General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)

SQT

E86-10013
NASA-CR-176406

Semi-annual Progress Report

to

The National Aeronautics and Space Administration

on

The TM Project

NASA-ORDER S-5607

"Utilizing remote sensing of thematic mapper data to improve our understanding of estuarine processes and their influence on the productivity of estuarine-dependent fisheries"

Joan A. Browder ← P.I.
Alan Rosenthal
Miami, Fla., Unit of Beaufort, N. C., Laboratory
Southeast Fisheries Center
Miami, Fla. 33149

L. Nelson May, Jr.
Coastal Fisheries Institute
Center for Wetland Resources
Louisiana State University
Baton Rouge, La. 70803

Robert H. Baumann
Center for Energy Studies
Louisiana State University
Baton Rouge, La. 70803

James G. Gosselink
Coastal Ecology Institute
Center for Wetland Resources
Louisiana State University
Baton Rouge, La. 70803

First Semi-Annual Progress Report
December 10, 1985

(E86-10013 NASA-CR-176406) UTILIZING REMOTE SENSING OF THEMATIC MAPPER DATA TO IMPROVE OUR UNDERSTANDING OF ESTUARINE PROCESSES AND THEIR INFLUENCE ON THE PRODUCTIVITY OF (National Marine Fisheries Service) 17 p

N86-14712

G3/43 Unclas 00013

Introduction

The purpose of the project is to refine and validate a probabilistic spatial computer model through the analyses of thematic mapper imagery. The model is designed to determine how the interface between marshland and water changes as marshland is converted to water in a disintegrating marsh. Coastal marshland in Louisiana is disintegrating at the rate of approximately 40 sq mi a year (Gagliano et al. 1981), and an evaluation of the potential impact of this loss on the landings of estuarine-dependent fisheries is needed by fisheries managers. Understanding how marshland-water interface changes as coastal marshland is lost is essential to the process of evaluating fisheries effects, because several studies suggest that the production of estuarine-dependent fish and shellfish may be more closely related to the interface between marshland and water than to acreage of marshland (Faller 1979, Dow 1982, Zimmerman et al. 1984). The need to address this practical problem has provided an opportunity to apply some scientifically interesting new techniques to the analyses of satellite imagery. Our progress with the development of these techniques is the subject of our first report.

The study group consists of two research teams. The first, located at the Southeast Fisheries Center in Miami (Miami Unit of the Beaufort, N. C., Laboratory) consists of Joan Browder and Alan Rosenthal. The second, located at Louisiana State University in Baton Rouge, La., consists of Nelson May, Robert Baumann, and James Gosselink. Image analyses is being performed on the Fisheries Image Analyses System at the Slidell, La., Laboratory of the Mississippi Laboratories of the Southeast Fisheries Center.

Following are summaries of work accomplished to date and immediate future plans of the two research teams.

Background

The model simulates a disintegrating marsh, starting with a solidly vegetated marsh and ending with total open water. Disintegration proceeds one pixel at a time, the specific pixel converting to water at each iteration determined by a probability function linked to a random number generator. Weighting factors in the probability function allow us to weight the probability that a pixel will be converted at the next interation based on the number of sides on which it is exposed to water or based on its position in the marsh.

The probability function is:

$$F = 1 + W S + G B$$

where F = frequency of a given pixel on the selection list (relative probability), W = weight given per side bordered by water, S = number of sides bordered by water, G = weight given to pixels initially bordering the main water body, and B = a Boolean character equal to 1 or Ø that indicates whether a pixel borders the main water body. When W = Ø and G = Ø, selection is random except that boundary pixels have a slightly lower probability of disintegrating throughout the simulation because they are assumed to have one side bordered by permanent land. F is calculated for each pixel at each iteration.

Early modeling results (Browder et al. 1985) indicated that the marshland-water interface reaches its maximum in an area when the spatial composition of the marsh is about 5Ø percent land and 5Ø percent water but that the magnitude of maximum interface changes inversely with the weighting factor of the probability function that converts segments of land to water. The strength of the weighting factor is reflected in the spatial distribution of land and water. With increasing weighting factor, the degree of clustering of water pixels is greater and water bodies become larger and less scattered.

