SHRIMP ASSESSMENT

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By

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The shrimp stock assessment project was initiated to critically analyze file and newly-obtained pink shrimp fishery and research data for estimation of stock size, equilibrium yield, and fishing power/CPUE/fishing mortality relationships.

This report summarizes progress to date on data analysis and compilation, discusses some specialized work accomplished, underway, or planned to overcome specific data shortcomings, and outlines what we have found so far in running different growth, yield, and recruitment models on Oregon pink shrimp data.

Data Analysis

Collation and initial analysis of Oregon pink shrimp market sampling data for the period 1966 to 1980 is now complete. This data was organized in both tabular and graphic form and has been published as Report Number 81-2 of the ODFW Information Report Series, Fisheries, entitled "Length-frequency, size, sex and age composition data by month and area for pink shrimp landed in Oregon 1966 to 1980."

The sampling data in report 81-2, and other pertinent information, was then analyzed to identify discrete stock units to use for population studies. We looked for evidence that age composition, morphological or genetic characteristics, parasites carried, time of spawning, maturity rates, or growth characteristics were different between shrimp taken from different beds along the Oregon coast (Figure 1).

Of these, only growth characteristics were found to indicate distinct, geographically separate, stocks within the area of interest. Morphological and genetic information was generally unavailable, but is sorely needed given an inability to use conventional marking techniques to verify pink shrimp stock uniqueness.

There seem to be three distinct growth patterns along the pacific coast, and these were associated with logical topographic and oceanographic stock isolation features. Growth appears to be relatively slow north of the Columbia River, intermediate in the area from the Columbia to Cape Mendocino, California, and fastest south of Cape Mendocino (see Figure 2).

Growth is a particularly important variable with respect to yield-per-recruit modelling. We felt that this made it particularly useful as a stock definition characteristic, and we chose all pink shrimp between the Columbia River and Cape Mendocino, Calfornia, (Oregon statistical areas 18-28) as the unit stock we would model.

There is some indication, however, that there may be another stock "break" at Cape Blanco, but there is presently no "hard" data to support this. In some years, higher incidence of early maturity (primary females) of shrimp in southern beds and special oceanographic conditions suggest discontinuity at least to either side of the Cape Blanco area. Other fish species also appear to migrate differently on either side of this area apparently as a result of oceanographic processes.

Since discrete stocks may have different maturity or mortality rates, and this would affect recruitment modelling, this potential must be explored. We propose to test for genetic indications that substocks exist by electrophoretic examination of blood proteins. We are presently testing for the presence of inter-area migration pathways along the Oregon coast by dropping sea-bed and surface current drifters around known shrimp beds, and monitoring where they are recovered by fishing trawls.

Population Modelling

An urgent need to evaluate proposed shrimp trawl-gear regulation changes prior to the March, 1982, Pacific Fisheries Management Council meeting made it necessary to run a number of population models prior to completely refining the area 18-28 unit stock data set. While we expected some of the basic data and estimates derived from that data to change slightly once the refinement task was completed, this preliminary run did provide reasonable answers to questions pressing at the time plus a valuable test run of relationships operating within Oregon shrimp stocks.

We developed a number of computer programs to test available population models, evaluated the suitability of those models with respect to "fit" to shrimp population dynamics, and, in turn, found a number of important inter-relationships that must be recognized to properly model pink shrimp fishery and population dynamics.

These preliminary conclusions regarding future work with pink shrimp include:

1. Age 1 shrimp are not fully recruited to the gear and catch of this age class must be adjusted for net selectivity. We used a selection curve developed from net-mesh studies we ran in 1981, and which we hope to extend and verify in 1983 (Figure 3).

2. Cohort analysis is unsuitable for estimating population parameters in pink shrimp because of an apparent lack of stability in mortality and catchability variables.

3. Catch/effort is an unreliable indicator of stock abundance unless the effect of oceanographic variation on availability of shrimp to the gear is factored in. We correlated volume of upwelling with effort in order to improve the relationship of effort to catch (R^2 values approximating .90).

