RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No.1803
(D.c.9)

ICNAF Res.Doc.67/25

ANNUAL MEETING - JUNE 1967

SEASONAL AND AREAL DISTRIBUTIONS OF ZOOPLANKTON IN COASTAL WATERS OF THE GULF OF MAINE, 1965 and 1966

by
Kenneth Sherman
U.S. Bureau of Commercial Fisheries
Biological Laboratory
Boothbay Harbor, Maine

Sampling for zooplankton in 1965 and 1966 was similar to the earlier surveys of 1963 and 1964. Four stations were sampled seasonally in each of three Gulf of Maine coastal areas -- western (Cape Ann to Cape Elizabeth), central (Cape Elizabeth to Mt. Desert) and eastern (Mt. Desert to Machias Bay). Station locations and cruise dates are given in Figure 1. Oblique tows of 30 minutes were made with a Gulf III Sampler fitted with monel netting of 0.37 mm apertures.

Nineteen zooplankton groups (taxa) were in the samples. Of these 11 constituted more than 1 percent of the total zooplankton. Six of the groups were holoplanktonic (permanently planktonic) -- copepods, appendicularians, pteropods, euphausiids, cladocerans, and chaetognaths; 5 were meroplanktonic (temporarily planktonic) -- cirriped larvae, decapod larvae, brachyuran zoea, fish eggs, and crustacean eggs. Copepods were the dominant forms in all seasons in both years; they ranged from 97 percent of the total zooplankton in winter to 71 percent in summer, 1965 and 35 percent in summer, 1966.

Nineteen copepod species were in the samples. The dominant species in both years was Calanus finmarchicus; this species represented 71 percent of the total copepods in 1965 and 75 percent in 1966. Mean numbers of C. finmarchicus exceeded 3,000 per 100m^3 per station in each of the years. Four of the commonly occurring species in 1965--C. finmarchicus, Temora longicornis, Centropages typicus, and Pseudocalanus minutus--also were common in 1966. The remaining species, Metridia lucens, was among the less numerous species in 1966. Two additional copepods, Oithona similis and Acartia longiremis, were among the common species in 1966. Along the coast numbers of copepods generally decreased eastward in spring, summer, and fall. Notable exceptions were concentrations of C. finmarchicus in the central area in spring 1965, and T. longicornis in the eastern area in summer 1966. During winter the numbers of copepods were at an annual low and distributions were variable. The greatest concentration encountered in winter was of C. finmarchicus in the central area in 1965.

Zooplankton volumes

Zooplankton volumes in 1965 and 1966 showed similar seasonal trends in abundance in the western and eastern areas of the Gulf (fig. 2). Volumes in the west increased from a winter low to a summer high and declined in fall. In the east volumes were low (<2.5 cc/100m^3) in all seasons.

Seasonal variations were greatest in the central area; volumes were high in the winter of 1965, but decreased in spring. In contrast, the 1966 volumes increased from a low in winter to an annual high in spring. Volumes decreased from summer to fall in both years. These values are, however, considered as minimal estimates of zooplankton abundance; sampling was done only in daylight in the upper 20 m of water, and relatively large netting (0.37 mm apertures) was used to obtain the larger zooplankton, particularly calanoid copepods.

Differences among the coastal areas were significant in spring, summer, and fall; volumes generally decreased from west to east. The notable exception was in the high volumes in the central area in spring, 1966. Winter volumes were low in 1966 (<3cc/100m^3/station), and differences among the areas were not significant. Volumes in the winter of 1965 were higher in the western area (>3cc/100m^3/station). They reached a particularly high value at a station in the central region (26cc/100m^3). However, the differences in volumes among the areas were not statistically significant.

Annual trends in zooplankton abundance along the coast were similar in 1965 and 1966. Mean-annual volumes for each of the areas declined from a high in the west to an eastern low in both years. Western area volumes were significantly higher than eastern volumes ($P<.001$) in both years. Volumes in the central area were between the western and eastern extremes. The between-year volumes in the central and eastern areas were similar, but volumes in the western area in 1965 were approximately 4 times greater than in 1966 ($P<.01$).

