Site: New Bedford
Break: 17.9.2
Other: 5/112

BIOACCUMULATION AND BIOLOGICAL EFFECTS OF PCBs ON MARINE BIVALVE MOLLUSCS IN NEW BEDFORD HARBOR, MASSACHUSETTS

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Uptake and bioaccumulation of organic contaminants by marine bivalves are dependent on the bioavailability of specific compounds, the duration of exposure, and the physiological condition of populations. During the past year, we have conducted an extensive field and laboratory program directed at identifying the bioaccumulation and biological effects of PCBs on the mussel Mytilus edulis. These efforts have been directed at determining whether or not PCB uptake and accumulation results in any deleterious effects on energy metabolism and reproduction. An extensive series of chemical analyses for chlorobiphenyls (PCBs) and physiological measurements have been conducted on Mytilus edulis transplants at two stations in Buzzards Bay (Massachusetts) and one station in Nantucket Sound (Massachusetts). For chemical analyses, duplicate samples of pooled individuals were collected on a bi-weekly basis from November 1984 through November 1985 and analyzed for PCBs and PAHs by glass capillary gas chromatography and gas chromatography-mass spectrometry, after alkaline digestion and column chromatographic isolation of specific classes of compounds. During the same time period, physiological measurements (respiration rates, feeding rates, scope for growth, and condition indices) were also conducted.

Mussel transplants in the harbor, positioned at the Hurricane Barrier, show considerable uptake initially and then a gradual stabilization of all individual chlorobiphenyls measured. Concentrations are exceedingly high (10^{-6} g g^{-1} dry weight range), and there appears to be some fluctuation in concentration of some of the chlorobiphenyls during the late spring and summer with a marked decline during autumn, correlated with gametogenesis and spawning activity. Condition indices of mussel transplants at this station are always lower than at other stations, indicative of a reduction in physiological condition; fluctuations in chlorobiphenyl content correlate with these changes in condition index. Rapid uptake followed by stabilization of chlorobiphenyl concentrations were evident in mussels transplanted at both Cleveland Ledge and Nantucket Sound; concentrations at the two stations are similar (maximum concentration = 100 x 10^{-9} g g^{-1} dry weight). Condition indices of mussels at Cleveland Ledge are lower than at Nantucket Sound during the first few months of the study but are equal during the period of gametogenesis and decline after spawning. In all instances, with the exception of the post-spawning period, condition indices of mussels at these two stations are considerably higher than at New Bedford Harbor. Fluctuations in concentrations related to gametogenesis and spawning were also observed at these stations. Other physiological measurements support the trends in condition indices observed among mussels from the three stations.

The composition of the chlorobiphenyl mixture at the New Bedford site is markedly different from that observed at the other sites. For example, chlorobiphenyl IUPAC 23 and IUPAC 95 are present in greater relative

abundance than other chlorobiphenyls measured in animals transplanted to New Bedford Harbor, whereas these two chlorobiphenyls are at intermediate concentrations in mussels from the other two sites. Chlorobiphenyl No. 28 is a trichlorobiphenyl and has a lower K_{ow} (5.69) than several of the other chlorobiphenyls [e.g., No. 95 (6.55), No. 153 (7.75)]. At first inspection, we would not expect No. 28 to be present in such high concentrations relative to No. 153 because of the direct relationship shown by increasing bioconcentration factor with increasing K_{ow}. If we take into account, however, the high concentrations of chlorobiphenyl No. 28 relative to chlorobiphenyl No. 153 in the harbor water, then we conclude that the more important factor controlling concentration in mussels is the relative concentrations of individual chlorobiphenyls, modified to some extent by differences in partitioning between organisms and water, as indicated by differences in K_{ow}. The implications of these findings in assessing the management of contaminated shellfish stocks will be discussed.

