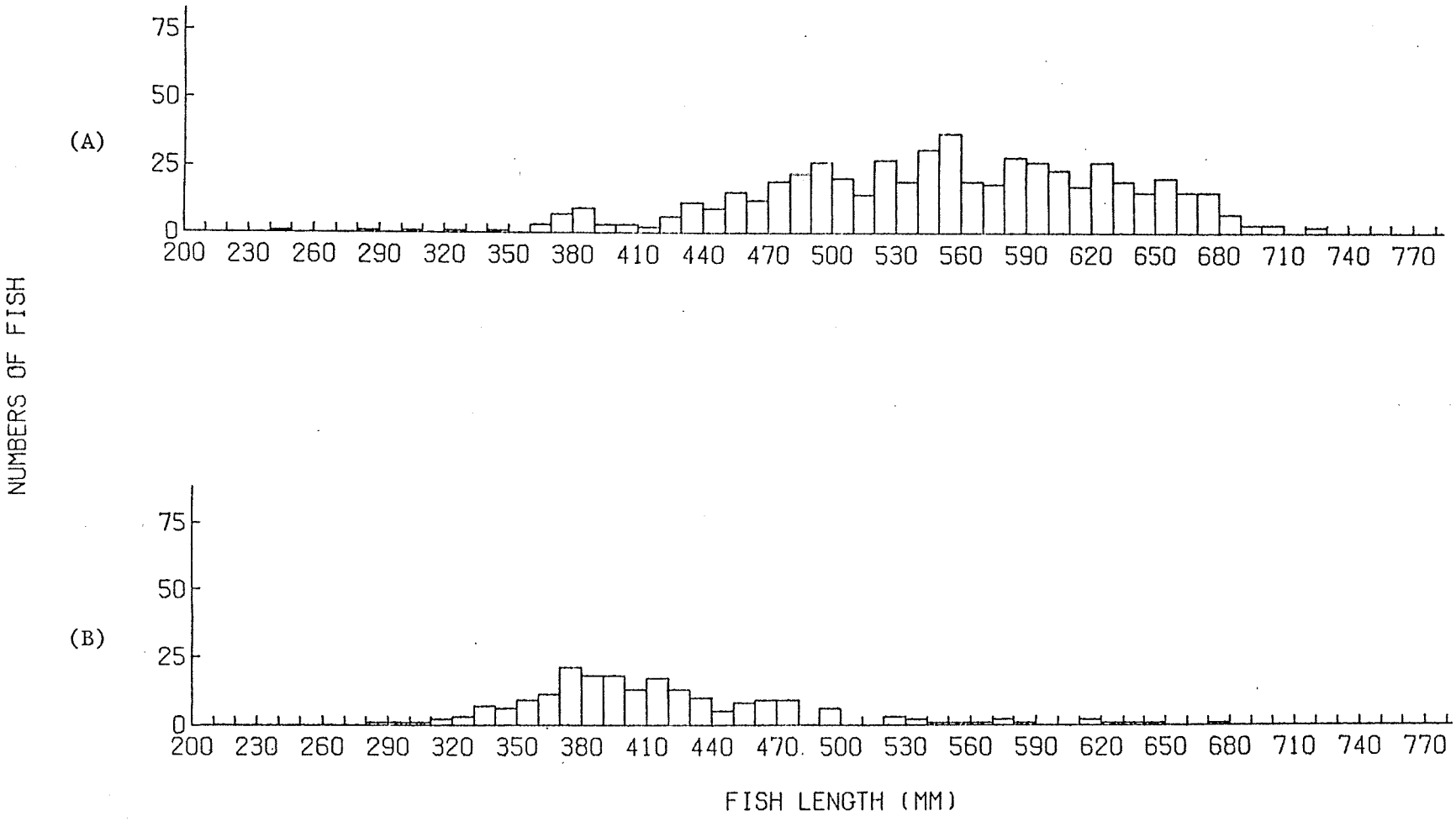

Fig. 1. (A) Length frequency distribution of 0.1 age fish, 556 values; (B) Length frequency distribution of 1.0 age fish, 205 values.