The west to east decline in volumes is a reflection of the general decrease in abundance of copepods along the coast from Cape Ann to Machias Bay. Variations in the abundance of C. finmarchicus, the dominant zooplankter, were responsible for the large between-year differences in volumes in the western Gulf. In summer, when the annual zooplankton volumes were highest, C. finmarchicus was approximately 4 times more numerous in 1965 (ca. 71,000/100m^3/station) than in 1966 (ca. 17,000/100m^3/station). The large seasonal differences in volumes in the central area in 1965 and 1966 were also the result of fluctuations in C. finmarchicus abundance; this species was approximately 4 times more numerous in winter 1965 than in 1966, but in spring 1966, numbers in the central area were approximately 7 times greater than in the previous year.

HYDROGRAPHY AND ZOOPLANKTON

Surface temperatures and salinities varied seasonally among the coastal areas, however, the seasonal trends within each area were similar. Mean temperatures in 1965 and 1966 generally increased from an annual low in winter to a summer high and declined in fall (fig. 3). The single exception was in the eastern area in 1966; mean temperatures increased slightly from summer (8.7°C) to fall (9.0°C). Temperatures in winter were low in each of the areas (<3.0°C). In spring, summer, and fall temperatures decreased from west to east. The range in temperature from winter to summer was greatest in the western area, exceeding values in the eastern region by approximately 5°C.

Seasonal changes in salinity were similar in both years. In the western and central areas mean salinities decreased from an annual high in winter to a low in spring, and underwent a subsequent rise in summer and fall. Salinities in the east decreased from winter to a low in spring, and increased progressively to the annual high in fall. Spring and summer salinities were lower in the western and central areas in 1966, and in the eastern area in 1965.

Areal differences in temperature and salinity along the Gulf coast result from local environmental conditions rather than from large-scale advection of waters. The low temperatures and high salinities of the eastern area from spring through fall are the products of vertical mixing through the water column induced by tidal stirring, and minimal river drainage; higher temperatures and lower salinities of the western region result from increased stability of the water column, reduced tidal mixing, and large-scale river runoff contribution. Profiles of temperature and salinity based on observations made in 1966 corroborate earlier reports of vertical mixing in the eastern Gulf and stratification of water in the western area during the warmer months (fig. 4). In winter, the relatively low temperatures and high salinities in the western and central areas result from wind induced mixing of the water column, and the movement of cold air over the Gulf from the adjacent land mass by the prevailing northwest winds of the season.

The general decrease in zooplankton volumes from west to east along the coast is similar to the areal decline in abundance observed in earlier investigations and appears to be caused by dissimilar hydrography. In the eastern Gulf the unstable water column, low temperatures depressing the growth of crustacean eggs and larvae, and lack of appreciable influx of zooplankton from the north and east lead to minimal conditions for population growth. In contrast the increased stability of the water column, and higher spring and summer temperatures westward provide an increasingly favorable environment for growth and development of zooplankton from Mt. Desert to Cape Ann.

The dominant zooplankter, C. finmarchicus, was more numerous in the western Gulf in 1965 than in 1966. Between-year differences in C. finmarchicus abundance and consequently displacement volumes as well, appear to be related to variations in development of the dominant non-tidal drift along the coast. In periods of low runoff circulation along the western north Atlantic coast is weak; less water is lost to the offshore system, and less water is drawn into the coastal system. In late spring and summer the dominant drift from Cape Elizabeth to Cape Ann is southerly, through the western area. Runoff in 1965 was lower than in 1966; consequently, the flow of non-tidal drift was weakened, and the loss of C. finmarchicus from out of the western area would have been reduced, contributing in part to the between-year differences in zooplankton abundance. A similar difference in C. finmarchicus abundance occurred in 1963 and 1964; C. finmarchicus was more numerous in 1964, when spring runoff was lower than in 1963.