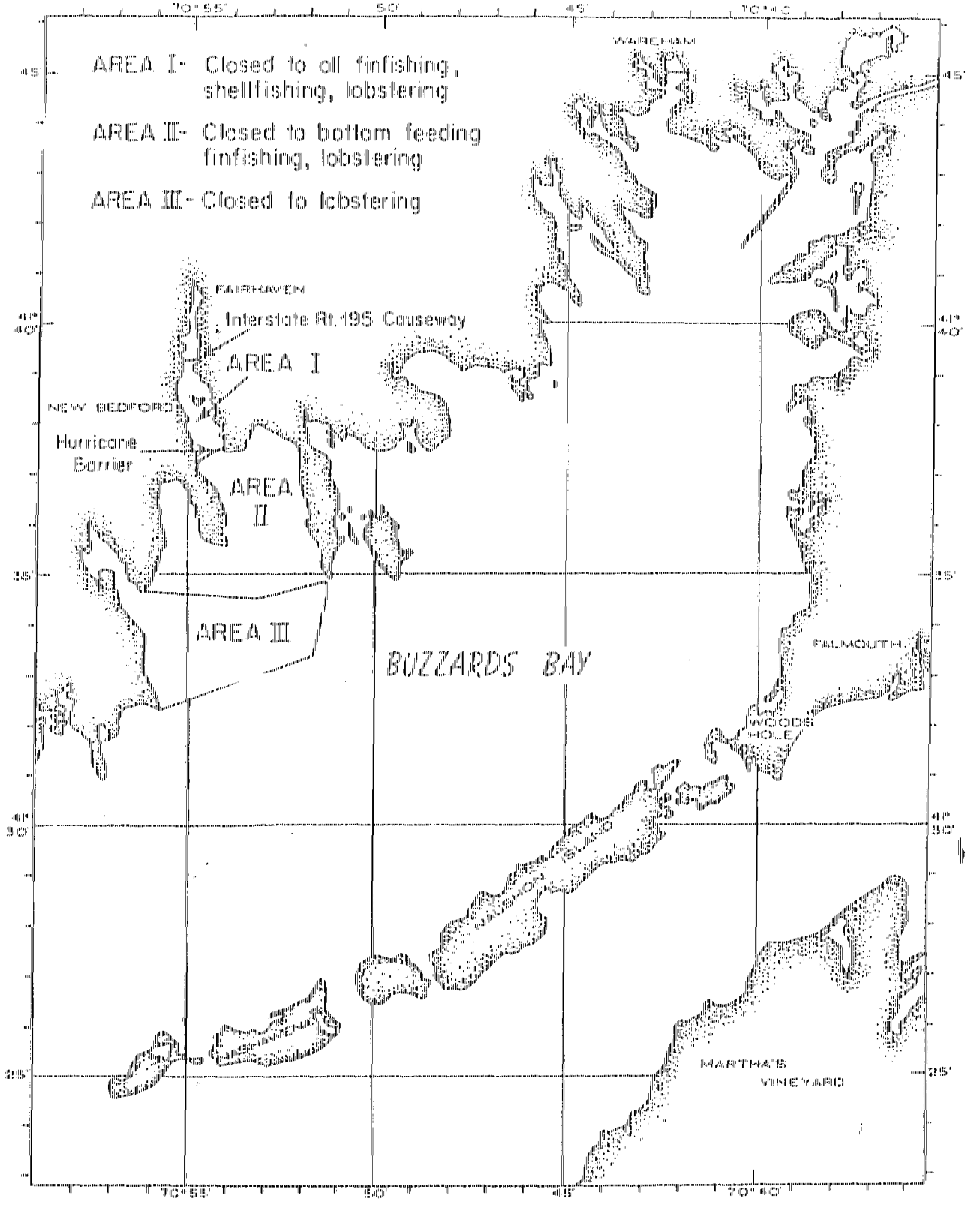

AREA I- Closed to all finfishing, shellfishing, lobstering
AREA II- Closed to bottom feeding finfishing, lobstering
AREA III- Closed to lobstering
70°55'
50'
45'
70°40'
45'
40'
35'
30'
WAREHAM
FAIRHAVEN
Interstate Rt. 195 Causeway
AREA I
NEW BEDFORD
Hurricane Barrier
AREA II
AREA III
BUZZARDS BAY
FALMOUTH
WOODS HOLE
MARTHAS VINEYARD

