Advanced Technologies and New Capabilities

Improving the accuracy and precision of USGS acoustic fish abundance estimates. The ongoing study focuses on quantifying and correcting potential biases caused by vessel noise and "acoustic dead zones" (ADZs) on fish abundance estimates from echosounders. The ADZs occur near the lakebed and water surface where fisheries echosounders cannot detect fishes (Figure X, shaded regions). Recent studies have shown that engine noise can cause fish to flee the vicinity of a research vessel, causing acoustic-based abundance estimates to be biased low.

In 2021, the USGS contracted Saildrone Corporation to carry out a spatially extensive mission in lakes Michigan and Huron from August 5-September 19 using two remotely helmed uncrewed surface vehicles (USVs; Figure XX insert). The wind powered Saildrone USVs operate almost silently and are therefore well suited to assess the effects of vessel noise on fish abundances. The Saildrones covered 3,613 nautical miles collecting split beam echosounder data continuously (Figure XX). Crewed vessels operated by USGS (*Sturgeon*), US FWS (M/V *Spencer-Baird*, R/V *Smith*), and Michigan DNR (S/V *Steelhead*) met the Saildrone on 15 different nights to gather comparative data to measure bias. These vessels also collected more than 40 midwater trawls in the vicinity of the Saildrone tracks to aid with the apportionment of species to the acoustically detected biomass. The Saildrone and ship acoustic data are currently under analysis by Cornell University.

Over several weeks in late summer 2022 in the Western Arm of Lake Superior, USGS and partners will quantify how the noise and ADZs affect acoustically estimated fish abundances. The data gathered will be used to develop methods for correcting any identified bias in the data. As in 2021, two Saildrone USVs will be deployed to gather comparative data with six crewed vessels operated by the Minnesota and Wisconsin DNRs, Grand Portage and Red Cliff Bands of Lake Superior Chippewa, the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry, and the USGS (Figure X). To enable comparison of fish avoidance of the different vessels, Michigan Technological University has conducted vessel noise profiling of the *Sturgeon*, *Kiyi*, R/V *Arcticus*, *Steelhead*, R/V *Agassis*, and Saildrone using a sensitive microphone array. The capability of Saildrones to improve estimates of rainbow smelt populations in shallow coastal waters will also be evaluated. Finally, the *Kiyi* will also be deploying the Lakehead University Seaspider. This device is lowered to the lakebed and is equipped with two up-looking transducers and is quiet. The Seaspider will provide additional information on how ships and Saildrones influence fish distribution. The ADZs will be investigated using echosounders deployed from an AUV engineered by Monterey Bay Aquarium Research Institute's to quantify fish near the water surface and lakebed. The AUV can be deployed throughout the water column, has up- and down-looking transducers, and is quiet. After the Lake Superior deployment, the MBARI AUV will be deployed in Lake Michigan alongside the *Sturgeon* for additional comparative work.

