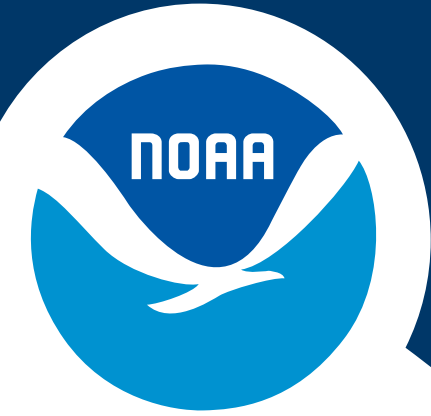


Can a Bottom-moored Echosounder Array Provide a Survey-comparable Index of Abundance?



Alex De Robertis¹, Robert Levine¹, Chris Wilson¹, Scott Furnish¹, Ivar Wangen²

¹Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Seattle, Washington 98115. Alex.DeRobertis@noaa.gov

²Simrad AS, Horten, Norway

Authors at this meeting

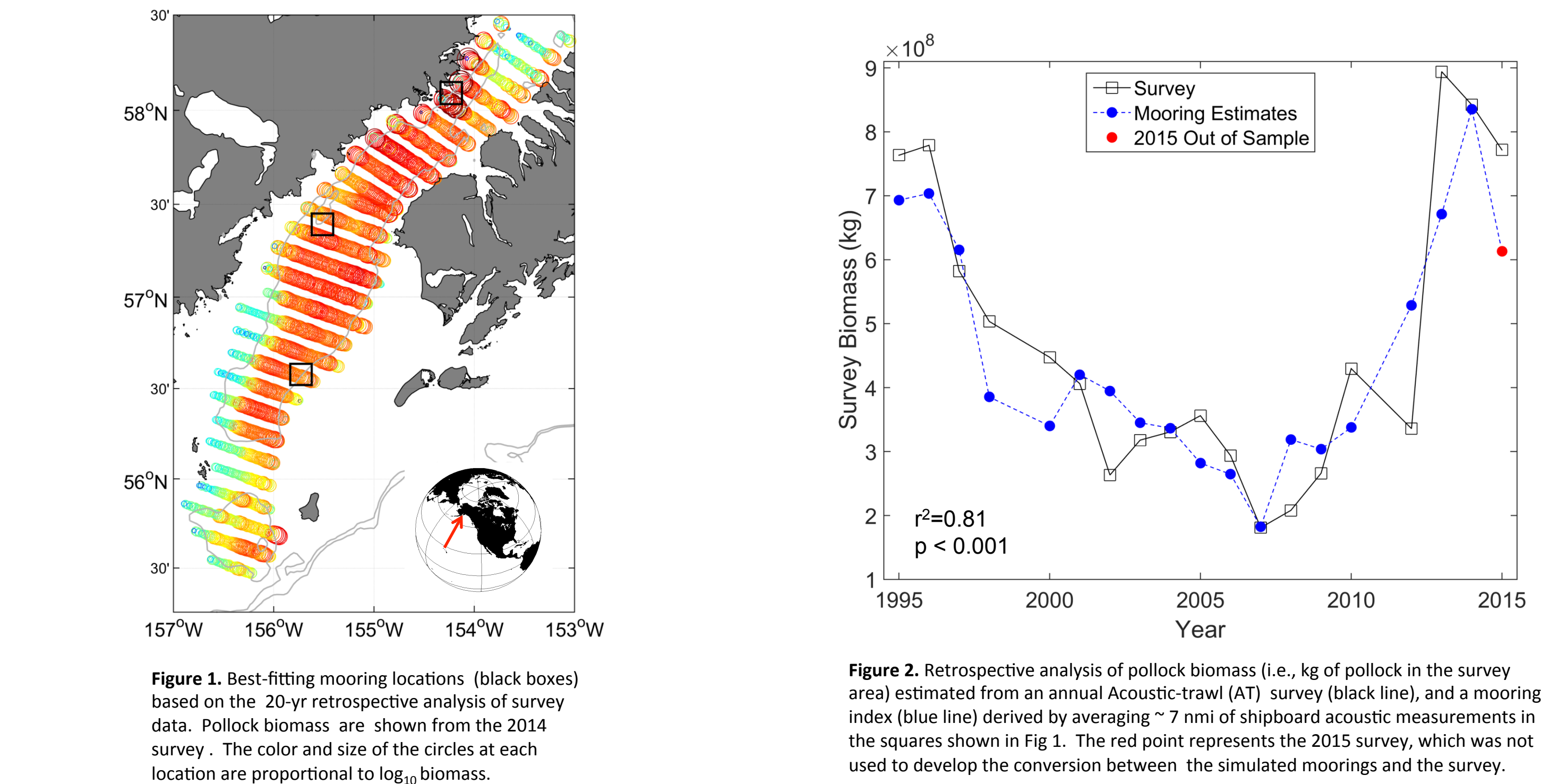


Background

- When fish form recurring spawning aggregations, moored echosounders may produce comparable abundance indices to those from shipboard surveys at a lower cost.
- We deployed 3 trawl-resistant echosounder moorings in Shelikof Strait, Alaska, an important spawning area for walleye pollock.
- The moorings were instrumented with a new 70 kHz split-beam echosounder to measure fish abundance over the spawning season.
- Vessels surveyed mooring sites repeatedly during the 3 month deployment.
- Moorings are scheduled for recovery in May 2015.

I. Can a few moorings measure abundance?

Analysis of 20 years of annual survey data of spawning walleye pollock in Alaska (Fig. 1) indicate that backscatter from as few as three moored echosounders may provide an index of pollock abundance comparable to that produced by a 5600 nmi² survey. (Fig. 2).