We plan to refine and validate our model by measuring and comparing the spatial distribution of land and water in simulated marshes and actual marshes in Louisiana, adjusting model coefficients so that spatial patterns in simulated marshes more nearly approximate those in the actual marshes, and placing actual marshes on disintegration curves (from zero to 100% conversion of land to water) produced from model simulations. The successful matching of model probability functions to patterns of land and water in actual marshes should not only quantify the relationship between magnitude of maximum interface and patterns of land and water in the actual marshes but also confirm the model's prediction that maximum interface always occurs at about 50 percent land loss.

A critical phase of the study is the development of quantitative parameters that are descriptive of the spatial distribution of land and water. The development and testing of such parameters has been a major activity of the NMFS team for the past six months. Software development to measure both marshland-water interface and the parameters describing land and water parameters has been the major activity at LSU during its three months of involvement (since September).

NMFS Activities

The behavior of the model was tested beyond the limits of the original tests discussed in the proposal by extending the weighting factor for sides adjacent to water (W) up to 36 (originally we tested it only through 5). We found that the stage in disintegration at which maximum interface occurs remained around 50 percent (Fig. 1, Table 1), but that maximum interface, expressed as percent maximum possible interface, decreased from about 51 percent at W = 0 (the random case) to 23 percent at W = 36 (Fig. 2, Table 1).

Algorithms were developed to measure spatial patterns. Four parameters which have been implemented are: (1) frequency distribution of water pixels by water-cluster size; (2) frequency distribution of water clusters by size (in terms of water pixels); (3) frequency distribution of water pixels by number of sides bordered by other water pixels; and (4) percent pixels as water by distance from main water body (in terms of pixel row). There are actually two versions of parameters one and two above: one including all water clusters and the other including only those water clusters connected to the main water body.

In early tests with 20 repetitions of the same weighting factor, we found that parameter means appeared to reflect differences in the weighting factor. Means and confidence limits from these early tests are shown in Figures 3 through 6. In these simulations, the marsh size was 20 rows (pixels) by 50 columns (pixels). Pixels on each of the four edges of the marsh could have a maximum of three sides adjacent to water. Parameters were measured when the marsh was 50 percent water.

The frequency distribution of water pixels by water body size is shown for four different weighting factors in Figure 3. When W = 0, the random case, more than half the water pixels are contained in clusters of 1 to 25 water pixels. The number of water pixels contained in clusters of 1 to 25 pixels decreases and the distribution moves to the right as W increases.

The frequency distribution of water pixels in terms of number of sides bordered by other water pixels is shown for weighting factors (W) from 0 to 12 in Figure 5. The number of water pixels bordered on three or four sides by other water pixels increases with increasing weighting factor.

The number of water pixels with distance from a man water body (in pixel lengths, or rows) is shown in Figure 5. With G set at 3, pixels in the first row (the row bordering the main water body) have a higher probability of disintegrating than pixels in the other rows. The result is that the front row has a higher number of water pixels at 50 percent disintegration than do the other rows. When W is increased first to 2 and then to 4, the second row also has a higher number of water pixels than the other rows. Otherwise, the number of water pixels in each row does not differ with distance.

Work Scheduled for December 1985 to June 1986

Further systematic tests of variation in spatial pattern will be conducted the spatial pattern parameters in future weeks. We are presently developing algorithms for measuring spatial autocorrelation. When completed, the algorithms for measuring spatial patterns will be converted to FORTRAN 77 for inclusion in the ELAS software on the FIPS system in Slidell.

Our modeling work to date has been on a Hewlitt Packard 86-B microcomputer. We are rapidly reaching the memory limits of this computer, even though we have not yet expanded the size of the simulated marsh, as we intend to do. In our recent work (beyond that covered by this report), we are interfacing the HP with a Burroughs 6800 minicomputer by transfering files over a modem in order to increase execution speed. Our working unit soon will receive an AT&T Unix-PC microcomputer, which will be dedicated almost exclusively to this project and will give us greater capacity to expand both the size of the marsh and the number of parameters measured.

To summarize, activities in Miami during the next six months will consist of:

- development of techniques for measuring spatial autocorrelation
- measurement of spatial patterns on marshes simulated with alternative weighting factors
- conversion of spatial pattern parameters to FORTRAN 77 for inclusion in ELAS
- conversion of the model program to C for execution on the AT&T Unix microcomputer
- expansion of the size of the simulated marsh (in number of pixels).

