THE LATE-SUMMER WATERS OF THE GULF OF MEXICO

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After being chased by two hurricanes, "Beulah" and "Fern", BCF's R/V "Geronimo" returned to its home port of Galveston, Texas, on Oct. 8, 1967. It had finished what probably was the most comprehensive hydrographic survey of a sea ever made.

Cruise 16, which began August 14, was the second in a series of hydrographic surveys of the Gulf of Mexico. Each cruise is designed to cover all waters of the Gulf with the goal of describing the sea and determining how th waters and currents change in time.

We occupied 151 hydrographic stations (fi 1) using Nansen bottles with reversing ther mometers at standard depths. A total of 29 bathythermograph casts was made; sample of surface water for salinity determination were drawn at each lowering. Salinity an

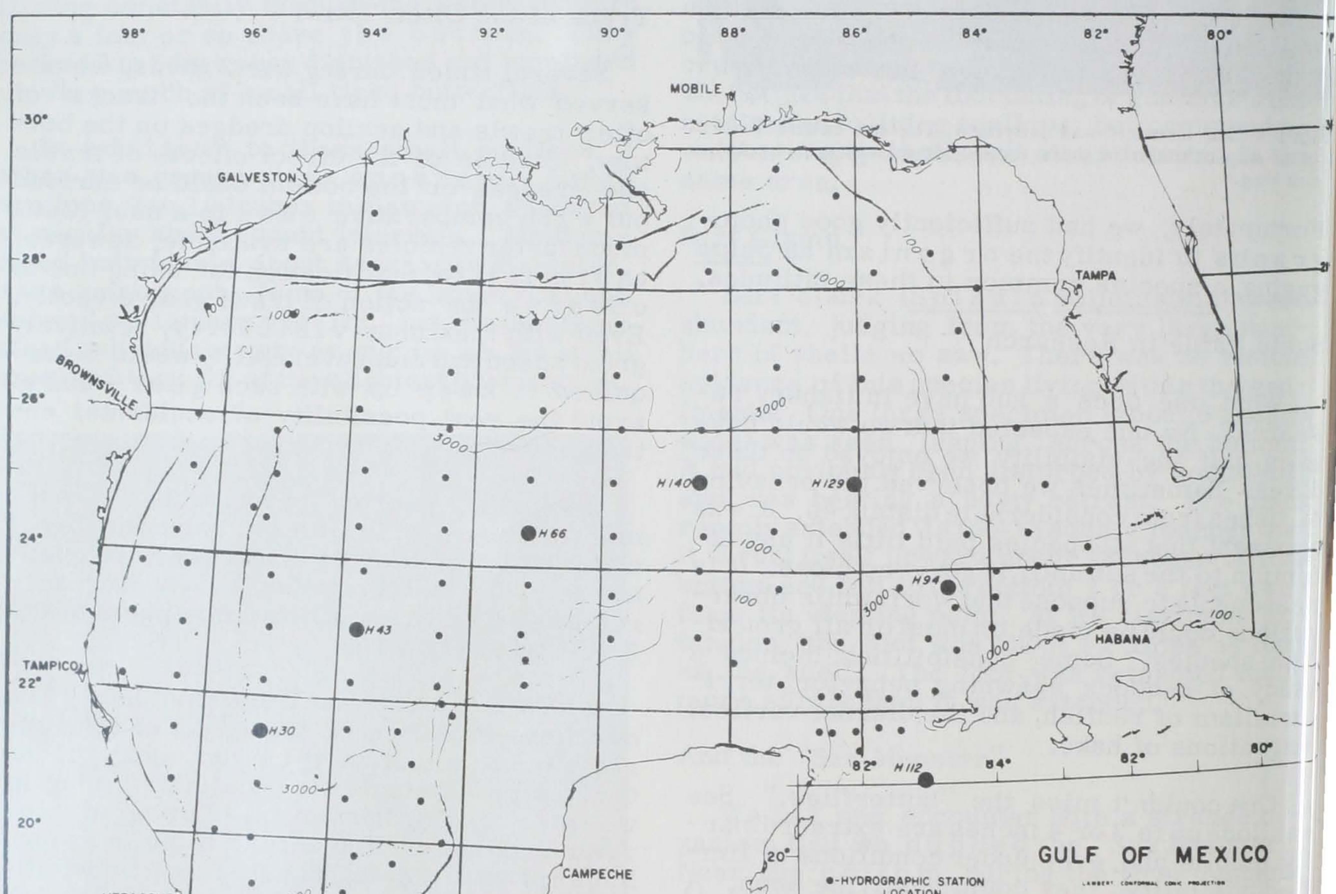

Fig. 1 - Cruise plan for cruise 16, "All Gulf II," of R/V Geronimo, Aug. 14-Oct. 8, 1967. Numbered stations (heavy dots) are u figures 2-4.

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ssolved oxygen analyses were made at sea. dditional water samples were frozen aboard ip and returned to the laboratory for chem- al analyses of phosphates and silicates.