Predicting survey biomass from simulated moorings

The survey area was gridded into 7 nmi² cells that were consistently visited on all surveys. Combinations of potential mooring locations were determined using one site from each of 3 strata within the strait (Fig. 3). We used differing amounts of ship data from locations m_1 , m_2 and m_3 to estimate the survey biomass from predicted moorings.

$$\log(BLy) = \log(a s_{A,m1,y} + b s_{A,m2,y} + c s_{A,m3,y} + d)$$

where y represents the year, B_y is the survey biomass, $s_{A,m}$ is the backscatter at mooring site m , and a , b and c and d are fitted parameters. The model was used to predict the biomass in the 2015 survey. Different amounts of survey data were used to represent the s_A observed by the moorings.

Potential mooring locations were identified based on how well they could predict previous survey biomass and historical fishing patterns.

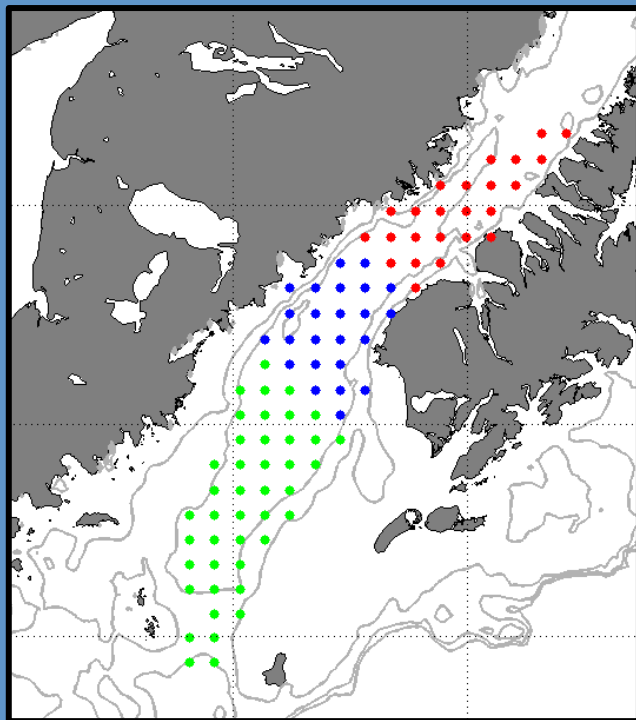


Figure 3. 96 grid cells contained data from all years, and strata were defined for a northern, middle, and southern area of approximately equal biomass.