LSU Activities

Work performed during the first three months of the project was concentrated in two main areas: (1) activities associated with the start-up of the project, such as meetings with co-investigators and acquisition of magnetic tapes, computer disk packs, topographic maps, and other supplies needed for the project, and (2) work with a contractor to begin some custom modifications of image-processing software required for the project.

Image-processing for the project is being performed at the NASA Slidell Computer Complex, Slidell, Louisiana, where the Southeast Fisheries Center maintains the Fisheries Image Processing System (FIPS). The system consists of a Sperry-Univac V77/600 computer and associated hardware and is equipped with a modified version of the Earth Resources Laboratory

Applcations Software (ELAS) (Graham et al. 1984). ELAS is a FORTRAN-based image-processing package developed by NASA for processing digital data from satellite remote sensors. Software modifications involved adapting existing capabilities in the latest version of ELAS to operate in the FIPS version of ELAS used in this study.

Adaptation of the Water Body (WBOD) Module

The water-body module (WBOD) is designed to categorize a user-specified class—for example, open water—into three classes: open bodies; small, closed bodies; and large, closed bodies. Information tabulated from repeated runs of the module will be used with other ELAS routines to determine the size-frequency distribution of water bodies from Landsat TM images of the Louisiana coastal marshes. Correct operation of the module was verified by running WBOD on a series of test files with known size-frequency distributions of water bodies. The FIPS version of WBOD became fully operational in mid-October.

Adaptation of the Shoreline Length (SLIN) MOdule

Adaptation of the shoreline length (SLIN) module to operate in FIPS has just been completed. The SLIN module will be used to measure the length of the shoreline in land-water images derived from classifications of Landsat TM data. Algorithms that preceded the development of SLIN (Faller 1979) were not symmetrical; that is, the reversal of land and water classes in a given image did not yield the same length measurement (Dow and Pearson 1982). SLIN uses a different algorithm to measure shoreline, avoiding the problem in the older software.

The lengths of boundaries between two adjacent land-cover types, such as land and water, are difficult to measure accurately in raster images. SLIN has a tendency to underestimate or overestimate the true shoreline length in a given area. The magnitude and direction of the bias is related to several factors (Dow and Pearson 1982):

- sizes of the pixels composing the map
- level of reticulation in the shoreline
- preprocessing techniques used to produce the land-water map from Landsat imagery.

Thus, experimental techniques may have to be devised to correct for the biases in shoreline lengths derived from Landsat images of the Mississippi deltaic plain.

Work Scheduled for December 1985 to June 1986

- delivery of the Landsat TM data tapes for the project
- conversion of the Landsat TM data to an ELAS format
- development of an experiment to quantify the magnitude and direction of the biases in shoreline-length measurements derived from the SLIN module
- selection of sample sites in the Mississippi deltaic plain by marsh type (fresh, brackish, salt) and delta lobe, with consideration of cloud cover and quality of the TM imagery
- measurement of percentage area of open water, shoreline lengths, maximum shoreline lengths, and determination of the distribution of water body sizes for each sample site
- analysis of U. S. Fish and Wildlife Service Habitat Maps (Wicker et al. 1980) to determine historical changes in land-water ratios and shoreline lengths between 1956 and 1978.

References

Browder, J. A., H. A. Bartley, and K. S. Davis. 1985. A probabilistic model of the relationship between marshland-water interface and marsh disintegration. Ecological Modelling 29: 245-260.

Dow, D. D. 1982. Software programs to measure interface complexity with remote-sensing data, with an example of a marine ecosystem application. NASA Rep. 219. National Aeronautics and Space Administration, Earth Resources Laboratory, National Space Technology Laboratories, NSTL, MS, 25 pp.

Dow, D. D., and R. W. Pearson. 1982. SLIN: a software program to measure interface length. NASA Rep. 208. National Aeronautics and Space Administration, Earth Resources Laboratory, National Space Technology Laboratories, NSTL, MS, 19 pp.

Faller, K. H. 1979. Shoreline as a controlling factor in commercial shrimp production. NASA Rep. TM-72-732. National Aeronautics and Space Administration, Earth Resources Laboratory, National Space Technology Laboratories, NSTL, MS, 33 pp.

Gagliano, S. M., K. J. Meyer-Arendt, and K. M. Wicker. 1981. Land loss in the Mississippi River deltaic plain. Trans. Gulf Coast Assoc. Geol. Soc. 31: 295-300.