4. Catchability appears to have decreased as effort has increased (Figure 4). This decline began after effort passed approximately 85,000 trawling hours, and probably is a result of both interferance between vessels, and also through additional gear-induced mortality. This induced mortality has apparently become so significant in recent years that yield/recruit analysis

now indicates that gear changes (that alter age of entry to the fishery) will have little or no effect on yield. This important concept is dependent upon the accuracy of our net selectivity curve and other data, but appears to be real enough that Oregon has moved away from management by larger mesh size. Additional data points will help verify this decision, but effort reached 130,000 hours in 1980 then dropped back to 117,000 in 1981.

5. A spawner/recruit relationship was found suggesting that some minimum spawning escapement is necessary, but we had to include an environmental term, volume of upwelling during larval release, to obtain a good fit in our preliminary recruitment model ($R^2 = .91$) (Figure 5).

Net Selectivity

Since catch by shrimp trawlers does not represent true shrimp population structure encountered by the gear, we developed a net selectivity curve from net-mesh selection tests conducted in 1981 (Figure 6) to permit correction of age/size composition data. A one-inch mesh trawl codend has been obtained to further extend and verify the shape of the selectivity curve.

Recent Focus

The area 18-28 unit stock data set is now complete. This summary data set provides catch, biological, and effort data in the form needed for use in population models. It has been published as Report Number 82-4 of the ODFW Information Report Series, Fisheries, entitled "Total Catch and Effort Tables, and Summary Biological Statistics, for Pink Shrimp Caught in Oregon Statistical Areas 18-28 by Month and Area 1966-1981; Catch Numbers Expanded by Age and Sex, Effort in Hours by Vessel Type" (copy attached).

We are now in the process of re-running and documenting our population models to verify yield and recruitment relationships we think we have identified operating in the Oregon pink shrimp fishery. We expect to obtain a useful predictive function for the Oregon pink shrimp stock and fishery.

