

ACOUSTIC ASSESSMENT OF BAITFISH STOCKS IN PUGET SOUND

by

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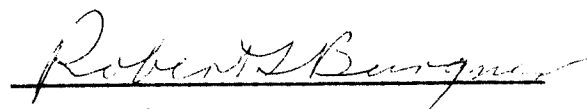
  
Robert S. Bergman  
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# ACOUSTIC ASSESSMENT OF BAITFISH STOCKS IN PUGET SOUND

## INTRODUCTION

A cooperative program between the Washington Department of Fisheries (WDF) and the Sea Grant Marine Acoustics Program to assess acoustically baitfish stocks in Puget Sound was initiated during the past year. Under the program the Fisheries Research Institute (FRI) contracted to aid in the collection of data and to analyze the data. The results of the work are reported here under the terms of the contract.

## MATERIALS AND METHODS

Acoustic data were collected on magnetic tape with the FRI acoustic data acquisition system described in Thorne, Nunnallee, and Green (1972), aboard either the 20-ft WDF *Research I* or the 67-ft RV *Commando* under charter to WDF, in several areas throughout Puget Sound and the Gulf of Georgia from September 15, 1972 to May 3, 1973. Each series consisted of a number of zigzag transects.

The acoustic data were analyzed with the Digital Data Acquisition and Processing System (DDAPS), described in Moose, Ehrenberg, and Green (1971), Moose, Thorne, and Nelson (1971), and Thorne (in press). Pending completion of target strength studies, the DDAPS was calibrated with net hauls with an assumption of 100% net efficiency (Thorne, Reeves, and Millikan, 1971; Thorne, in press). Densities of fish along transects were determined from the DDAPS analysis; then population estimates were obtained by extrapolation of the densities over the areas represented by the transects. Information on the size of areas was provided by WDF.

In addition, a more detailed analysis was made of the data from the various series in Carr Inlet for examination of the magnitude of the variance associated with the surveys. Integrated echo voltages were measured by DDAPS in 10-m depth strata at 2-min intervals along transects, then converted to estimates of herring density per unit surface area. Densities were classified as either high or low and weighed in proportion to the area represented by each observation. The population was estimated as the sum of the products of density and area in the strata. The variances of the population estimates were determined from the relationship

$$\text{Var } N_T = A_1^2 \text{Var } D_1 + A_2^2 \text{Var } D_2,$$

where  $N_T$  is the population estimate,

$A_1$  is the surface area of the low-density strata,

$A_2$  is the surface area of the high-density strata,

$\text{Var } D_1$  is the weighted mean low density, and

Var  $D_2$  is the weighted mean high density.

#### RESULTS AND DISCUSSION

The relationship between the net catches and the normalized integrations from the DDAPS is shown in Fig. 1. Variance increased with fish density. The data were transformed by taking logarithms, and the transformation appeared to normalize the variance (Fig. 2). The regression model

$$\log Y = a + b \log X,$$

where  $Y$  = net catch, and

$X$  = DDAPS integration,

was fitted to the data. The value of  $b$  was 0.87, with a variance of 0.025, and was not significantly different from 1.0, indicating a linear relationship. The model was recalculated with  $b = 1.0$  and used to determine fish densities from integrations along transects.

The results of acoustic surveys in Carr Inlet are presented in Table 1. The results of the two December series were in fair agreement. Population estimates in January were higher, suggesting movement into the area. The southbound January daytime series produced a considerably higher estimate than the other series, mainly because of high densities along 2 of the 17 transects. Most of the fish were found along these two transects, which represented one-third of the surface area. The results point out the need for better survey coverage in high-density areas. The night series yielded better results than the day series; the fish were dispersed at lower densities over a wider area and with considerably less patchiness.

The results of population estimates from surveys of other areas are given in Table 2. A large portion of the survey effort was expended in southern Puget Sound, where significant herring concentrations were observed over a large area. It is particularly interesting to note that the larger estimates in Carr Inlet in January were largely offset by decreased estimates in the remaining areas of southern Puget Sound. The combined estimate from Carr Inlet, Case Inlet, Drayton Passage, and Hale Passage was 40.6 million lbs in December and 47.2 million lbs in January.

Population estimates from most other areas were smaller than expected from the magnitude of the commercial fisheries. Greater knowledge of the herring behavior is needed before these values can be interpreted.