Graham, M. H., B. G. Junkin, M. T. Kalcic, R. W. Pearson, and B. R. Seyfarth. 1984. ELAS: Earth Resources Laboratory Applications Software, Volume II, ELAS User's Guide. National Aeronautics and Space Administration, Earth Resources Laboratory, National Space Technology Laboratories, NSTL, MS, 428 pp.

Wicker, K. M., J. B. Johnston, M. W. Young, and R. M. Rogers. 1980. The Mississippi deltaic plain region habitat mapping study. 464 maps. U. S. Fish and Wild. Serv., Office of Biol. Serv. FWS/OBS/79-07.

Zimmerman, R. J., T. J. Minello, and G. Zamora, Jr. 1984. Selection of vegetated habitat by brown shrimp, Penaeus aztecus, in a Galveston Bay salt marsh. U. S. Fish. Bull. 82: 325-336.

Table 1. Means and 95 percent confidence limits of percent land loss at maximum interface and maximum interface expressed as percent maximum possible interface for various weighting factors (W) (G=0, n=20).

W	Percent Land Loss			Maximum Interface (%)		
	LCI	Mean	UCI	LCI	Mean	UCI
0	49.40	50.69	51.98	50.94	51.39	51.85
1	47.55	49.16	50.77	41.41	42.04	42.66
2	46.20	48.08	49.95	37.99	38.71	39.43
3	48.22	50.15	52.08	35.92	36.60	37.29
4	45.57	47.73	49.83	33.80	34.45	35.08
5	49.23	51.36	53.49	33.00	33.58	34.15
6	48.49	50.41	52.32	31.39	31.92	32.45
7	47.61	49.94	52.26	30.79	31.54	32.30
8	46.61	49.51	52.41	30.03	30.60	31.17
9	49.81	52.04	54.27	29.45	30.15	30.85
10	45.75	48.20	50.65	29.24	29.86	30.48
11	46.50	48.74	50.38	28.57	29.29	30.02
12	47.08	49.46	51.84	28.16	28.76	29.36
16	46.89	49.17	51.45	26.56	27.31	28.07
20	48.17	50.40	52.62	25.32	25.97	26.62
24	46.55	49.61	52.67	24.91	25.63	26.33
28	47.86	50.67	53.48	23.78	24.47	25.15
32	47.43	49.88	52.33	23.30	23.93	24.56
36	46.55	50.74	54.92	22.34	22.91	23.47