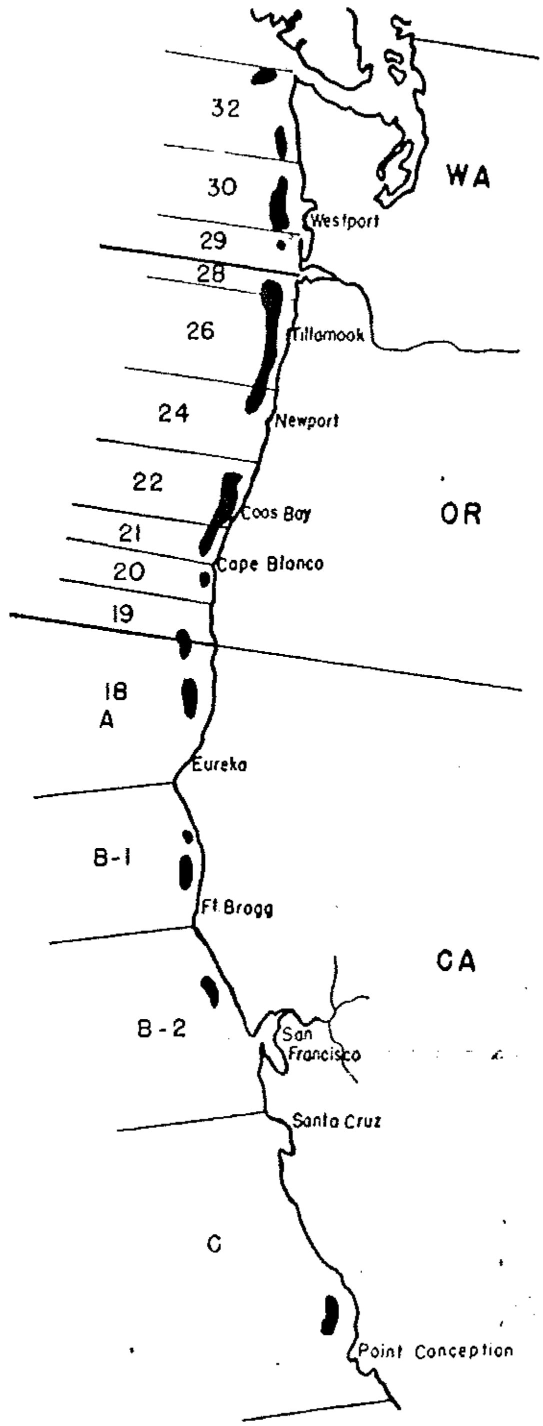

Figure 1. Location of pink shrimp, *Pandalus jordani*, beds (darkened areas) along the U.S. Pacific coast with Oregon (numbers) and California (letters) statistical area designations.

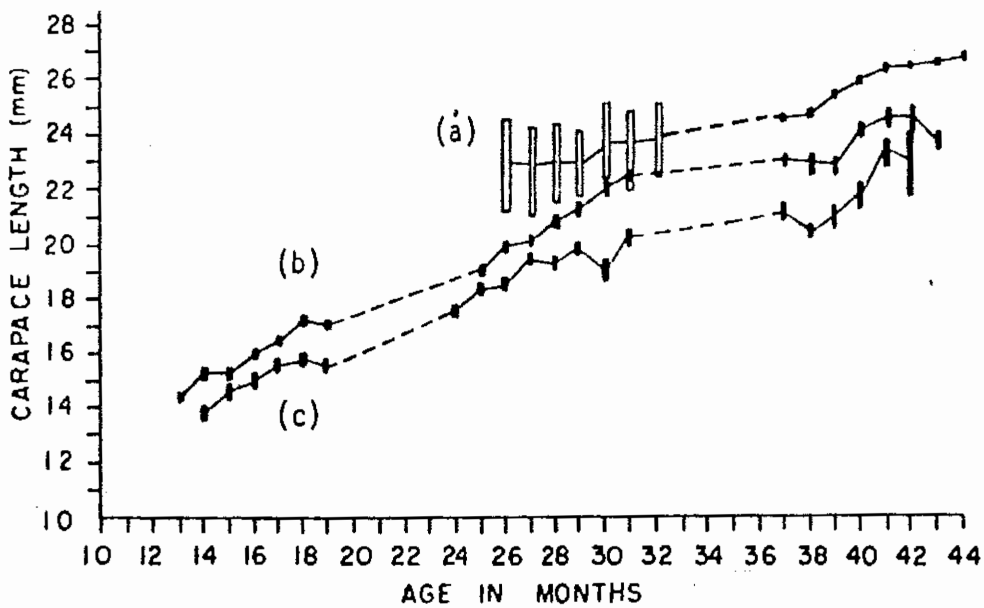

Figure 2. Comparison of average size at age of 1977 brood pink shrimp, *Pandalus jordani*, caught in (a) California area C, (b) Oregon areas 18-28, and (c) Oregon areas 29-32. Vertical bar height represents ± one standard deviation around the mean, but means only shown for Area C months 37-44.

