TWO LATEST FISHERY-INDEPENDENT SURVEY TECHNOLOGIES

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Two sea survey instruments were introduced: continuous underway fish egg sampler (CUFES) and an airborne light detecting and ranging (LIDAR) for survey of epiplegic fish. We have used CUFES in ichthyoplankton surveys primarily for Pacific sardine (*Sardinop sagax*) eggs off California since 1996 and it is also being used in many parts of world for sardine and anchovy egg surveys. Our analyses showed that CUFES improved estimates of sardine egg production, a key parameter for spawning biomass. CUFES provided spatial distributions of epipelagic fish eggs with high resolution. The spatial distribution coupled with environment variables, like sea surface temperature demonstrated the dynamics of the adult fish populations .

Our initial experiments and theoretical modeling showed that LIDAR has higher probability of detecting fish schools than visual aerial surveys for anchovy, sardine and herring. Swath width would have little or no effect on the rate schools would be encountered. The proportion of schools that could be detected depends on the LIDAR attenuation coefficient, fish size and reflectivity, the vertical distribution of fish school and the packing density: About half of the schools in typical coastal waters of California (=0.1) would be detected by the LIDAR during the day and about 64% to 84 % during the night, depending on school packing density. A greater proportion

of schools would be detected during the night because small pelagic fishes have a shallow vertical distribution, while in the day schools may extend down to 155 m; and schools below about 40 m depth would not be detectable to the laser. While schools tend to be more diffuse during the night than during the day, even the very diffuse night schools of anchovy (0.5 fish m^{-1}) would be detectable throughout the upper 20 m of the water column with a LIDAR. A greater proportion of sardine schools would be detectable during the night compared to the anchovy in our example because we used a packing density of 4 fish m^{-1} for sardine.