LIST OF FIGURES

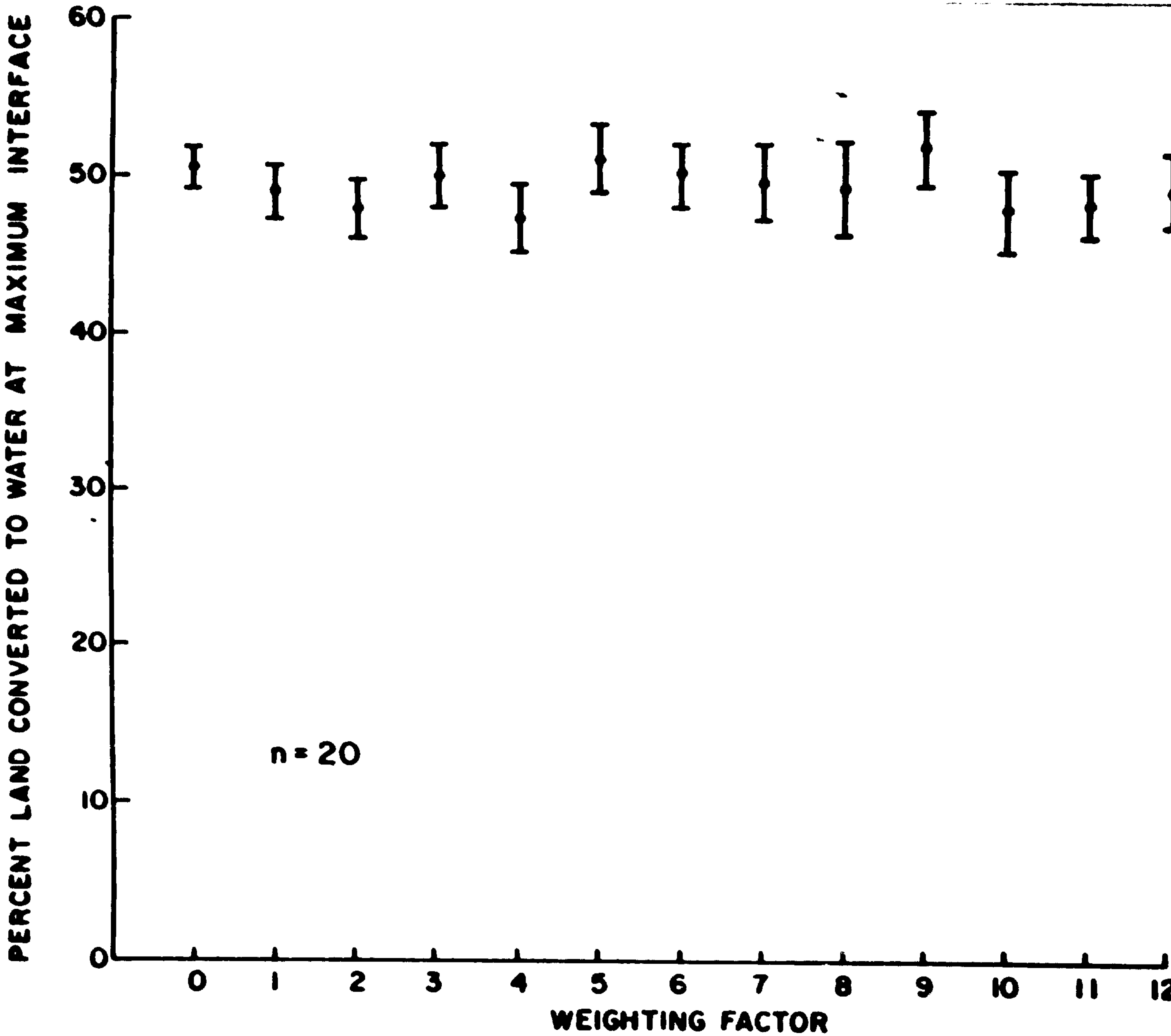

Figure 1. Percent land converted to water at maximum interface versus weighting factor (W). Dot indicates mean and vertical line indicates confidence range (n=20).