When weather and sea conditions permitted, ertical plankton hauls were made at the hy- rographic stations; 119 zooplankton samples ere collected to a maximum depth of 500 m.; 1 phytoplankton hauls were made to a depth 30 m.

Although the cruise data still are being rocessed, measurements from 7 stations ve been analyzed to depict some major fea- res of the Gulf waters (see fig. 1 for station cations). These stations were selected to scribe the structure of the water in the rthwestern Caribbean before it enters the ulf, and then to trace the water as it flows rough the Yucatan Straits and spreads rough the Gulf. The arc connecting these 7 stations generally represents a line along which the waters spread through the Gulf. The data are presented as vertical profiles of salinity, temperature, and dissolved oxygen for each station.

Six water masses in the Gulf are discernible in the vertical profiles of salinity (fig. 2). Dashed lines connect the cores of the separate water masses. The water masses present in the Gulf of Mexico are:

- Caribbean Surface Water (CSW)--This warm water forms in the Caribbean Sea and moves into the Gulf at the surface. It is characteristically water of relatively low salinity--36.0 to 36.2 parts per thousand (p.p.t.)--and is quickly lost by mixing with the western Gulf surface water (occurs only at stations 112, 94, and 129).

- Western Gulf Surface Water (WGSW)--High evaporation rates in the western Gulf pro-