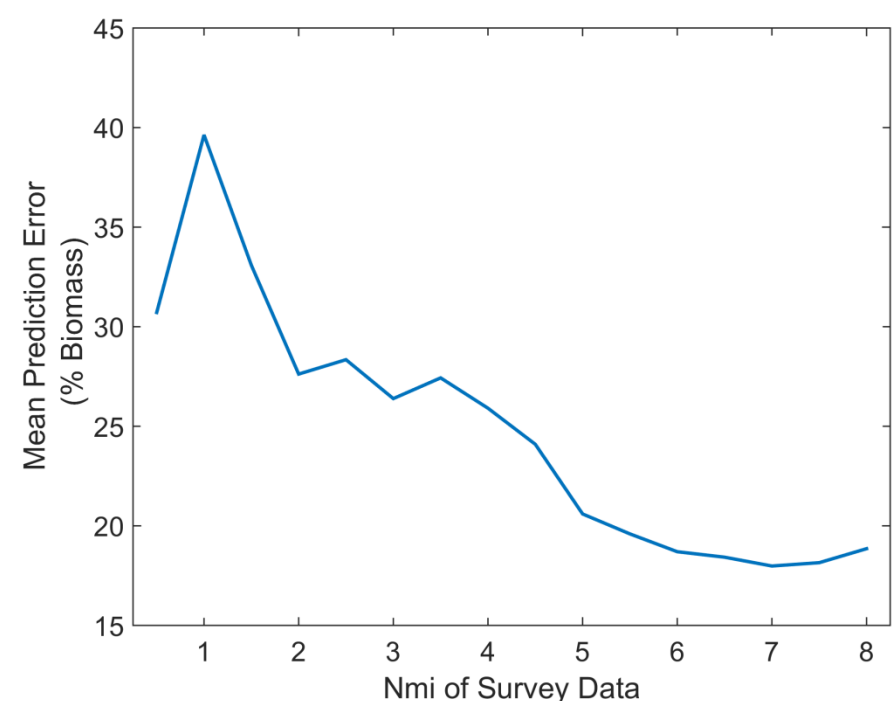


Figure 4. Model prediction error (% of survey biomass) for 3 moorings at the locations in Fig. 1 as a function of the amount of survey trackline to represent the mooring data.

The primary uncertainty in the moored echosounder approach is how spatially representative the data from a stationary echosounder are (Fig. 4).

II. Mooring design and deployment

We constructed 3 trawl-resistant moorings containing autonomous echosounders (Fig. 5).

The moorings were deployed on the seafloor at ~270 m for the duration of the pollock spawning season (February to May 2015).

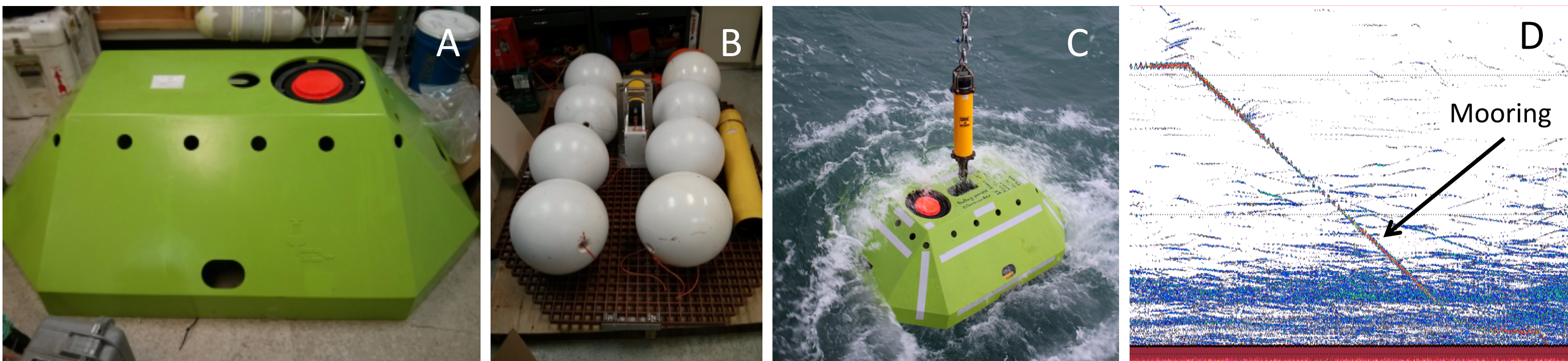


Figure 5. Trawl-resistant bottom mooring. Panel A: Trawl-resistant mooring with gimbaled transducer (orange). Panel B: Interior layout with flotation, acoustic release in center, and echosounder pressure case to the right. Panel C: mooring deployment using an acoustic release to lower the system. Panel D: echogram of the mooring deployment at 18 kHz, showing the system being lowered and released..

Acknowledgments

This work would not have been possible without the efforts of the captain and crew of the NOAA ship Oscar Dyson and the F/V Mar Del Norte. The work was funded by the NOAA Office of Science and Technology (Advanced Sampling Technology) and NOAA Cooperative Research (National) Program. Kresimir Williams conducted a preliminary analysis of the survey data and Darin Jones helped recover the moorings. The work benefitted from computer code written by Lars Andersen (Simrad), Rick Towler (NOAA), and Gavin Macaulay (IMR).