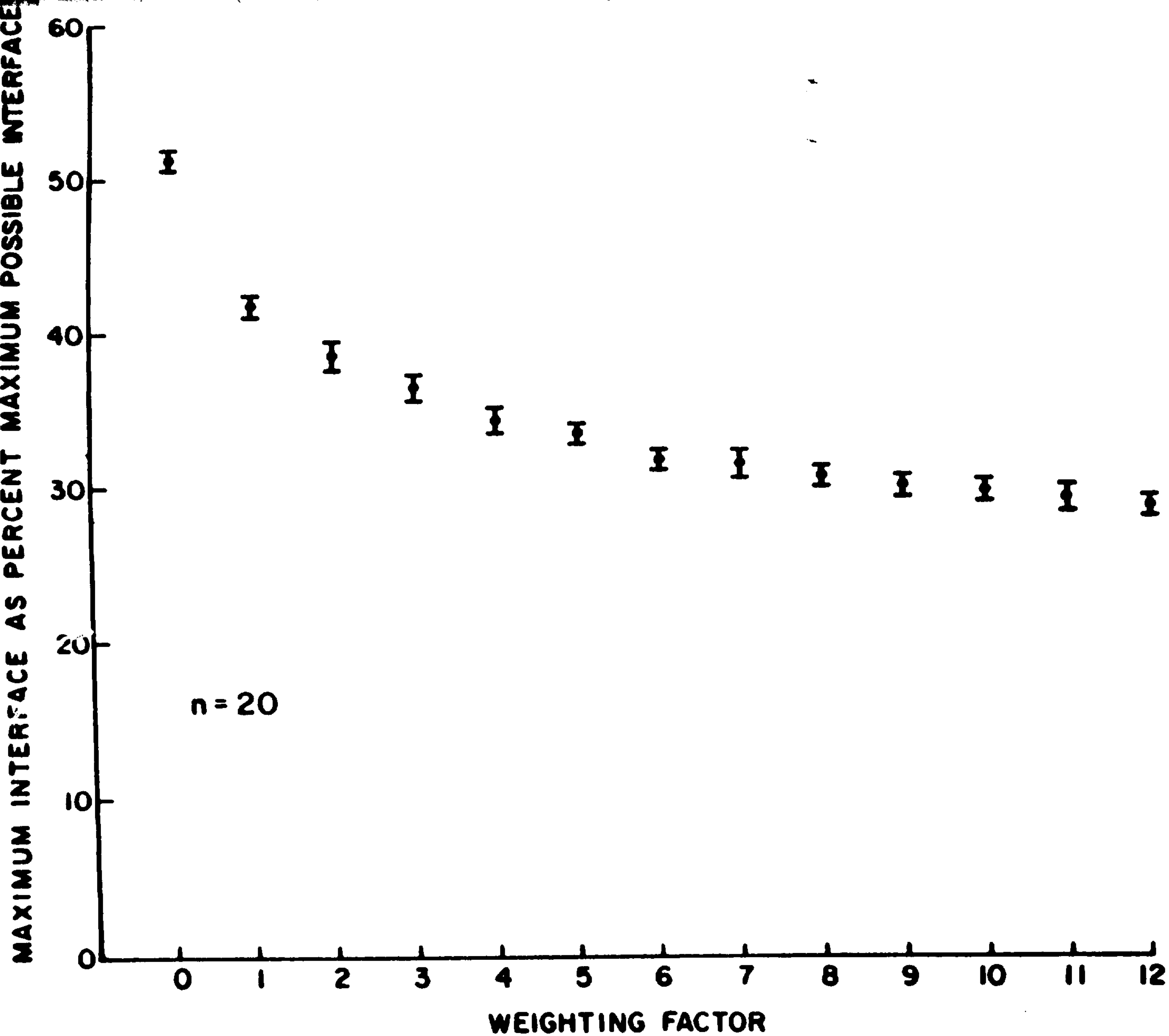

Figure 2. Maximum interface as percent maximum possible interface versus weighting factor (W). Dot indicates mean and vertical line indicates confidence range (n=2Ø).