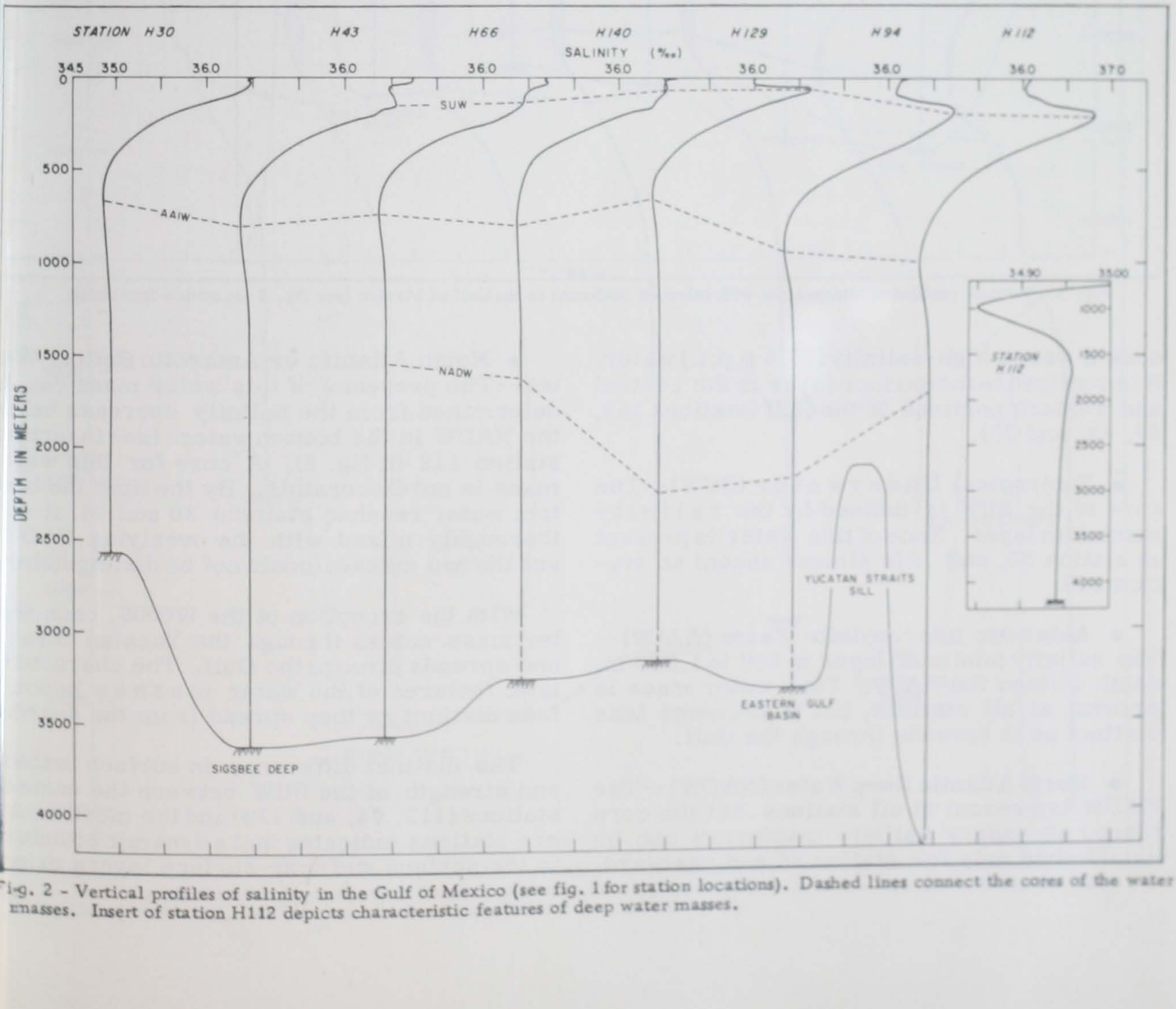

Fig. 2 - Vertical profiles of salinity in the Gulf of Mexico (see fig. 1 for station locations). Dashed lines connect the cores of the water masses. Insert of station H112 depicts characteristic features of deep water masses.