Table 2. Individual Chlorobiphenyls

IUPAC No.	Chlorine Substitution
8	2,4'
28	2,4,4'
29	2,4,5
44	2,2',3,5'
49	2,2',4,5'
52	2,2',5,5'
60	2,3,4,4'
70	2,3',4',5
85	2,2',3,4,5
87	2,2',3,4,5'
95	2,2',3,5',6
101	2,2',4,5,5'
105	2,3,3',4,4'
110	2,3,3',4',5
118	2,3',4,4',5
128	2,2',3,3',4,4'
129	2,2',3,3',4,5
137	2,2',3,3',6,6'
138	2,2',3,4,4',5
143	2,2',3,4,5,6'
153	2,2',4,4',5,5'
156	2,3,3',4,4',5
180	2,2',3,4,4',5,5'

PCB Conc. in New Bedford Harbor Mussels

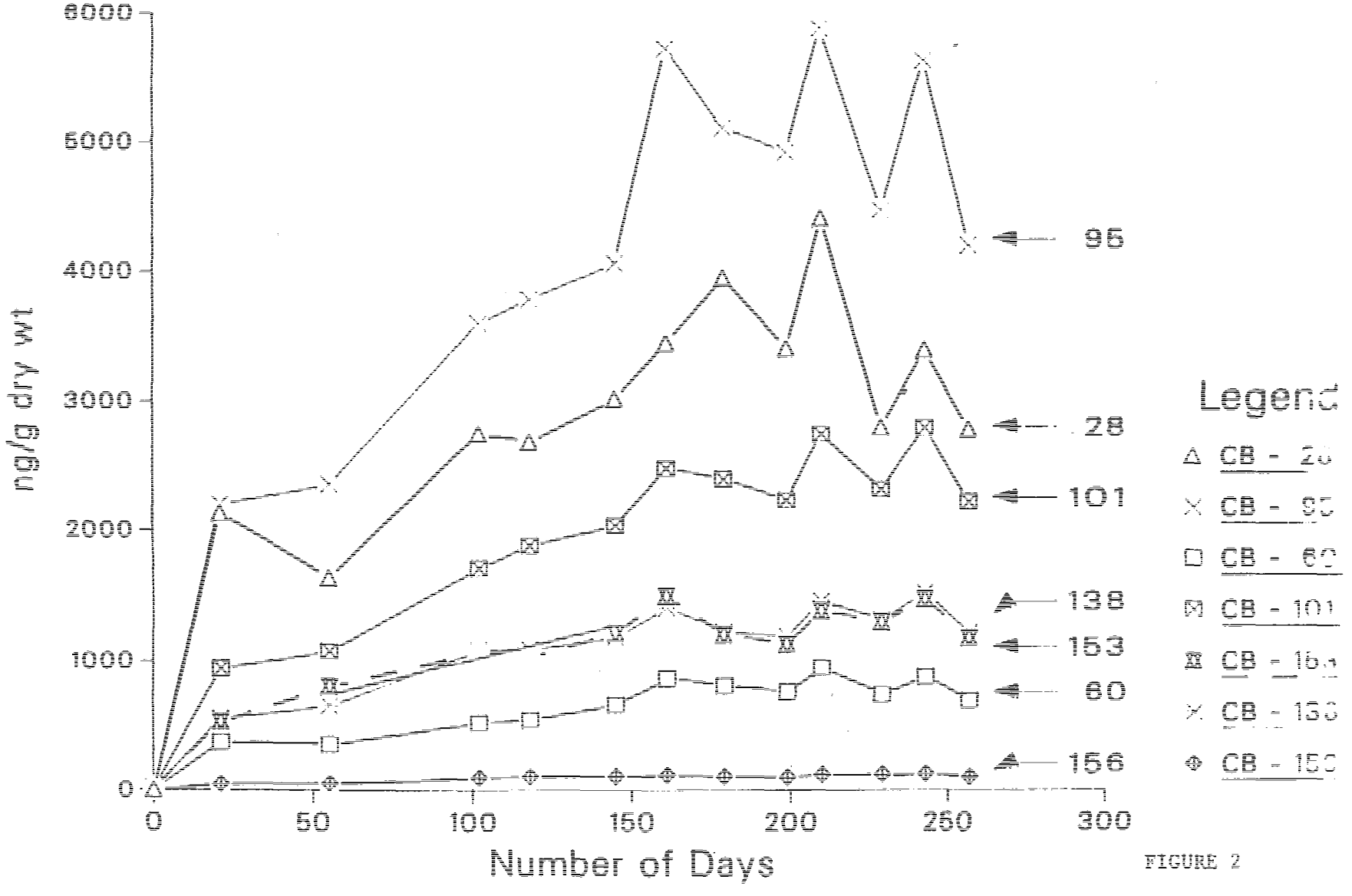


FIGURE 2

PCB Conc. in Cleveland Ledge Mussels

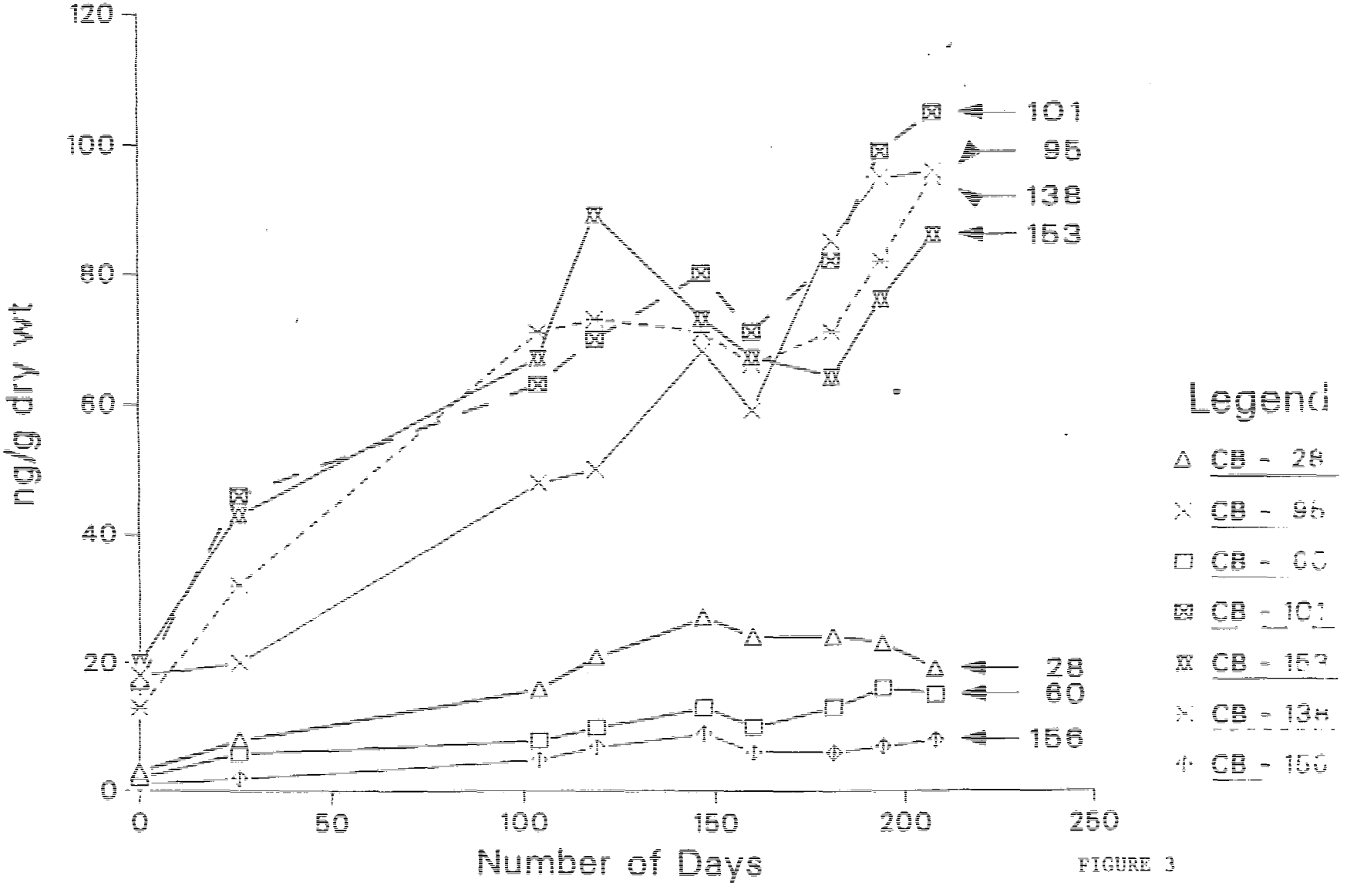


FIGURE 3

PCB Conc. in Vineyard Sound Mussels