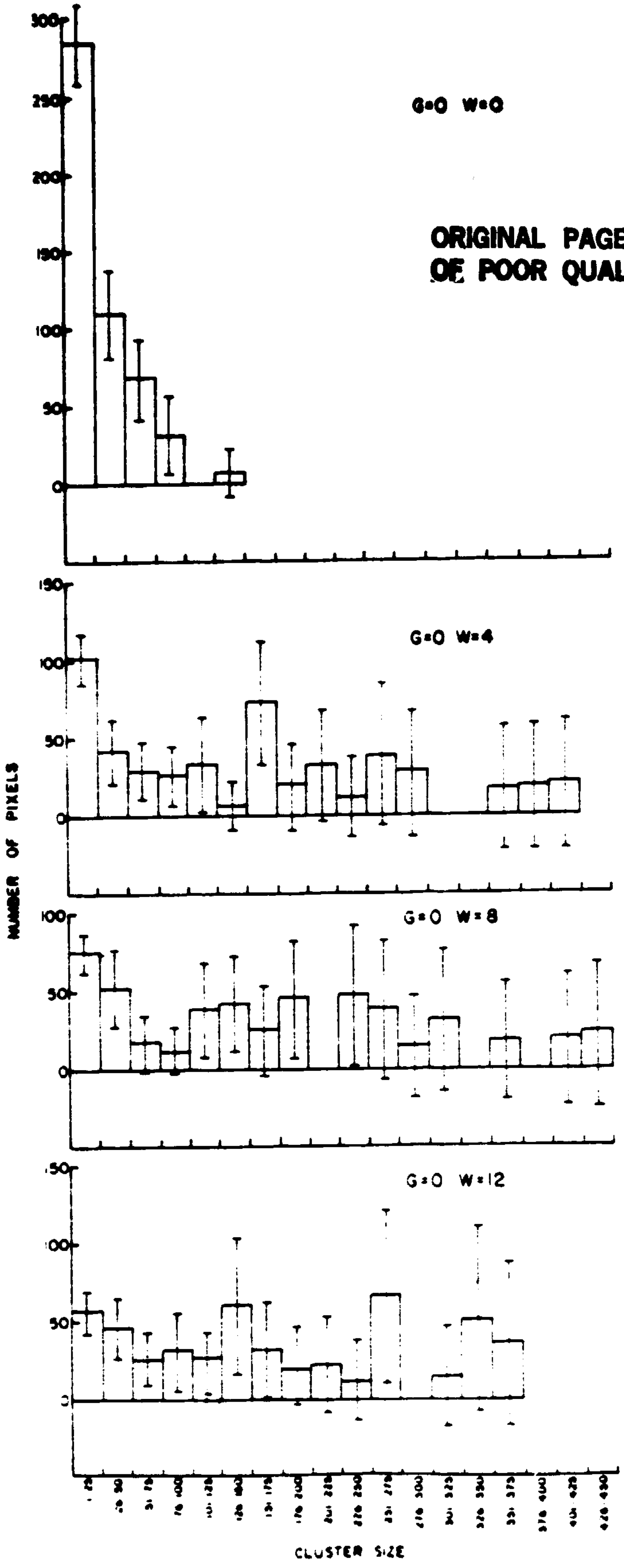

Figure 3. Frequency distribution of water pixels by water cluster size (in terms of number of pixels) at 50 percent disintegration. Top of bar indicates mean and vertical line indicates confidence range (n=20).

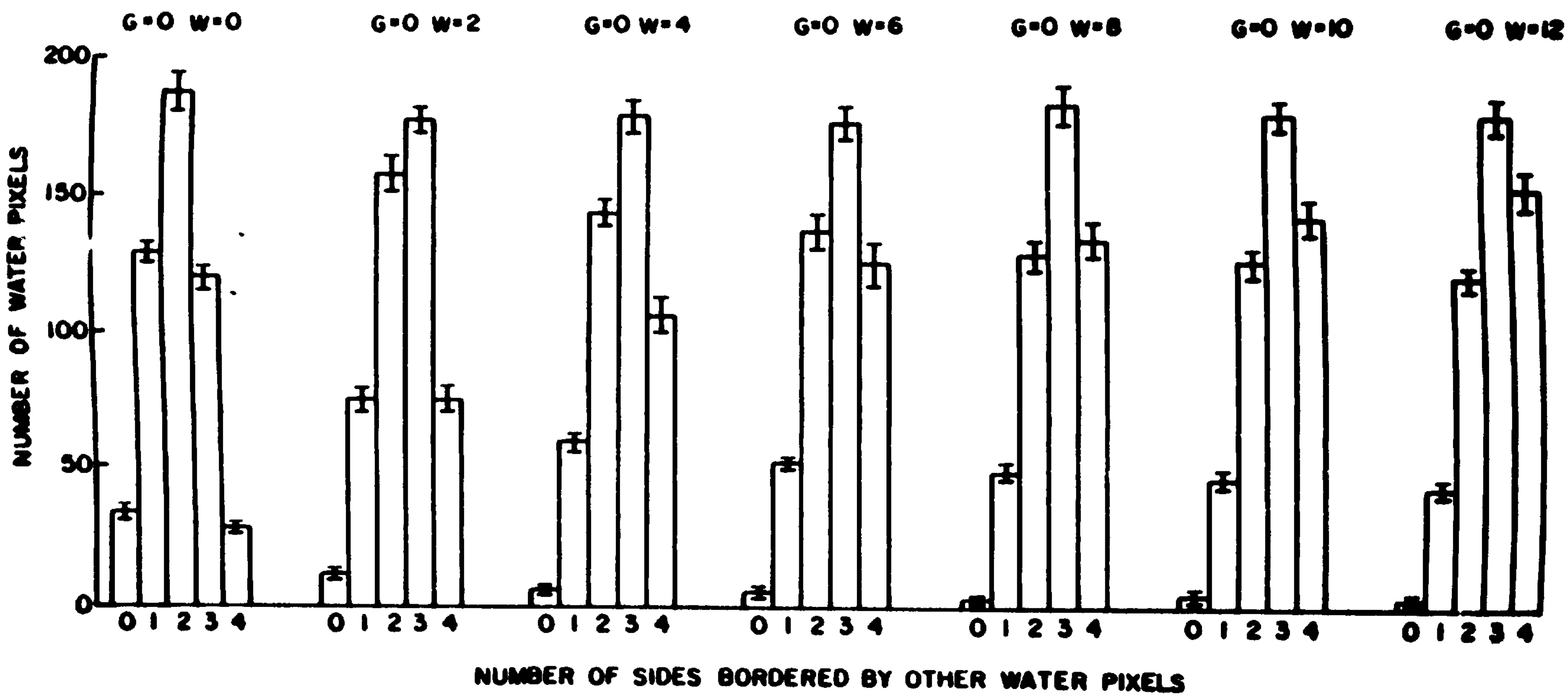

Figure 4. Frequency distribution of water pixels by number of sides bordered by other water pixels at 50 percent disintegration.