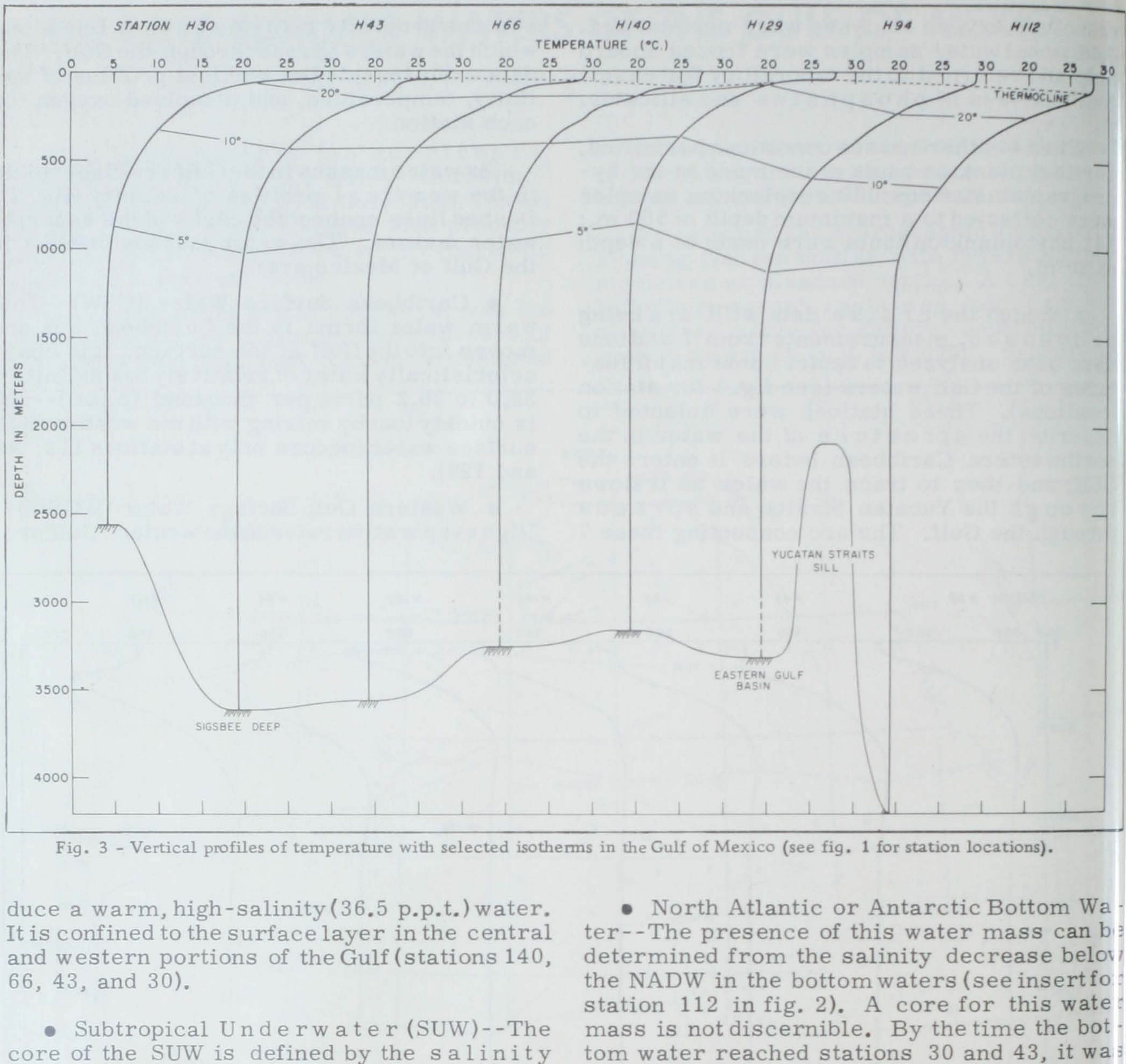

Fig. 3 - Vertical profiles of temperature with selected isotherms in the Gulf of Mexico (see fig. 1 for station locations).

duce a warm, high-salinity (36.5 p.p.t.) water. It is confined to the surface layer in the central and western portions of the Gulf (stations 140, 66, 43, and 30).

• Subtropical Underwater (SUW)--The core of the SUW is defined by the salinity maximum layer. None of this water is present at station 30, and it is almost absent at station 140.

• Antarctic Intermediate Water (AAIW)--The salinity minimum layer at 600 to 1,000 m. depth defines the AAIW. This water mass is present at all stations, but it becomes less distinct as it spreads through the Gulf.

• North Atlantic Deep Water (NADW)--The NADW is present at all stations, but the core (deep, secondary salinity maximum) can be established only for station 66 and eastward.

• North Atlantic or Antarctic Bottom Water--The presence of this water mass can be determined from the salinity decrease below the NADW in the bottom waters (see insert for station 112 in fig. 2). A core for this water mass is not discernible. By the time the bottom water reached stations 30 and 43, it was thoroughly mixed with the overlying NADW, and the two masses could not be distinguished.

With the exception of the WGSW, each water mass enters through the Yucatan Straits and spreads through the Gulf. The characteristic features of the water masses become less distinct as they spread from the source.

The distinct difference in surface waters and strength of the SUW between the eastern stations (112, 94, and 129) and the more western stations indicates that a dynamic boundary in the surface and near-surface layers exists

ːtween stations 129 and 140--that is, the flow rough the Yucatan Straits moves as far west- ard as station 129. Further penetration to e west of these upper waters is much slow- , however, and considerable mixing occurs the water spreads westward.

