

We are able to identify those currents and water masses by their temperature and salinity characteristics.

For instance, the California current, since it originates in northern latitudes, is a cold current. High rainfall and reduced evaporation in north latitudes also keep its salinity relatively low. By monitoring the temperature and salinity characteristics of the ocean waters, we are able to detect changes in current patterns and forecast distribution of the fish associated with these current systems.

For example, the Coast Guard provides monthly flights along the Pacific coast from Seattle to southern California, to enable the Bureau of Sport Fisheries and Wildlife to make aerial infrared measurements of surface temperature patterns. This information is distributed promptly to commercial and sports fishermen.

Albacore distribution in the eastern Pacific was affected by these changes in ocean conditions. Albacore are known to make transpacific migrations. At some stage of life the same fish may be sought by Japanese live-bait fishermen off Japan, Japan long-line fishermen in the west central North Pacific, and sport and commercial fishermen off the west coast of North America. In May and June each year the albacore move from central North Pacific waters into North American coastal waters. When spring warming occurs early in coastal waters, the albacore arrive early. If the coastal waters are warmer than usual, the fish appear farther north. The area of best catches during typical years is off northern California, Oregon, and Washington.

The CHAIRMAN. You say warm year; you are talking about the temperature of the water?

Dr. McHUGH. Yes, sir. I am talking about the years in which the water is warmer along our coast than it normally is.

The CHAIRMAN. It may not go hand in hand then, it may be cold on land and the water may be warm?

Dr. McHUGH. Yes, sir.

The CHAIRMAN. The relationship to the fact that the Japanese current plays a part in this case is why you get tuna fishermen off Alaska as well?

Dr. McHUGH. That is right. Downstream from the California current, variations in the California current extension waters affect the Hawaiian skipjack fishery. We know a little bit more about the causes there. We have discovered that tuna always live in the shaded area labeled California current extension. The boundary between the California current extension, with relatively low salinity, and the North Pacific central water, with relatively high salinity, is well defined by a salinity gradient which usually lies just south of the islands during late autumn and early winter. During February or March it begins a northward movement, passing the islands in spring and reaching its northern position just north of the islands in July or August. The movement of the boundary is reflected in changes of surface salinity which are monitored by regular sampling near Koko Head, Oahu. We can determine pretty accurately when the tuna will be coming. In fact, for the coming year we are forecasting a very poor catch because the salinity started high and it did not look as if the waters would move as far north as it does in most years. Our forecasts have not always been completely accurate but we are looking into the future on how to improve our forecasts and to determine the causes and effects.