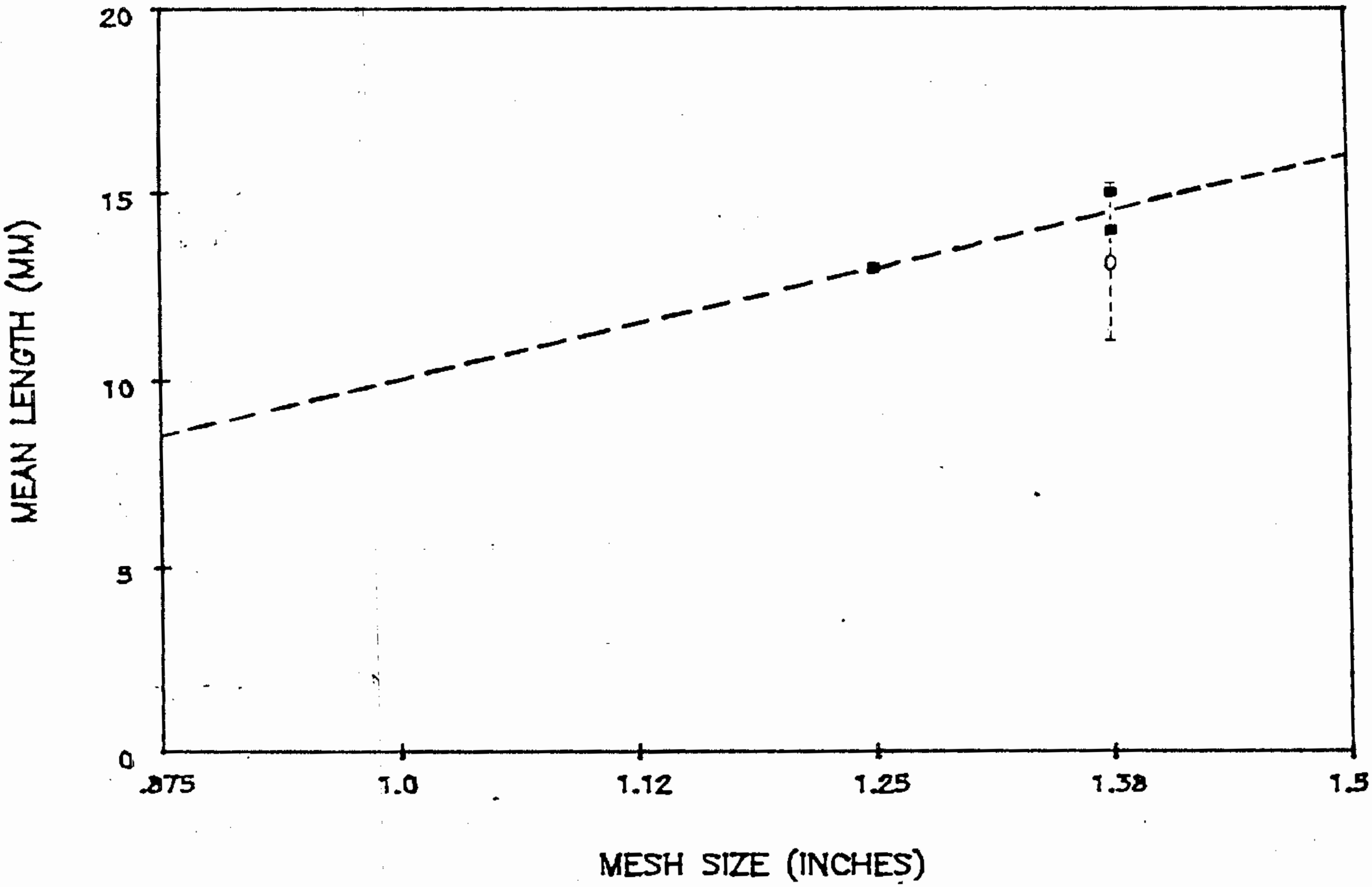

Figure 3. Weighted predictive regression of $\hat{l}_{50}$ against mesh size. The imprecision of the point 0 is over twice that of the other points.