The rising level of the cores of the SUW d AAIW westward from station 112 to station 9 indicates that the axis of the rapid, north- rd flow into the Gulf from the Caribbean is the east of station 129. The varying thick- ess of the warm, surface water (fig. 3) and e upward slope of the isotherms to the west lso depict these features. In addition, the epths of the isotherms indicate that the warm upper waters are never again as deep in the central and western Gulf as in the Caribbean (station 112) and eastern Gulf (station 94).

The deepening of the NADW after entering the Gulf is probably because of spilling of the deep water over the shallow sill of the Yucatan Straits (at about 2,100 m.). The reason for shoaling of the core depth of the NADW in the western Gulf is unclear, but probably the current regime in the deep waters of the western Gulf is somewhat different from that in the upper layers.

The distribution of dissolved oxygen, expressed in milliliters per liter of sea water,

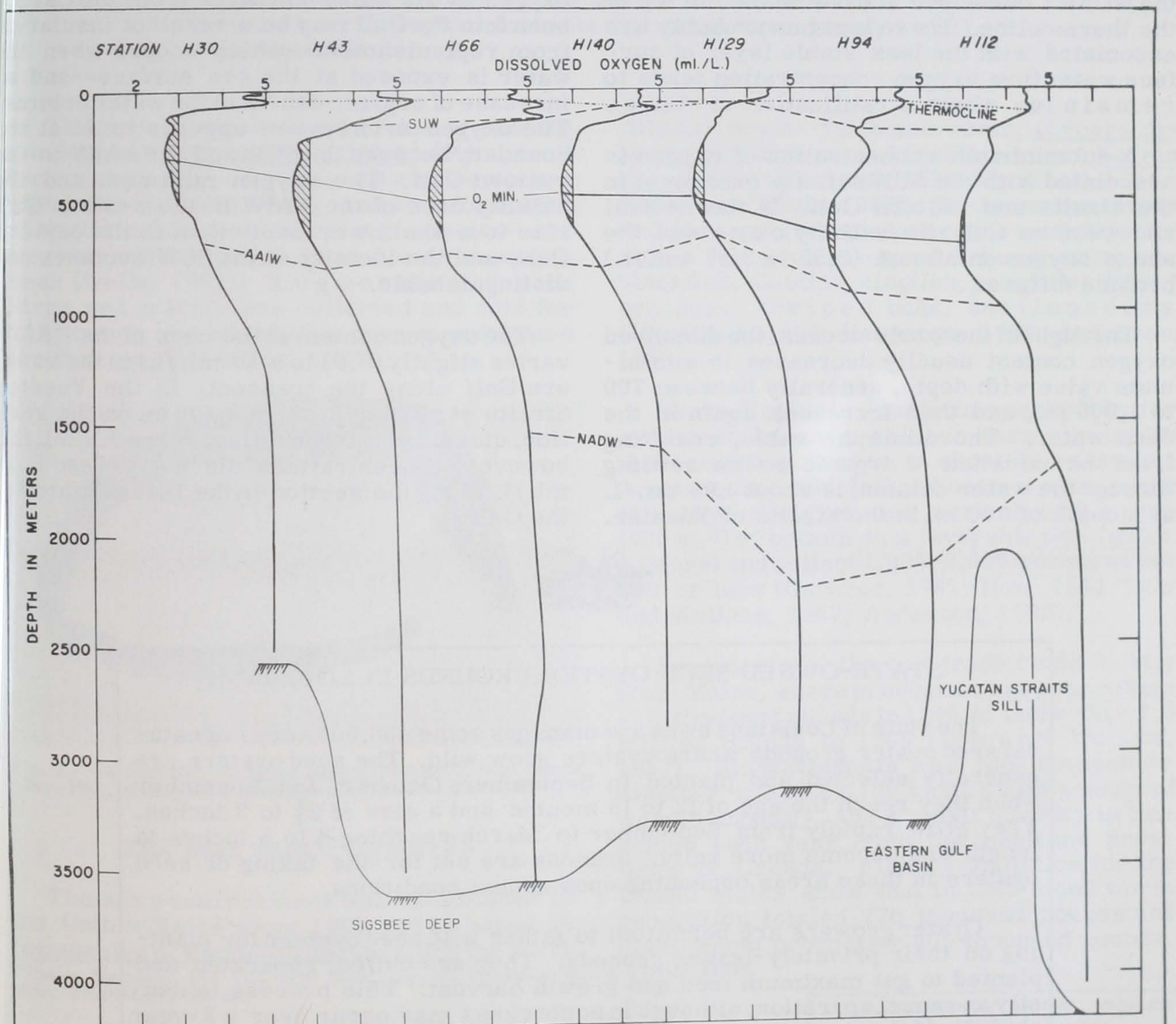

Fig. 4 - Vertical profiles of dissolved oxygen in the Gulf of Mexico showing the oxygen minimum layer (solid line), the top of the thermocline (dotted line), and the cores of water masses (dashed lines--from fig. 2).

is shown at stations along the section from the Yucatan Straits to the western Gulf in vertical profiles (fig. 4). Similar to the conservative properties of salinity and temperature used to characterize a water mass, the dissolved oxygen content (considered a "semiconservative" property) may be a valuable feature in identifying and tracing a water mass.

Along the transect, the surface oxygen--defined as the amount of oxygen in the upper meter of water--shows little variation (4.43 to 4.58 ml./l.) in the CSW and the WGSW. At 100 m., the CSW shows a submaximum oxygen concentration at the thermocline and near the top of the SUW. Two prominent maxima occur in the WGSW: one above and one below the top of the thermocline. These maxima probably are associated with the less stable layer of surface water (low oxygen concentration tends to remain low where stratification is stable).

A subminimum concentration of oxygen is associated with the SUW salinity maximum in the straits and eastern Gulf. In the central and western Gulf, the salinity core and the sharp oxygen minimum (3.52 to 3.57 ml./l.) become diffuse.

