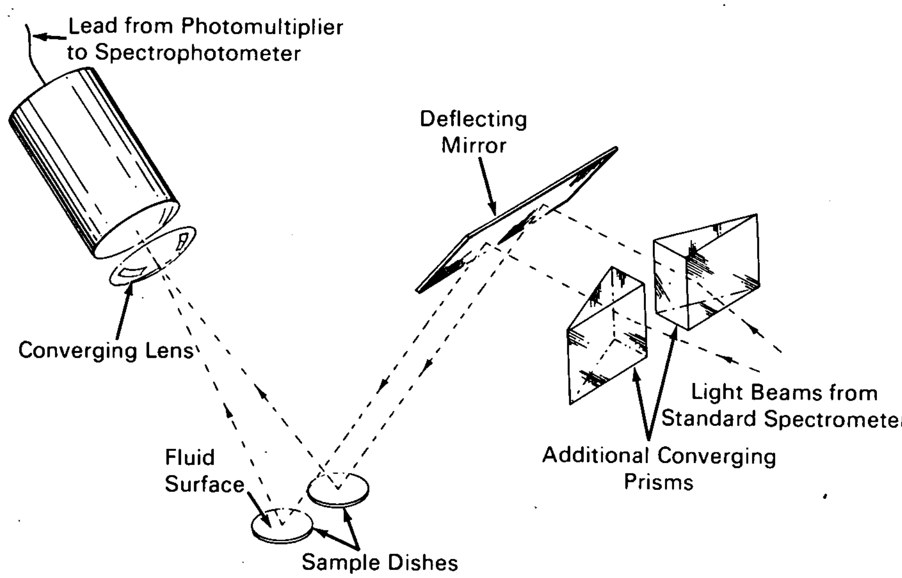
NASA TECH BRIEF

Discrimination of Fish Oil and Mineral Oil Slicks on Sea Water



Dual Beam Reflectance Apparatus

The problem:

Distinguish between fish oil and mineral oil slicks on sea water.

The solution:

Fish oil and mineral oil slicks on sea water can be discriminated by their different spreading characteristics and by their reflectivities and color variations over a range of wavelengths. Mineral oil slicks are easily recognized by their stability and high reflectivity and color variation over the surface of sea water. Fish oil slicks are visible only by virtue of their calming effect on the surface and are therefore more visible at oblique angles of observation.

How it's done:

Laboratory experiments on spreading characteristics of various oils on sea water when the surface was either calm or agitated were carried out. Reflectivities of oil and oil films were determined using a dual beam reflectance apparatus sketched in the drawing. In addition, a field trip investigation was made on the west coast of Florida. Photographs were taken from aircraft of various types of oil and other slicks on the ocean's surface and correlated with the presence of schools of fish in the area. A boat was used to obtain simultaneous information concerning the type of fish and actual size of the schools of fish.

A single drop of test oil was placed on a smooth surface of sea water in a 5 inch diameter dish. Spreading effects were observed with naked eye, a microscope, and a closed circuit T.V. system set to high contrast. The reflectivity of the surface near normal incidence was noted. In other tests, the surface was

(continued overleaf)

agitated to simulate the effects of sea waves on the oil film. Cod liver, herring, menhaden, hake, tuna, and shark liver oils, a mineral oil, and SAE lubricating oil were tested.

Fish oils spread more slowly forming unstable films. On agitation of the sea water, these films broke up to form small lenses on the surface. In this state the reflectivity of the surface near normal incidence was similar to that of water. Mineral oil films formed more readily and were more stable on agitation.

The drawing of the dual beam reflectance apparatus shows that placing a prism in each of the beams from a spectrophotometer allows convergence of the two beams after a pathlength of approximately 11 inches. A mirror deflects the light immediately after it passes through the prisms. The angle of the mirror can be adjusted to give different angles of incidence onto a horizontal fluid surface. A photomultiplier placed in a housing and connected to the spectrophotometer picks up the reflections from the fluid surface. A light-tight box surrounds the equipment built onto the spectrophotometer and eliminates the need for a dark room. Disposable dishes hold the fluid under test and the reference fluid. These dishes are on an incline so that reflection from the bottom of the dish does not strike the photomultiplier. A quartz converging lens placed before the photomultiplier converges the 1.25 inch beam onto the photomultiplier acceptance area which is only 0.5 inch in diameter.

The mirror was set at 30 degrees to the horizontal making the angle of incidence and reflection 30 degrees for the reflectance tests. The tungsten light source was placed in position and the wavelength dial of the spectrophotometer was set to 000. This gave a strong visible beam and made positioning of the dishes and photomultiplier considerably easier.

SAE 30 lubrication oil was used for the reference beam, since this oil was stable and had a higher reflectance than sea water. This reduced the ratio of sample to reference and avoided damage to the spectrophotometer. A wavelength range from 2800 to 4300 Å was employed. The zero reflectance line was traced in each of the tests. Reflectivity versus wavelength was also traced for sea water, oil film on sea water before and after agitation, and the bulk oil.

Mineral oil slicks present no problem for identification and separation from fish-related slicks. At a low observation angle both fish oil and mineral oil slicks may appear the same. As the angle of the observation is increased, however, mineral oil slicks remain easily visible and show considerable structure and color.

The difference in reflectivity between a rough and a smooth sea water surface is greater at larger angles of observation measured from the normal. At normal observation the light from a surface where waves are present is polarized whereas from a calm surface the light is unpolarized.

Dual beam reflectivity measurements showed that at an angle of incidence of 30 degrees the reflectivity of the oils ranged from 1.8 to 2.5 times that of sea water, while at an angle of incidence of 60 degrees the relative reflectivities were smaller. There was little variation of reflectivity with wavelength. Reflectivities of the oil films were lower than those of the bulk materials.

Notes:

1. This information should be of interest to oil companies, the Bureau of Fisheries, and the fishing industry.
2. If observed from an aircraft flying at 3000 feet or higher, large flocks of dark colored ducks on the sea surface form a slick that can readily be confused with a fish-related slick.
3. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference: NASA CR-10466 (N69-21068), The Feasibility of Detection and Classification of Fish Oil Slicks by Remote Sensing.

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