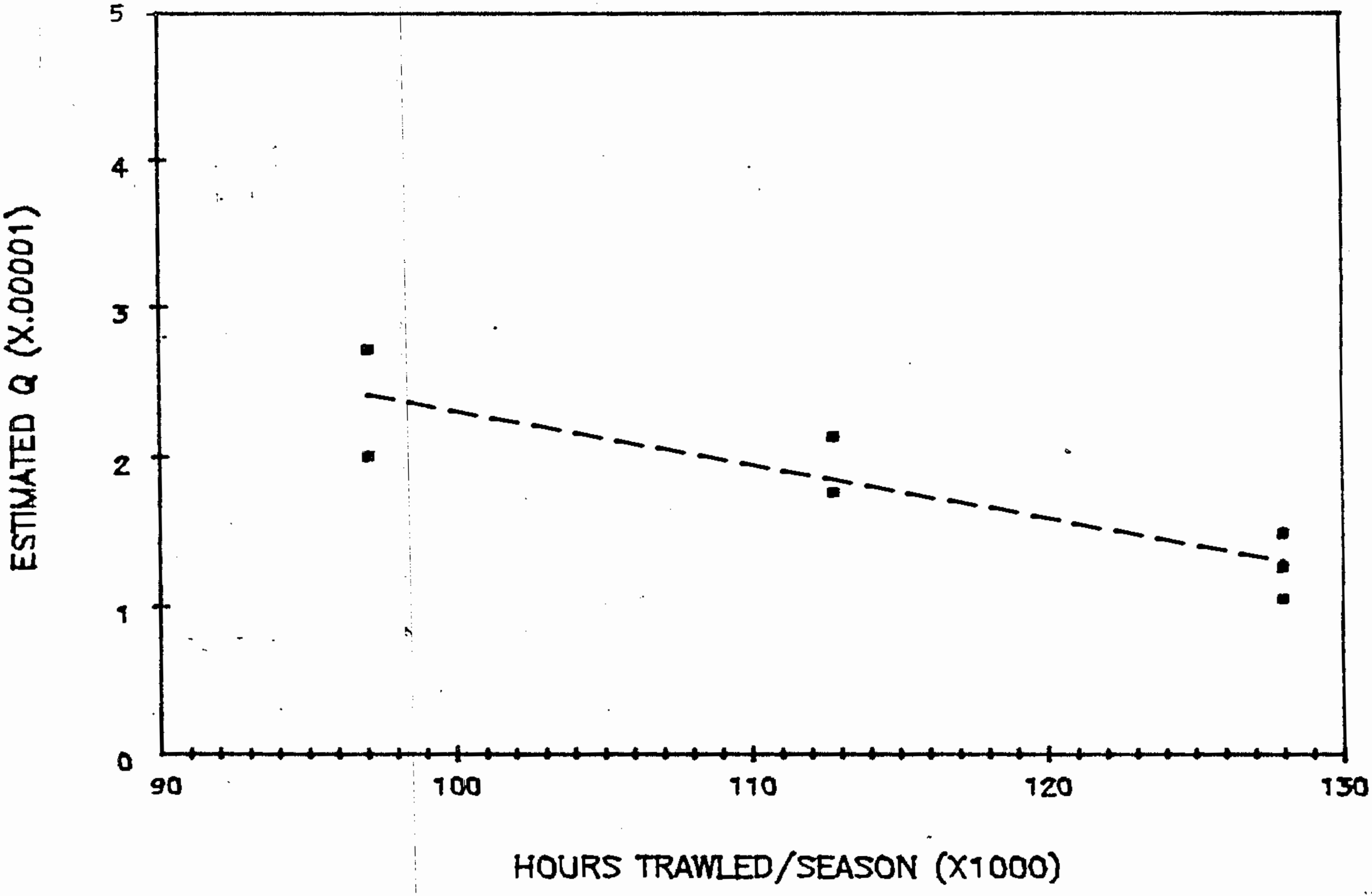

Figure 4. Weighted regression of significant values of $\hat{q}_{jk}$ against annual fishing effort E_k in years k over ages j. Weights are the reciprocals of the variances for $\hat{q}$, the catchability coefficient.