Throughout the world oceans, the dissolved oxygen content usually decreases to a minimum value with depth, generally between 700 to 1,000 m., and then increases again in the deep water. The minimum value, resulting from the oxidation of organic matter settling through the water column, is about 2.98 ml./l. at a depth of 700 m. in the straits of Yucatan. In the western Gulf, the depth of the minimum layer rises to 300 m., and the concentration of oxygen decreases to 2.64 ml./l.

As the water passes through the Caribbean and into the Gulf of Mexico, the oxygen content decreases slightly. The oxygen minimum layer in the eastern Gulf coincides with a layer in which water density increases uniformly; this feature is not marked, however, in the western Gulf. The oxygen minimum rises somewhat above the density gradient as the cores of the AAIW and NADW decrease in depth in the western Gulf.

The progressive decrease in dissolved oxygen in the minimum layer from the Caribbean into the Gulf may be a result of insulation from replenishment--which occurs when the water is exposed at the sea surface--and an increase of organic debris in the water column. The oxygen minimum appears to lie at the boundary between the SUW and the AAIW in the eastern Gulf. The oxygen minimum and the salinity core of the AAIW in the western Gulf rise to a shallower depth than in the eastern Gulf, and the identity of the SUW becomes indistinguishable.

The oxygen content at the core of the NADW varies slightly (5.03 to 5.10 ml./l.) in the eastern Gulf along the transect. In the Yucatan Straits at sill depth, about 2,100 m. on the section, dissolved oxygen values were 5.6 ml./l.; however, concentrations did not exceed 5.28 ml./l. along the section in the bottom water of the Gulf.

STATE-OWNED SEED OYSTER GROUNDS IN LOUISIANA

The State of Louisiana owns and manages some 450,000 acres of natural seed oyster grounds where oysters grow wild. The seed oysters are generally selected and planted in September, October, and November when they reach the age of 12 to 16 months and a size of $2\frac{1}{2}$ to 3 inches. They grow rapidly from September to March reaching 4 to 5 inches in length and become more salty. Seasons are set for the taking of seed oysters in these areas depending upon annual conditions.

Oyster growers are permitted to gather wild seed oysters for planting on their privately-leased grounds. They are culled, separated and planted to get maximum food and growth harvest. This process is usually an annual operation, although in some cases may occur over a 2-year period. (Louisiana Conservationist)