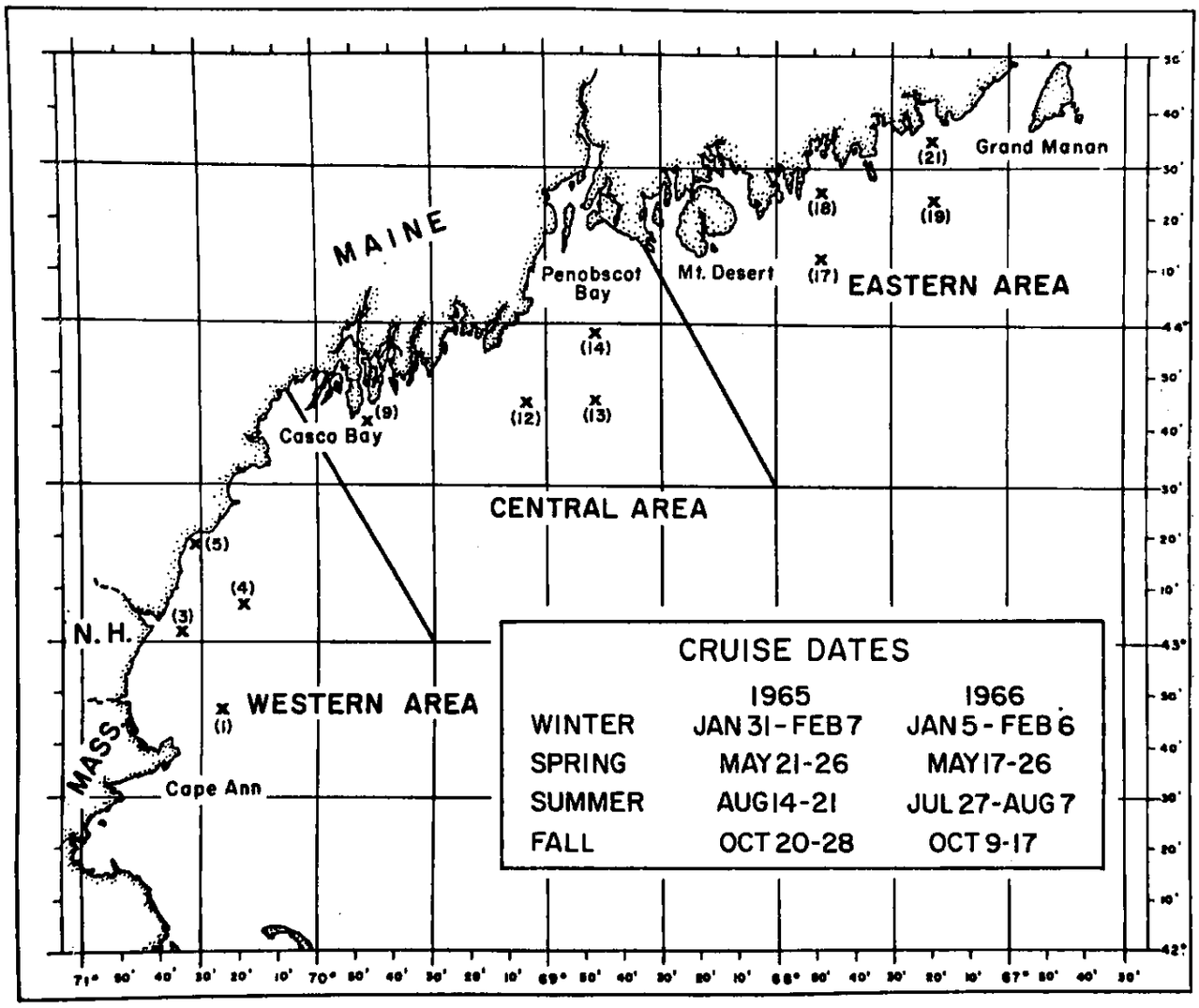

Figure 1. Zooplankton sampling stations, Gulf of Maine coastal waters, 1965 and 1966. Station numbers are shown in parentheses.