The recommendations and general content presented in this poster do not necessarily represent the views or official position of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

III. Ship surveys near the moorings

We conducted acoustic trawl surveys in the vicinity of the moorings (Fig. 6).

Pollock abundance and maturity state changed appreciably during the deployment (Fig. 7).

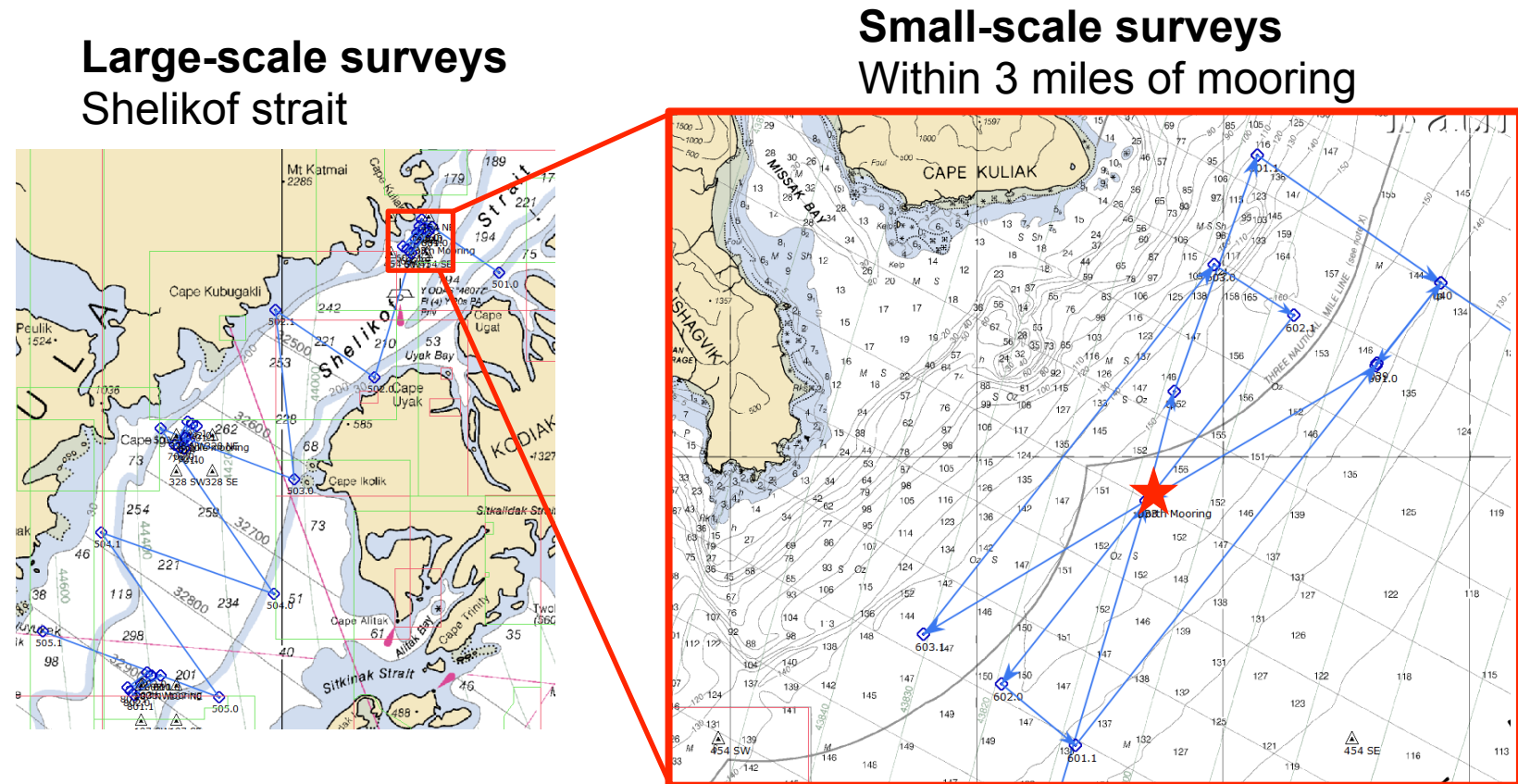


Figure 6. Moorings were visited 4-5 times over the 3 month deployment. Repeated large-scale surveys were completed of the Strait. Smaller-scale acoustic surveys and trawl sampling was conducted in the immediate vicinity of the mooring sites.