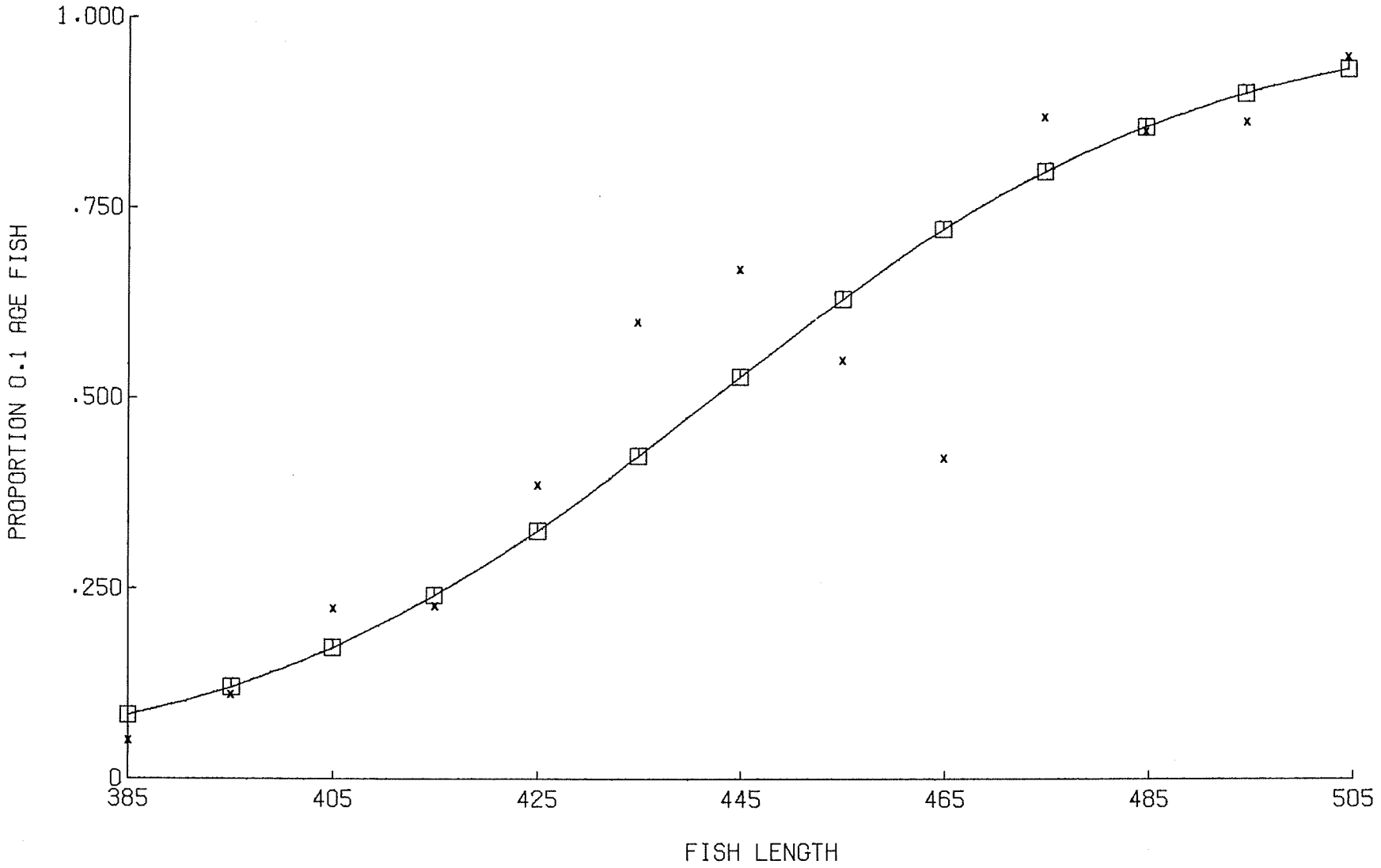

Fig. 2. Logistic curve modelling the relationship between the relative proportions of 1.0 jacks and 0.1 adults and fish length. X = raw proportions of 0.1 age fish; ⊡ = adjusted proportions of 0.1 age fish