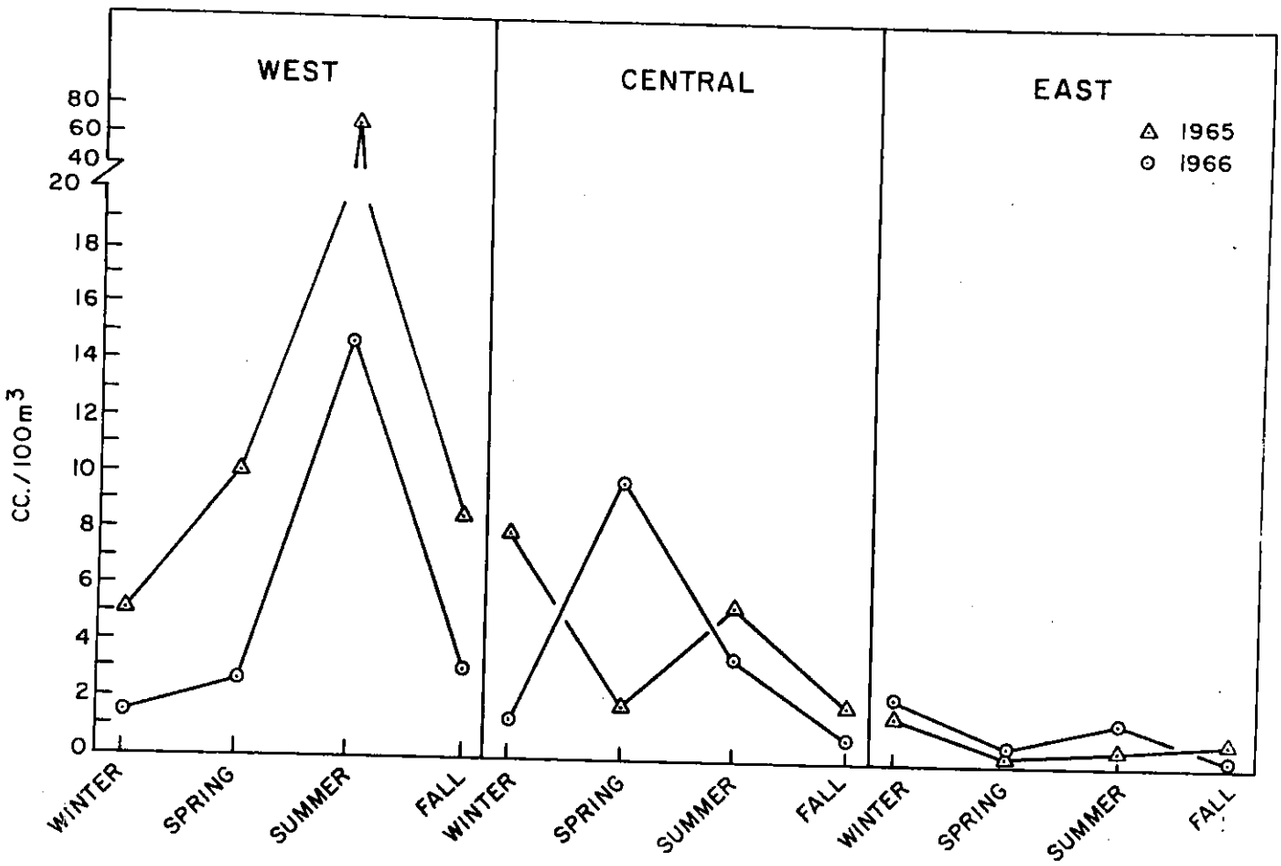

Figure 2. Mean seasonal zooplankton volumes by Gulf of Maine coastal areas in 1965 and 1966.