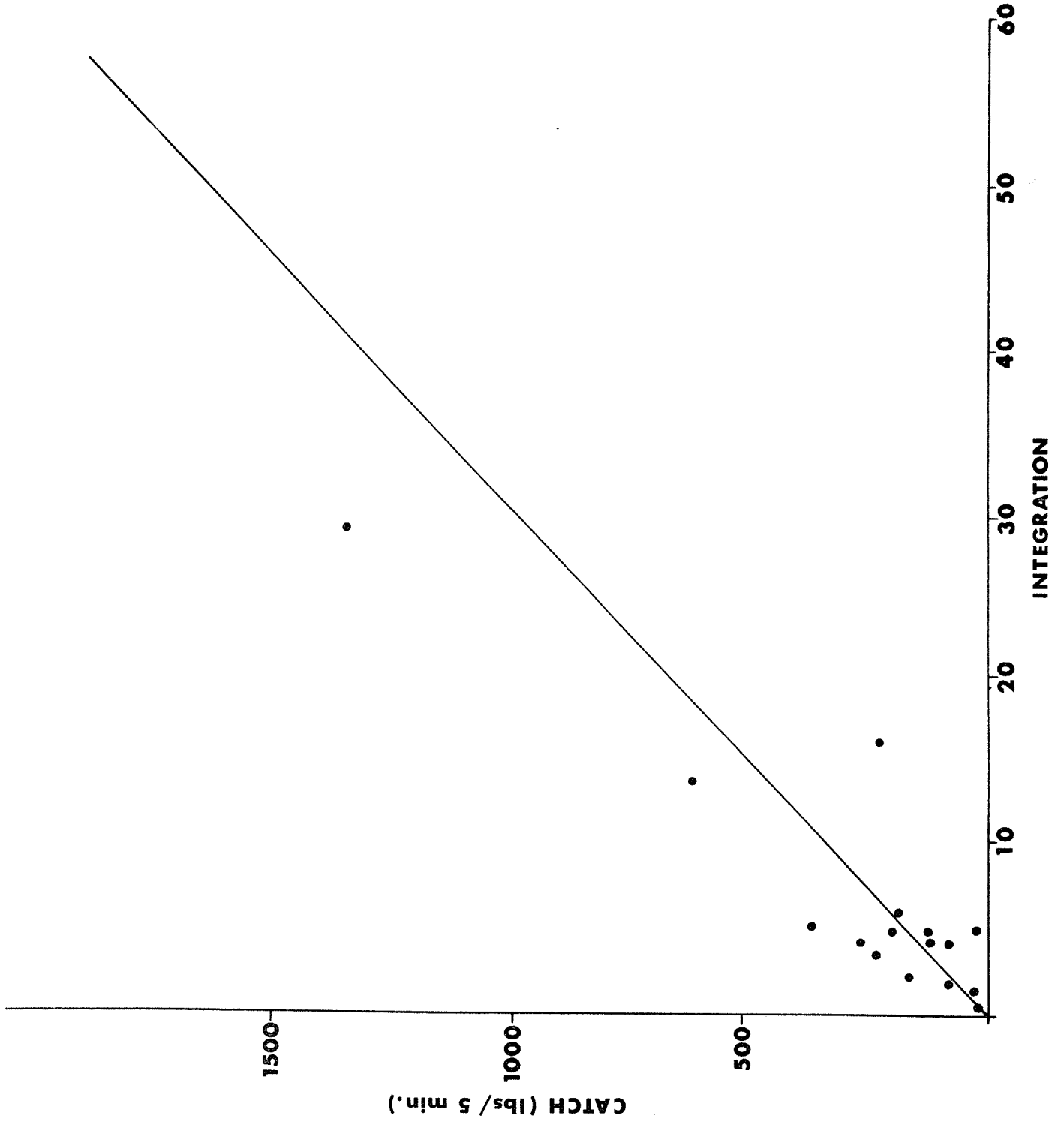


Fig. 1 - Relationship between catches of herring and DDAPS integration.