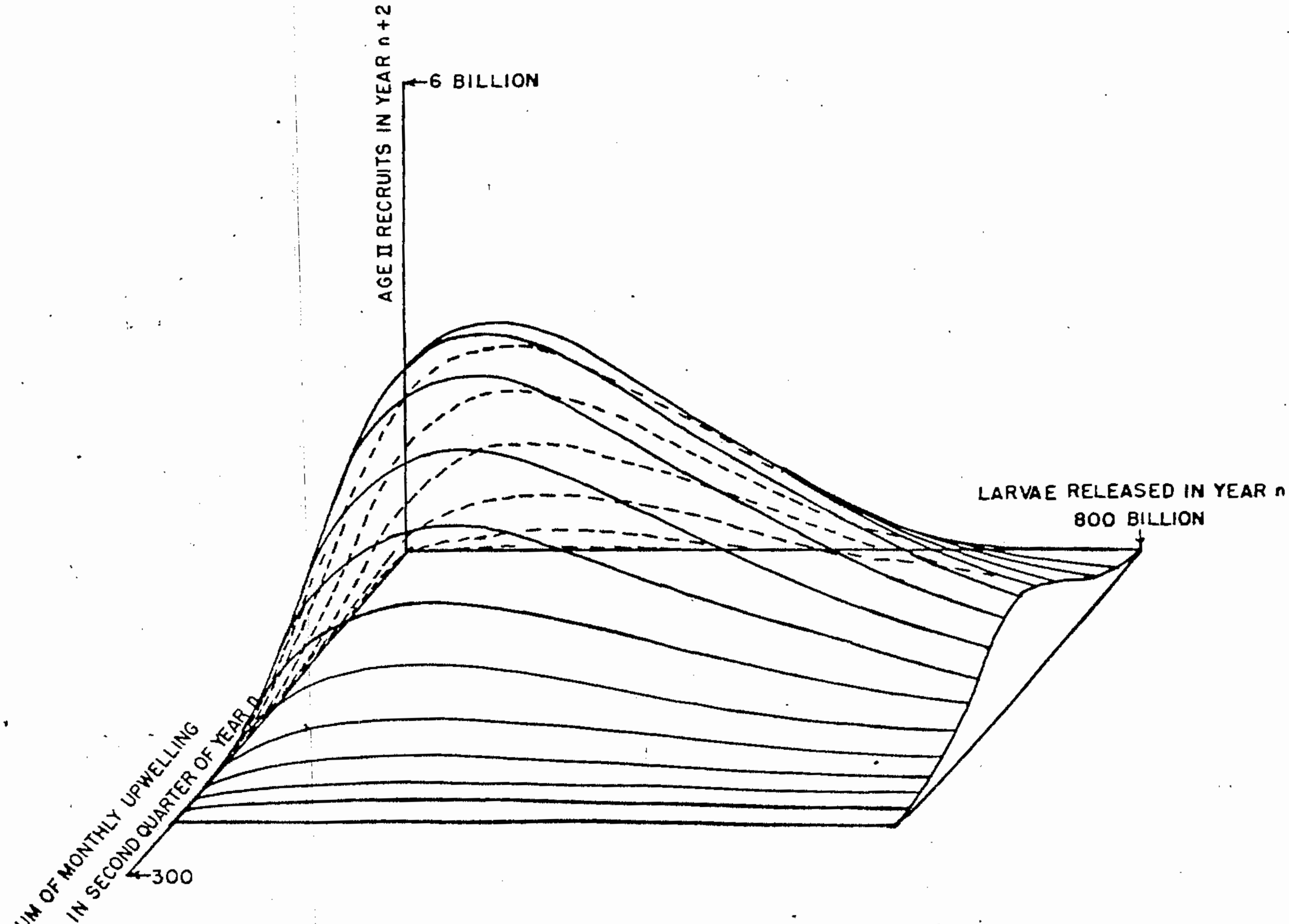

Figure 5. Response surface of **R**ecruitment as a function of **L**arval abundance (spawners) and **U**pwelling indices in the second quarter. Regression equation is

$$\widehat{\ln [R_{k+2}/L_k]} = \widehat{\ln \alpha} - \hat{a}L_k + \hat{b}L_kU_k - \hat{c}L_kU_k^2$$