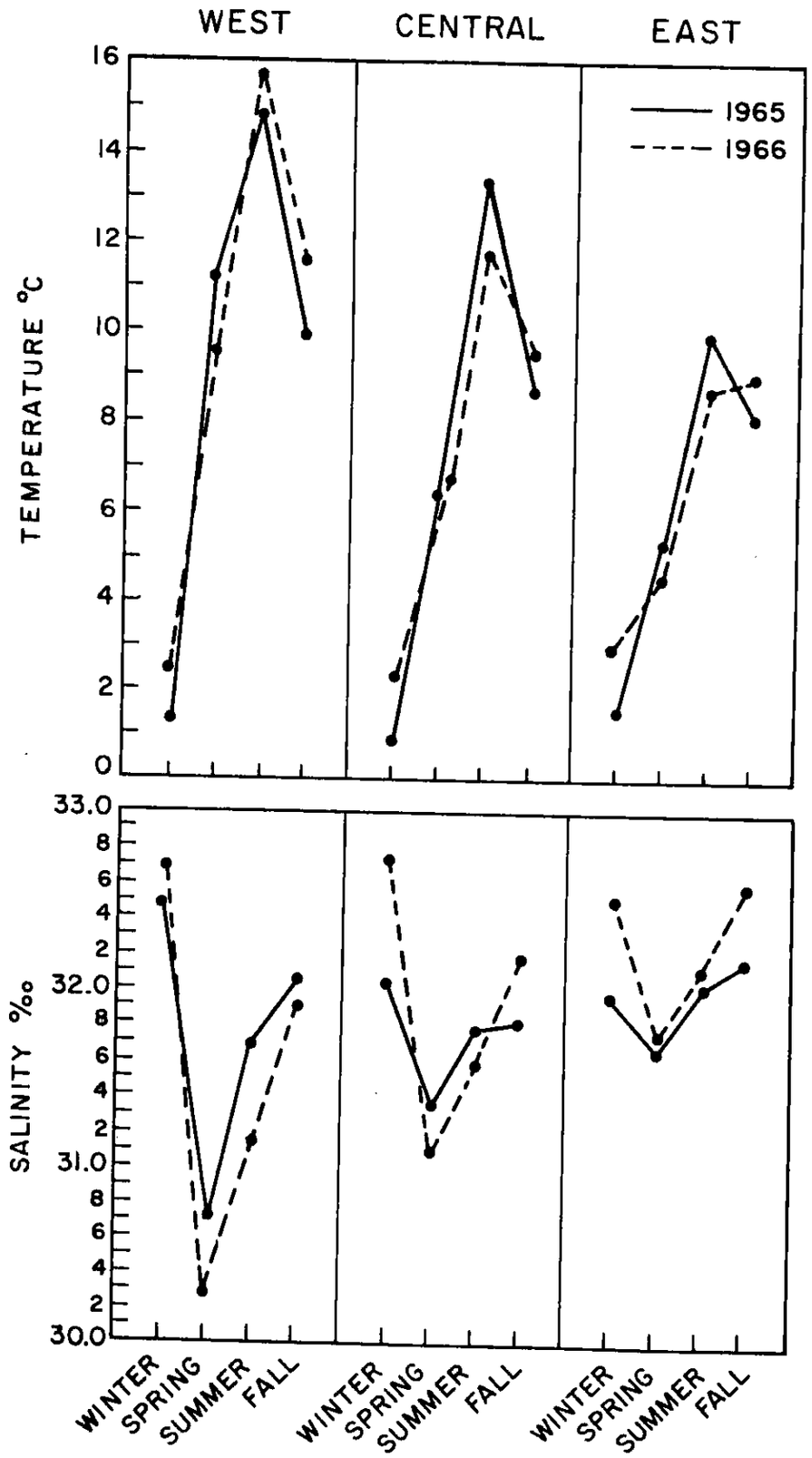

Figure 3. Mean seasonal surface temperature and salinity for the western, central, and eastern areas of the coastal Gulf of Maine in 1965 and 1966.