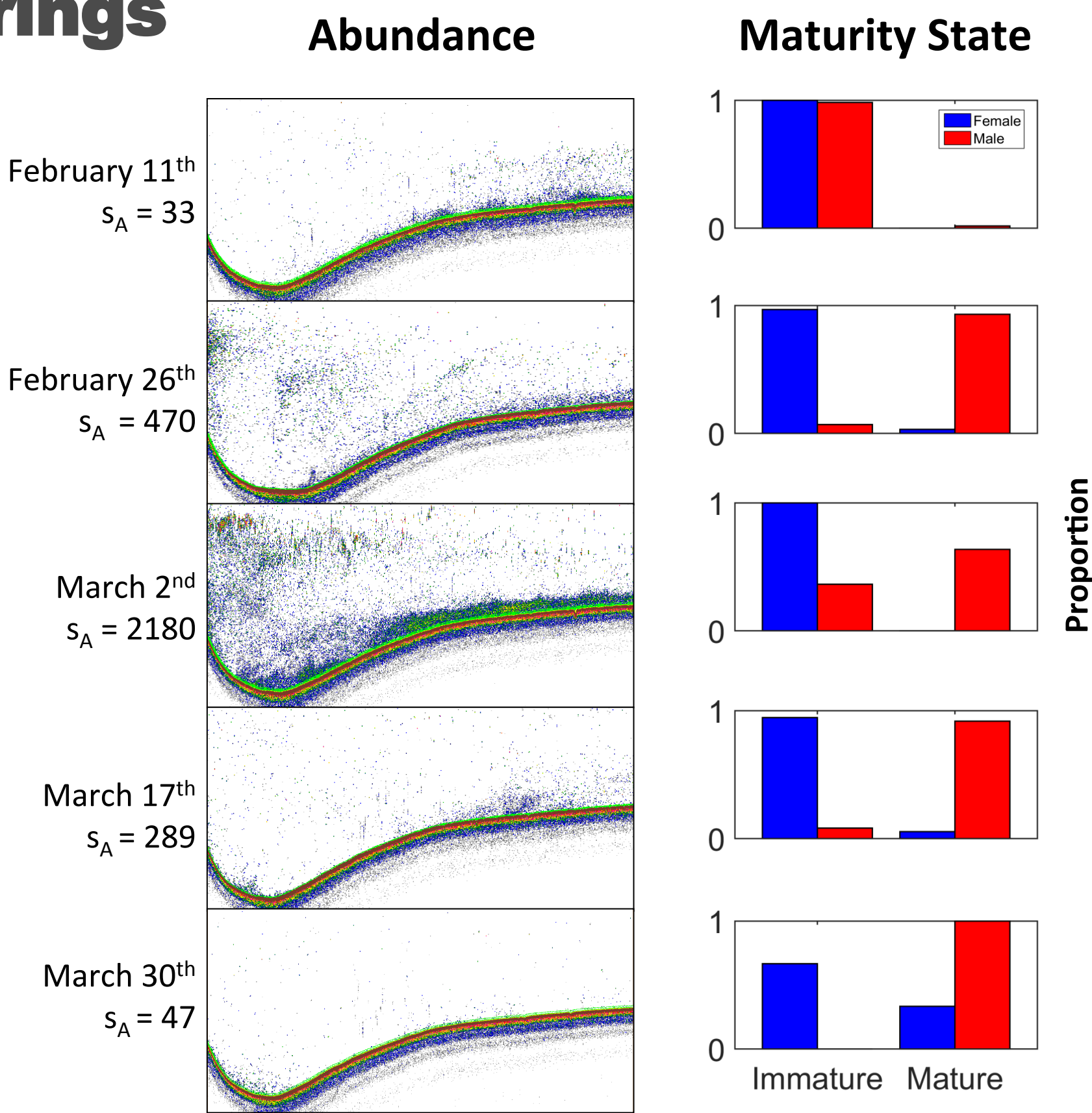


Figure 7. The northern mooring line was surveyed 5 times over the spawning period between February and March. Echograms from area bounded by the northern box in Fig. 1, and maturity state of >40 cm pollock from trawl samples at the northern mooring site. The s_A indicates the average fish abundance changed > 50 fold in less than a month.

IV. Testing of autonomous echosounder

A prototype 70 kHz split-beam echosounder (WBAT) with a new depth-rated transducer was built for this project by Simrad.

The instrument was calibrated at 270 m, and shows very little change in sensitivity with depth (Fig. 8).

