

The CHAIRMAN. You are getting a lot more data now, I take it, regarding the quality of the water from a temperature standpoint, and so forth, than you were heretofore?

Dr. McHUGH. Yes, we are conducting many more oceanographic surveys in these areas.

The CHAIRMAN. But the application of this knowledge goes beyond fisheries and gets into the problems of undersea warfare, does it not?

Dr. McHUGH. Yes, indeed.

The CHAIRMAN. So it is this tremendous interest in oceanography and ocean temperatures that you feel are particularly important to many other areas besides resources in the sea.

Dr. McHUGH. Yes, we are working very closely with the Navy and a number of other Government agencies and State agencies, too. We have a very close relationship with the Navy in the Pacific to get information on ocean characteristics from the tuna boats, from our own research vessels, and merchant ships. These are sent in by radio. They are then transmitted back to the Navy and are run into a computer and produced on charts which can then be relayed back. This has helped the Navy also because they are getting information and we are both benefiting.

The CHAIRMAN. Therefore you have a good exchange program with other agencies in the Government.

Dr. McHUGH. We feel we do. And it is very much to their advantage and ours, too.

One other thing I wanted to mention, another rule of thumb, is by fishing around the sea mounts which are so abundant off the coasts of California and Central and South America. Fishermen have known for years that tuna will congregate at times near islands or reefs. Later it was discovered that they also like to gather around sea mounts, which do not reach the surface. The regular navigational charts were not adequate to locate these features on the fishing grounds, so the Bureau developed its own set of charts. These are in great demand by tuna fishermen. Using information gathered by the Navy, too, we have found that some of the differences in tuna abundance are related to the topography of the ocean bottom. These charts have been very helpful and the fishermen say they catch them more easily.

I would like to come back to chart No. 1 which shows the entire ocean. We are now beginning to realize the changes in tuna abundance are not only related to changes taking place in the ocean conditions but also we have to look farther and farther over the horizon, sometimes many thousands of miles away, to try to explain why the ocean changes.

For example, scientific studies recently carried out by the Inter-American Tropical Tuna Commission have shown that the strength and position of the Azores high-pressure cell over the Atlantic Ocean affects precipitation and winds in the eastern tropical Pacific Ocean, which in turn affect ocean circulation and distribution of tuna in the Eastern Pacific. The strength and position of the Azores high also affects upwelling and increases biological productivity off the coast of Africa, with profound effects, no doubt, upon fisheries there also.

In another study it was suggested that the severe flow of warm surface water into coastal Peru where normally cold water was found is related to meteorological and oceanographic processes thousands of