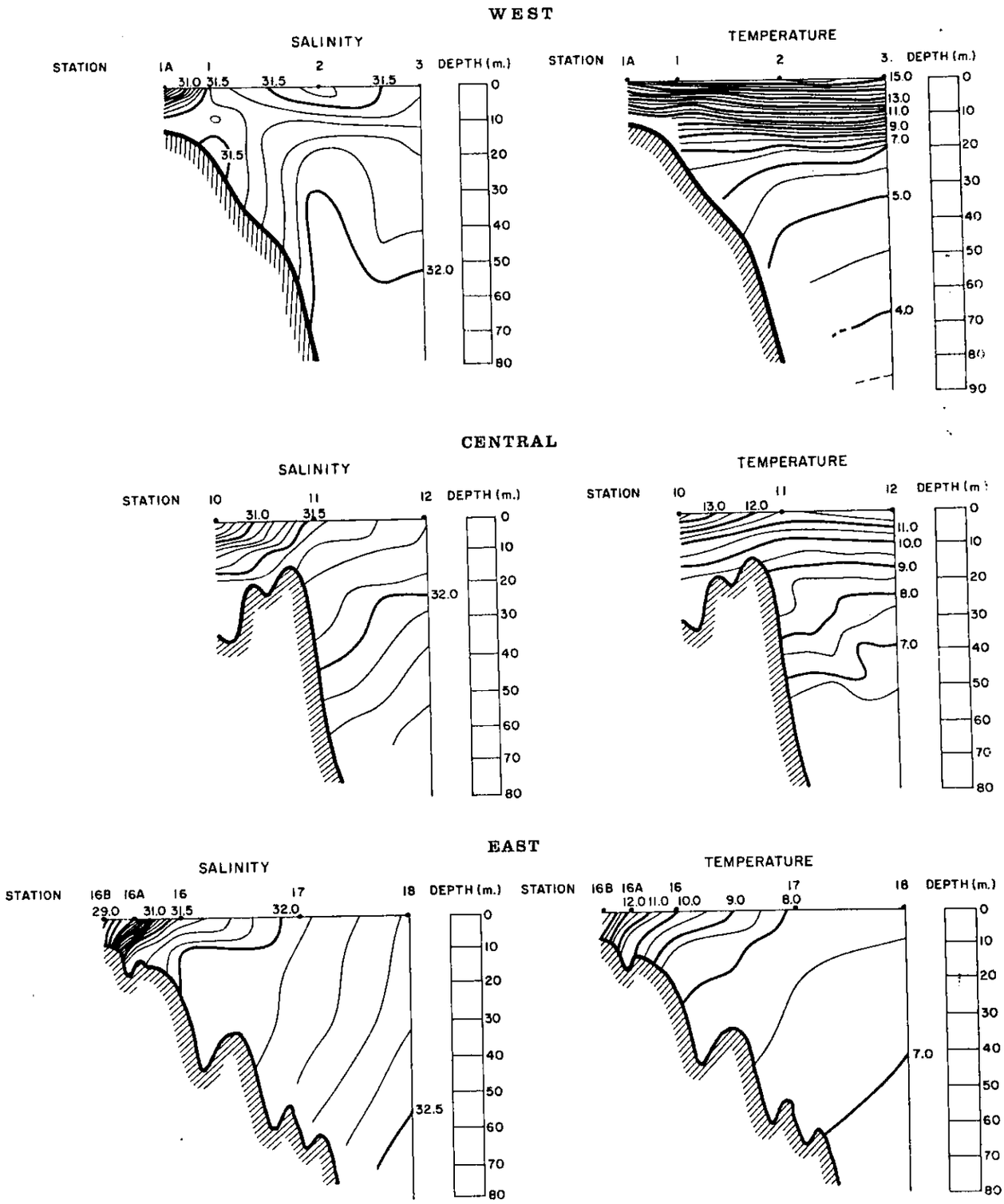

Figure 4. Inshore-offshore vertical profiles of temperature (°C) and salinity (ppt), Gulf of Maine coastal waters, summer 1966.