A 70 kHz EK60 and WBAT were operated sequentially (Fig. 9), and produced comparable results over a broad range of backscattering strengths (Fig. 10).

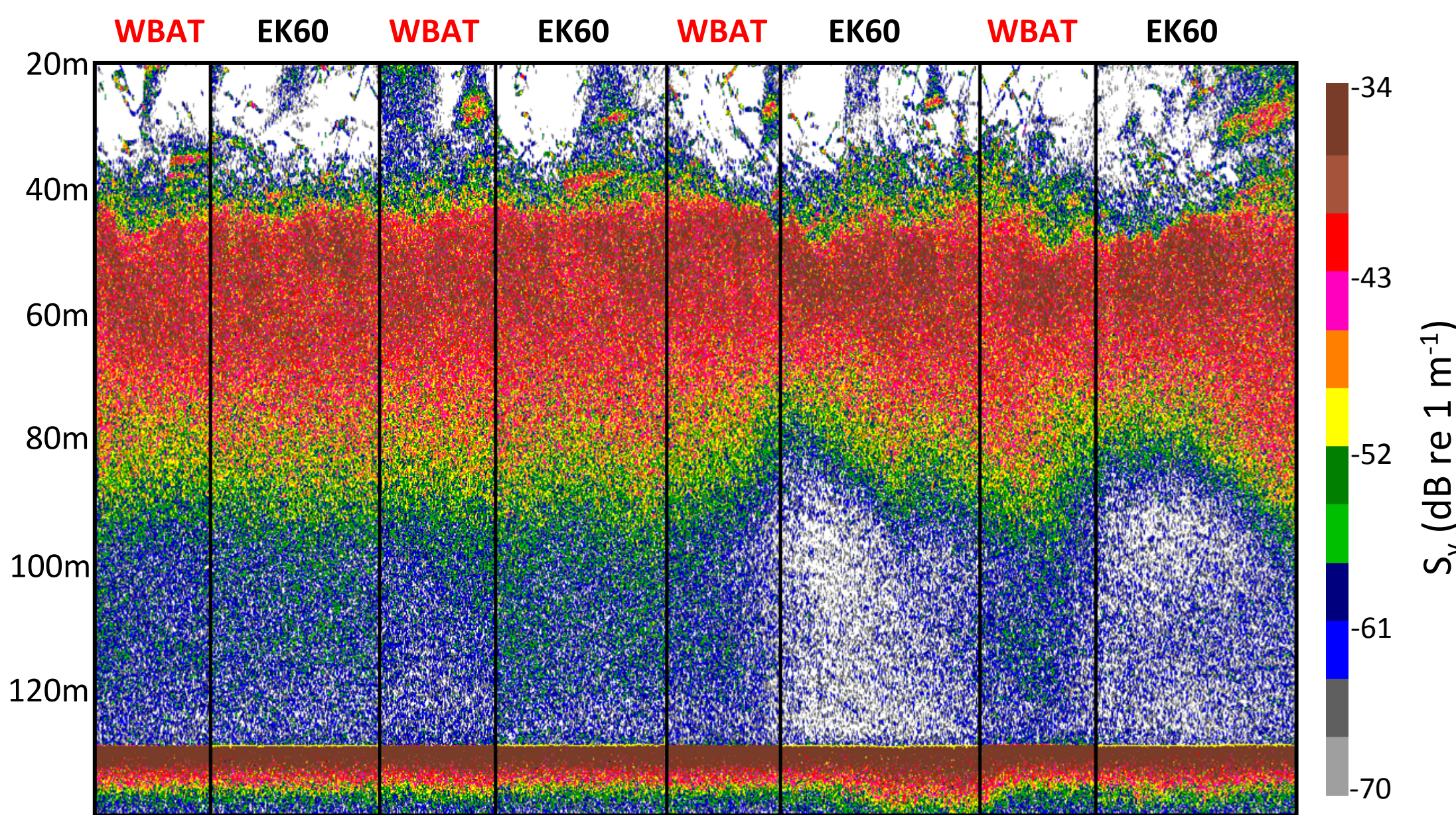


Figure 9. Example of 4 sequential measurements made with side-by-side WBAT and EK60 echosounders on a dense fish layer.