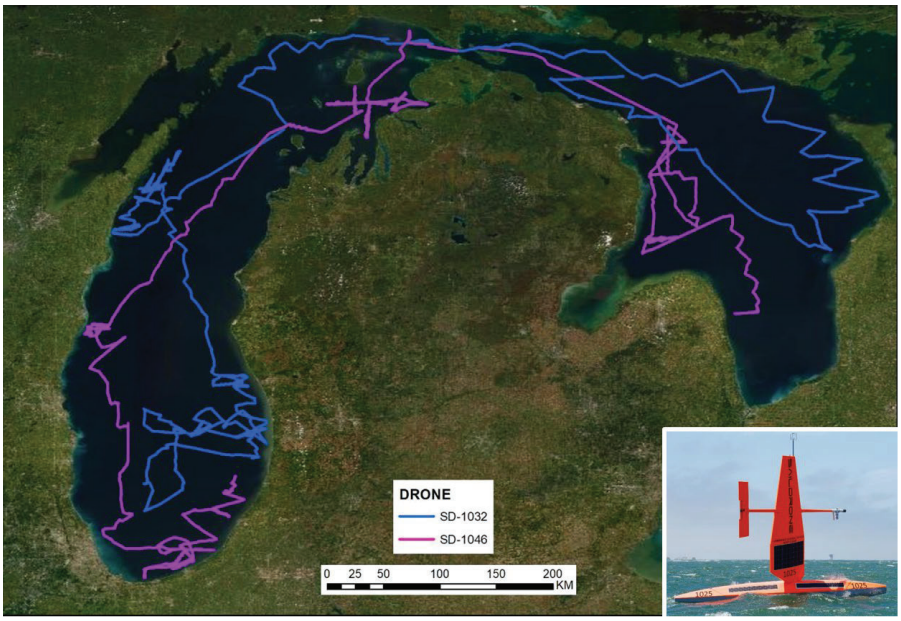

Fig. 15. Two Saildrone Explorer unmanned surface vehicles (inset bottom right), sailed 3,613 nautical miles in Lakes Michigan and Huron in summer 2021. Photo credit: Saildrone, Inc., used with permission.

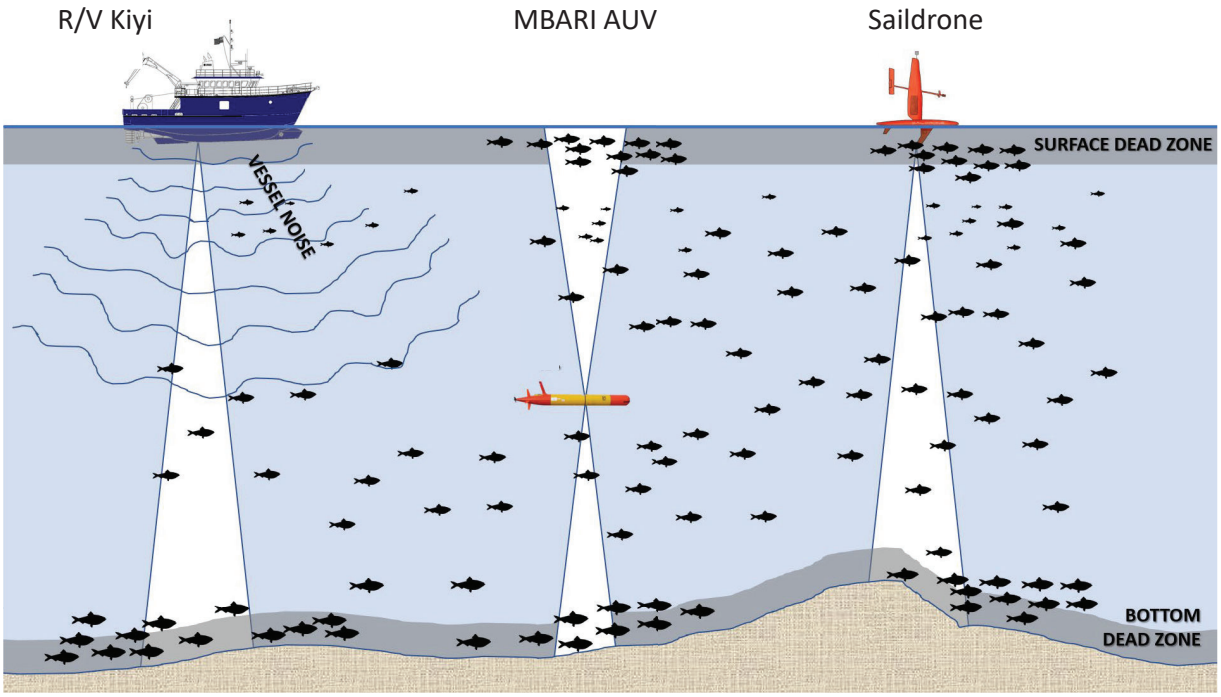

Fig. 16. Proposed gear comparisons to quantify how the noise produced by a vessel may influence fish acoustic data and thus population estimates. Ships operate at the surface, have down-looking transducers, and can be noisy. The Monterey Bay Aquarium Research Institute's (MBARI) AUV can be deployed throughout the water column, has up- and down-looking transducers, and is quiet. Saildrones operate at the surface, have down-looking transducers, and are quiet.