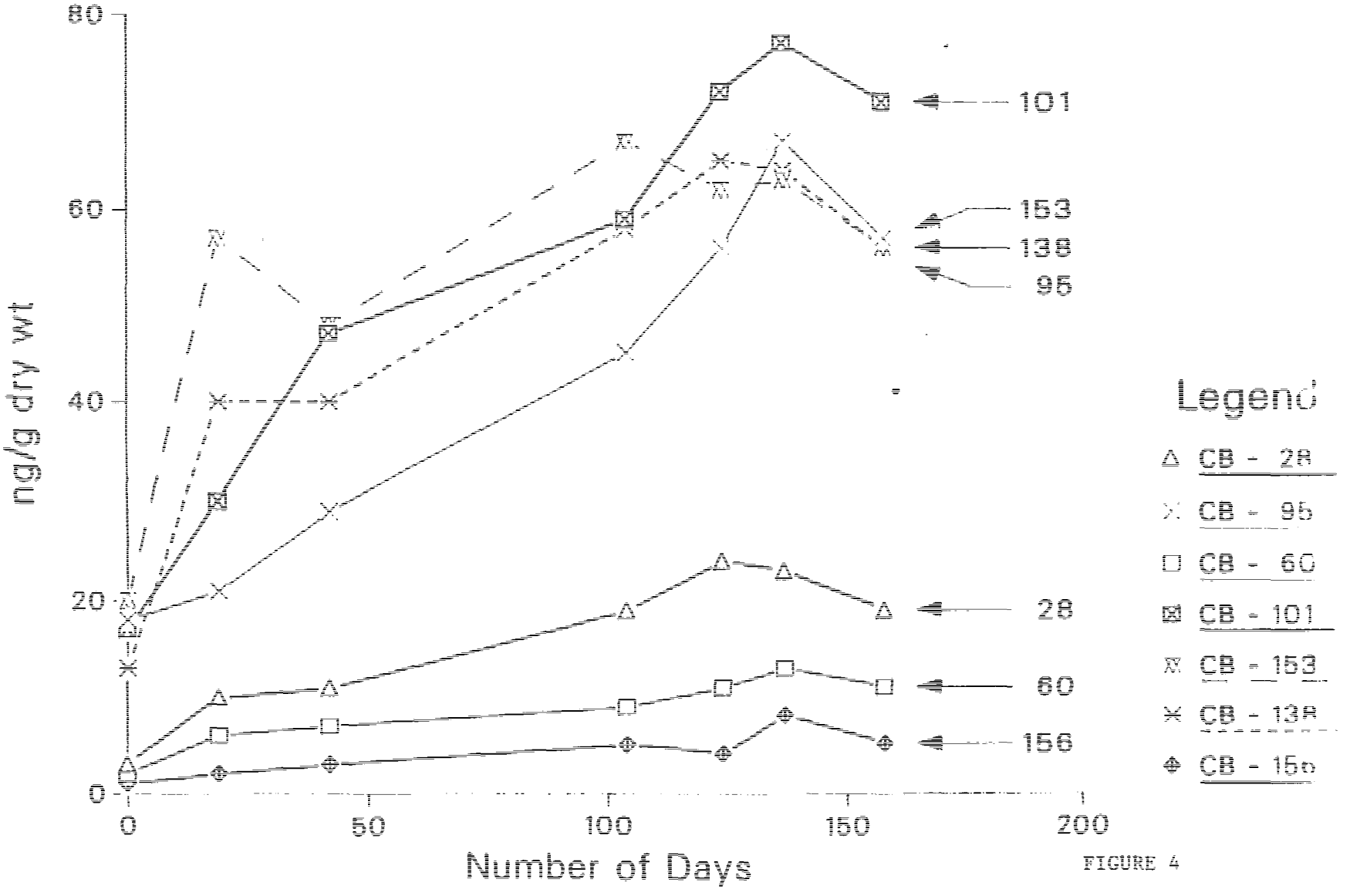
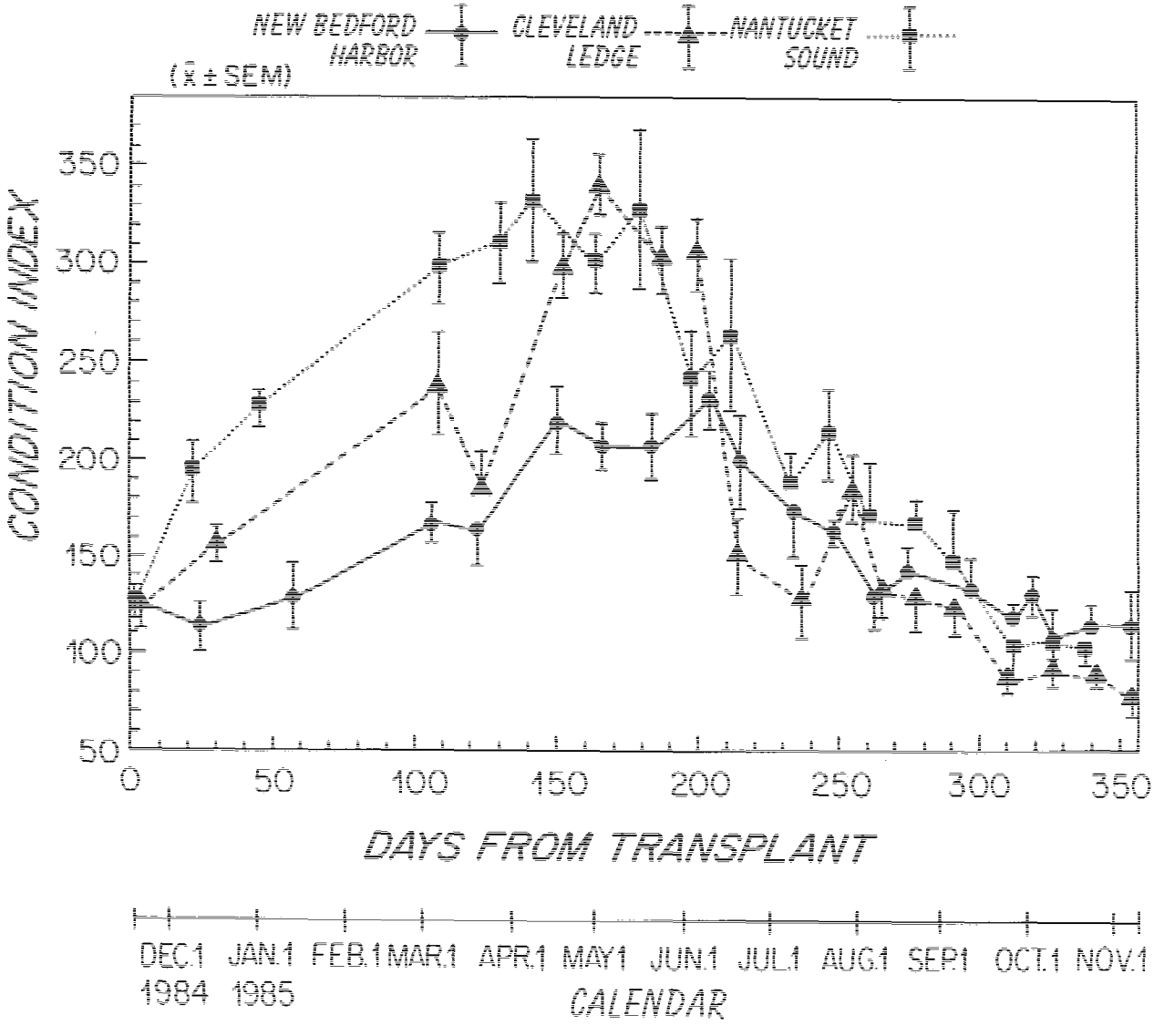


FIGURE 4

CONDITION INDICES OF MUSSELS

FROM TIME OF TRANSPLANT



SCOPE FOR GROWTH
OF MUSSELS AT TRANSPLANT SITES