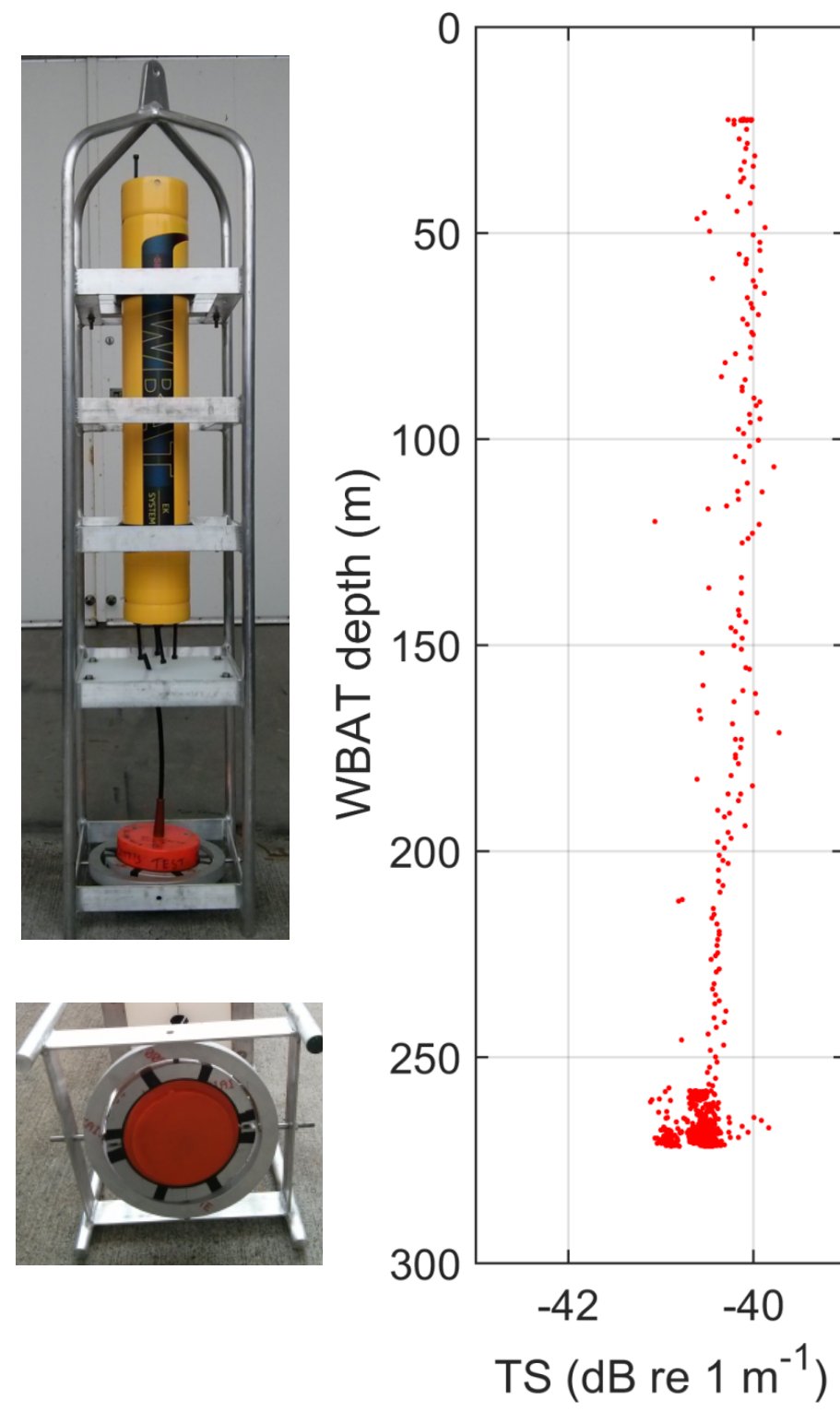


Figure 8. The WBAT was lowered to 270 m on a frame with a calibration sphere suspended on a gimbaled transducer (left). Very little change in the target strength of the sphere was observed with depth (right).