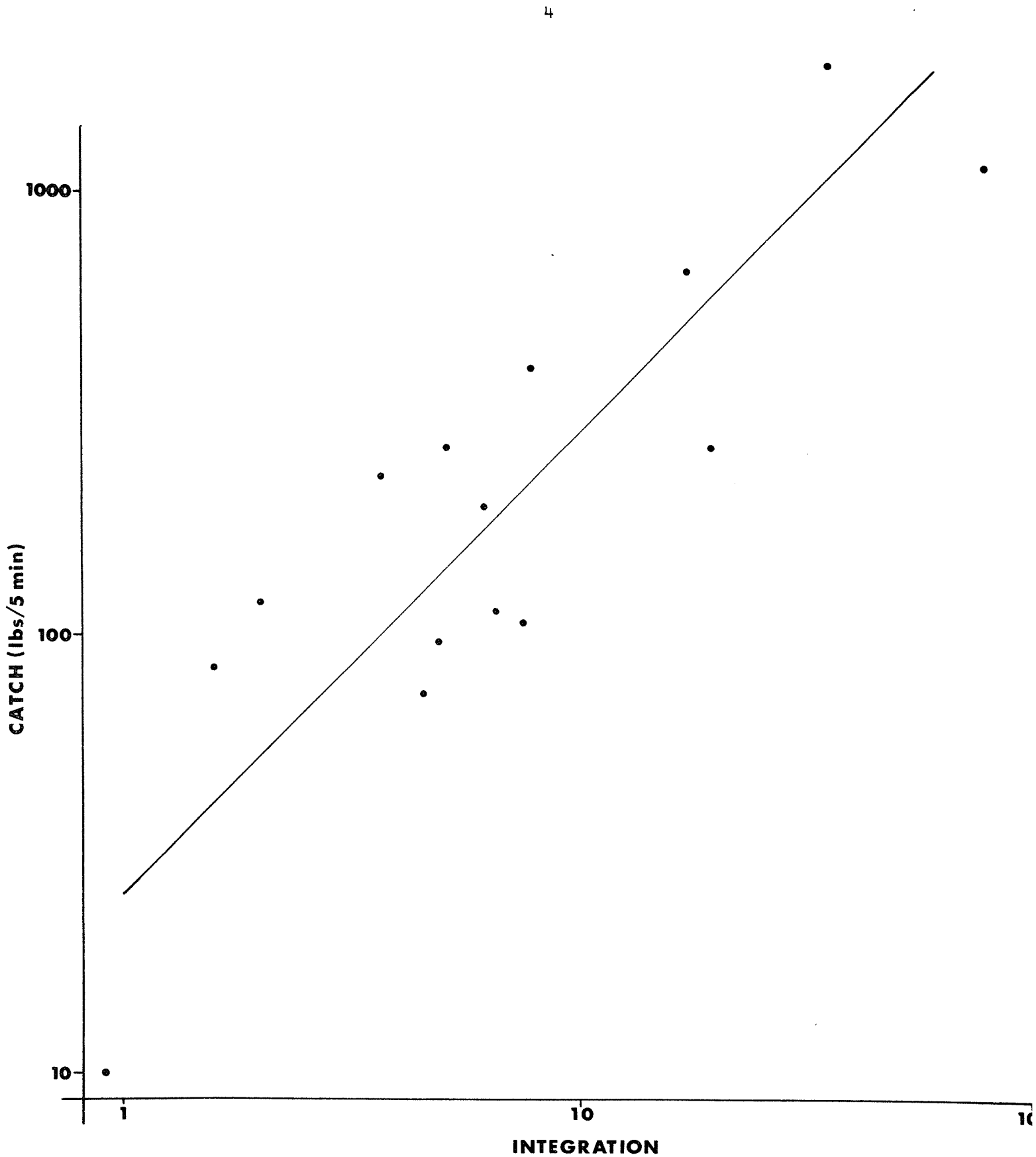


Fig. 2. Relationship between catches of herring and DDAPS integration plotted on logarithmic scales.

Table 1. Results of acoustic surveys of herring in Carr Inlet during December 1972 and January 1973

Series	Population estimate ( $10^6$ lb)	Variance $10^{12}$	Number of observations
December-Northbound-Day	16.4	25.9	25
December-Southbound-Day	24.2	29.4	35
December-Combined	20.3	14.0	60
January-Northbound-Day	25.3	10.8	26
January-Southbound-Day	56.0	55.8	24
January-Southbound-Night	24.4	5.5	34
January-Combined	35.2	26.9	84

Table 2. Results of acoustic surveys in various areas of Puget Sound and vicinity, September 15, 1972 to May 3, 1973

Location	Date	Run	Surface area $10^6 \text{m}^2$	Biomass $10^6 \text{lbs}$
Bellingham Bay	9/15	Day		insignificant
East Sound	9/15	Night		insignificant
Bellingham Bay (Area A)	11/2	Night	6.9	0.14
Bellingham Bay (Area A)	11/3	Day	6.9	4.09
East Sound	11/3	Day		insignificant
Waldron I	11/4	Night		insignificant
Hale Passage	12/19	Night	8.9	2.99
Drayton Passage	12/20	Day	8.7	8.06
Case Inlet (Areas 2-5)	12/20	Day 1	44.3	13.91
Case Inlet (Areas 3-5)	12/20	Day 2	32.0	4.61
Colvos Passage	1/16	Day	23.6	1.37
Hale Passage	1/17	Night	8.9	1.74
Drayton Passage	1/17	Night	8.7	3.66
Case Inlet (Areas 4-5)	1/18	Day 1	23.8	6.12
Case Inlet (Areas 4-5)	1/18	Day 2	23.8	7.00
Hood Canal	2/26	Day	25.5	3.10
Holmes Harbor	2/28	Night	16.9	0.50
Gulf of Georgia	5/3	Night	146.1	8.01

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