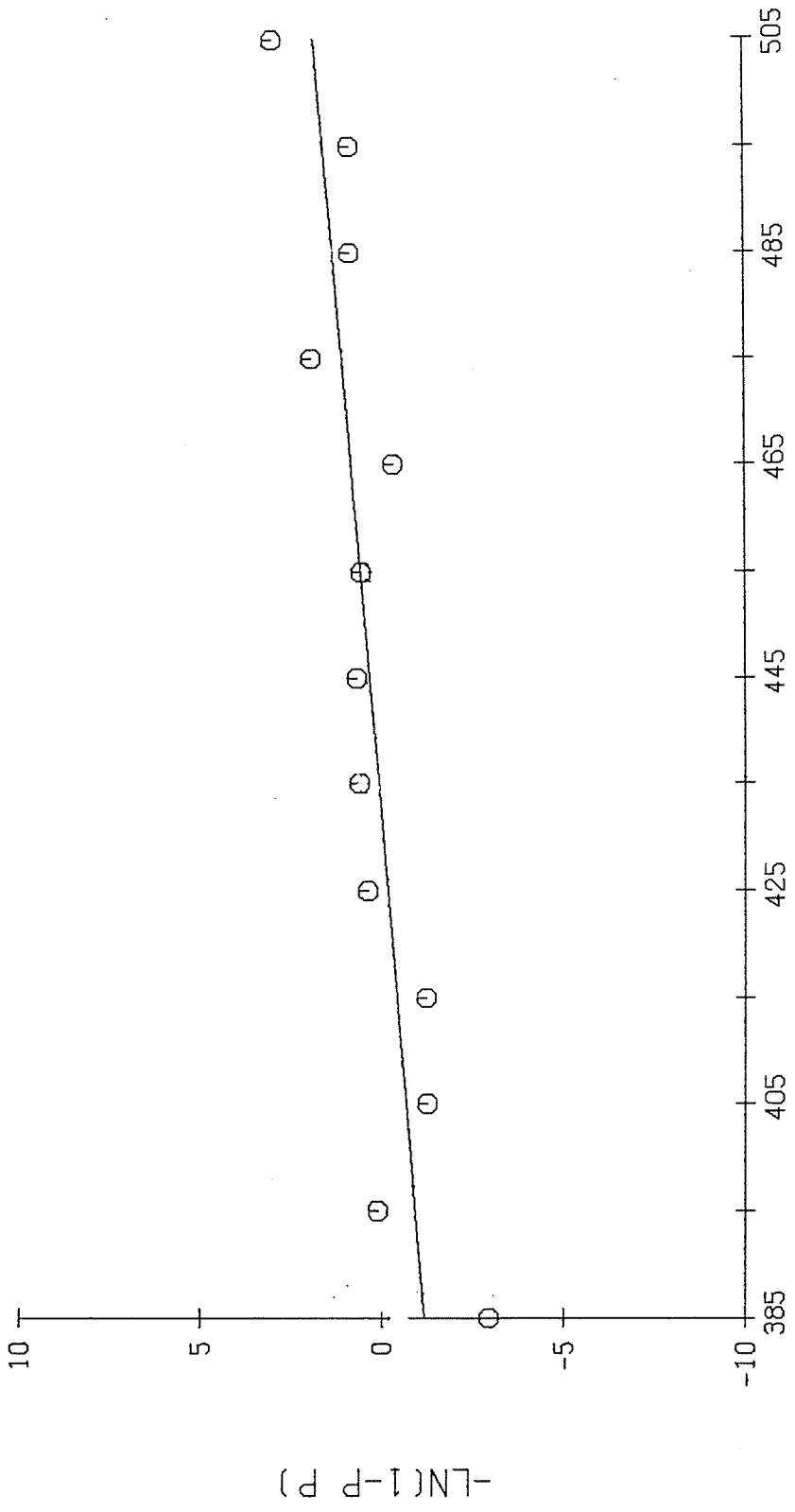

Fig. 3. Regression of $-\ln\left(\frac{1-p}{p}\right)$ on fish length used to estimate value of "a" and "b" in the logistic equation $p = \frac{1}{1+e^{-(a+b\ell)}}$.

range 400-500 mm. The inflection point of the curve--that length at which each age group theoretically is equally well represented--falls at 442.3 mm. The relative percentages of both age groups in each 10 mm increment are presented in Table 2.

Table 2. Raw and adjusted proportions of age 0.1 adults in the 1980 coho return as a function of fish length.

Fish length(mm)	n	Proportion 0.1 (p)	$-\ln(\frac{1-p}{p})$	Adjusted proportion 0.1
385	1	.050	-2.944	.083
395	2	.111	-2.801	.120
405	4	.222	-1.254	.172
415	5	.227	-1.225	.241
425	4	.385	-0.468	.326
435	15	.600	0.405	.424
445	8	.667	0.695	.528
455	9	.550	0.201	.630
465	19	.421	-0.319	.722
475	18	.870	1.901	.798
485	20	.852	1.750	.857
495	19	.864	1.850	.901
505	19	.950	2.944	.933

SUMMARY OF CONCLUSIONS

1. The 1980 coho return to OAF-Yaquina Bay was composed primarily of 0.1 age adults. Nearly 72% returned as 0.1's, 26.5% as 1.0 jacks, 1.3% as 0.2 adults, and 0.3% as 1.1 adults.

2. Length frequency analysis indicates that nearly 90% of cohos less than 390 mm in length are 1.0 age jacks and over 90% of those larger than 490 mm are 0.1 age adults. The relative percentages of both age groups within the intervening 100 mm varies as a function of fish length. A logistic model of the change in relative percentages with increasing fish length should produce reasonably accurate estimates of actual age composition.

3. Sample size for future age composition studies should approximate 1% of the total return per week of the run, to a minimum of 100 scales per week.

LITERATURE CITED

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