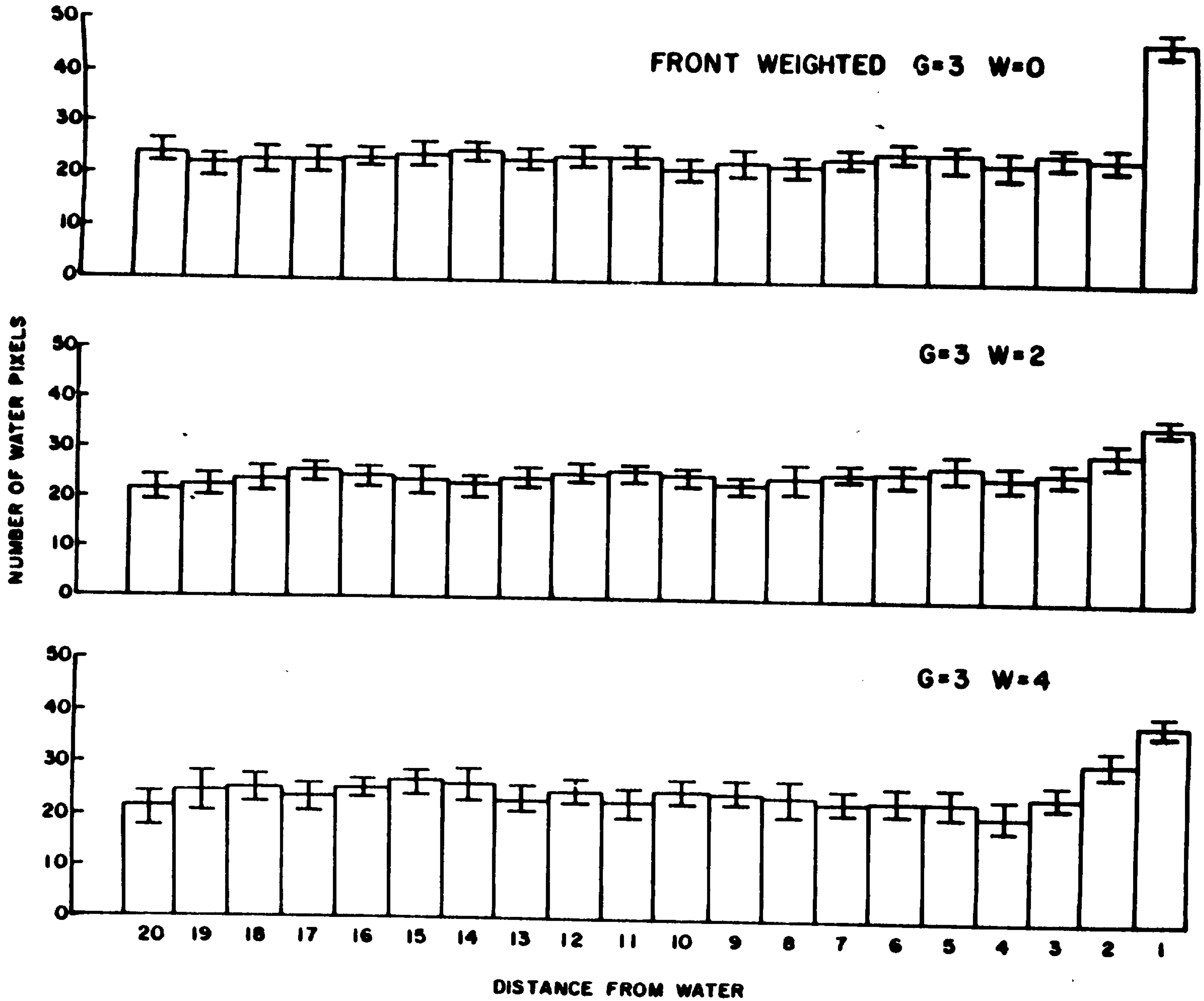

Figure 5. Number of water pixels by distance from water (in pixel lengths, or rows) at 5Ø percent disintegration.