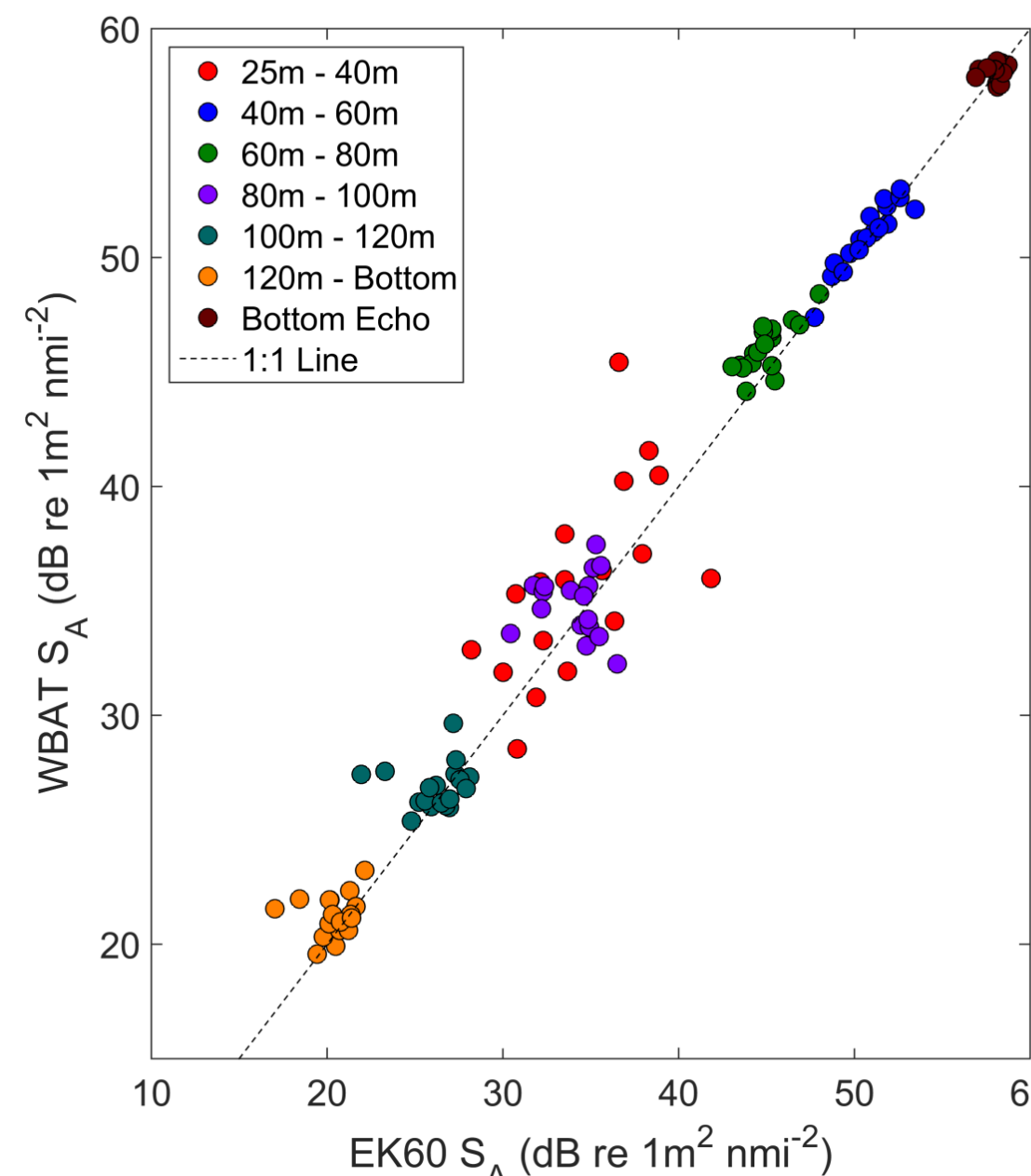


Figure 10. WBAT echosounders produce data comparable to that of a standard shipboard EK60. Each point represents a depth layer integration from the comparison depicted in Fig. 9 (n=18). S_A is the $10 \log_{10}(s_A)$, where s_A is the nautical area backscattering coefficient. The gains of the echosounders have been adjusted such that the integral of the bottom echo from both instruments is equivalent.

Conclusions

- Shelikof Strait is highly suited to stationary measurements of abundance as fish are spatially correlated and backscatter is dominated by walleye pollock.
- The primary uncertainty in the moored echosounder approach is knowledge of the spatial-representativeness of long-term observations from a single location, which will depend on the behavior of the fish.
- Moored echosounders can produce high-quality acoustic measurements that are comparable to those from shipboard echosounders.
- Pollock move quickly through the spawning grounds. Moored echosounders will provide insights into the behavior and duration of the spawning aggregations, which will reduce uncertainty related to survey timing.

Future work

- Compare ship and moored echosounders to establish how spatially representative stationary measurements are.
- Evaluate the feasibility of designing a mooring array (number and placement of moorings) capable of providing abundance information
- Examine the timing of the formation of spawning aggregations and the behaviors of spawning pollock.