

Do pollock dive in response to survey bottom trawls?



Stan Kotwicki, Alex De Robertis, and Kresimir Williams
Alaska Fisheries Science Center, NMFS/NOAA, Seattle WA
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Objectives

- 1. Validate bottom trawl effective fishing height by directly observing pollock diving behavior in front of the survey trawl using acoustic instruments.
- 2. Derive a whole water column abundance estimate by combing bottom trawl and acoustic methods.

Introduction

Walleye pollock (*Gadus chalcogrammus*) are a dominant species with important commercial and ecological roles in the North Pacific. Due to their semi-demersal distribution, separate bottom trawl (BT) surveys and acoustic trawl (AT) surveys are used to estimate their abundance and to determine spatial distribution in the eastern Bering Sea (EBS). Combining BT and AT data can provide more accurate and precise abundance estimates than what can be provided by either survey alone. However to combine data from both surveys it is necessary to know the effective fishing height of the BT. Effective fishing height for the 83–112 otter trawl used in the Eastern Bering Sea BT surveys has been estimated to be on average 16 m above bottom using modelling techniques. This estimate suggests that pollock dive into the trawl opening because the headrope height of the BT is only 3m. In this study we will perform observations to confirm pollock diving behavior into the BT.

Survey sampling

Acoustic and bottom trawl techniques are necessary to sample the entire vertical extent of pollock distribution in the water column, because both have blind zones (Figure 1). Acoustic instruments are effective at sampling the water column, but they have a near-bottom acoustic dead zone (ADZ), where fish near the seafloor cannot be detected. Bottom trawls can catch pollock only up to the effective fishing height (EFH). Pollock availability to the bottom trawl survey depends on the EFH. Pollock availability to the acoustic survey depends on how many pollock are in the ADZ. A whole water column abundance estimate of pollock can be obtained by subtracting the overlap from the sum of bottom trawl and acoustic estimates. However, to estimate overlap it is necessary to know the effective fishing height.

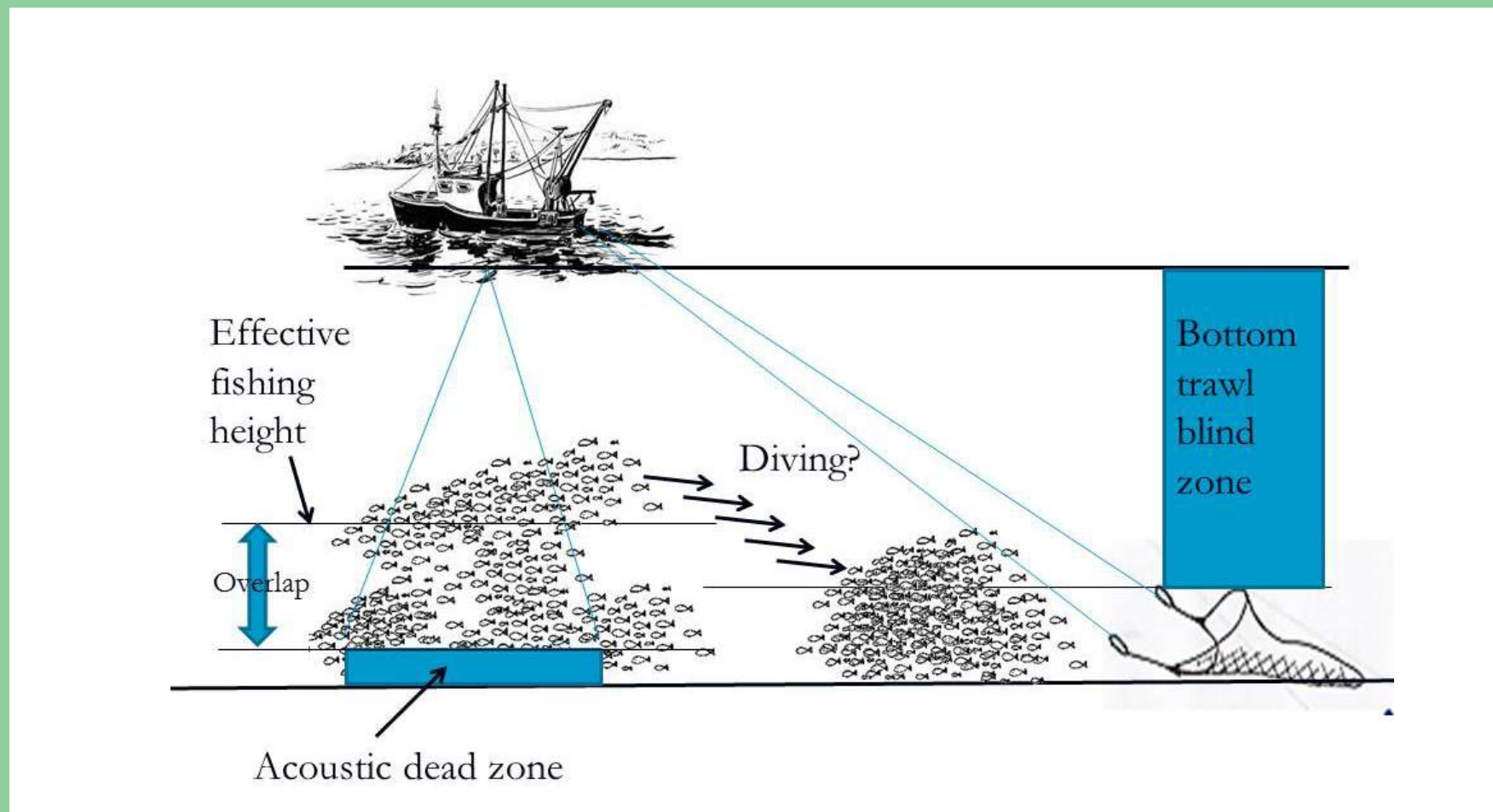


Figure1. Illustration of walleye pollock sampling by an echosounder and a bottom trawl. Note that acoustic data is collected directly under the survey vessel, while bottom trawl catches pollock some distance behind the vessel. Diving may occur in the time between vessel passing over schools of pollock and trawl caching same schools.

Validation of model results through observations

The planned experiment will quantify the degree of diving in response to the bottom trawl by conducting simultaneous observations of pollock behavior under the survey vessel and in the front of the trawl. These observations will be performed from the survey vessel and a small boat equipped with acoustic instruments (Figure 4). The boat will be towed by the BT survey vessel and will have a remotely controlled side to side navigation system allowing for observations of pollock vertical distribution at any point between the fishing vessel and the opening of the trawl. The data from the towed echosounder will be telemetered back to the operator on the survey vessel via an Ethernet radio link to provide real-time feedback.

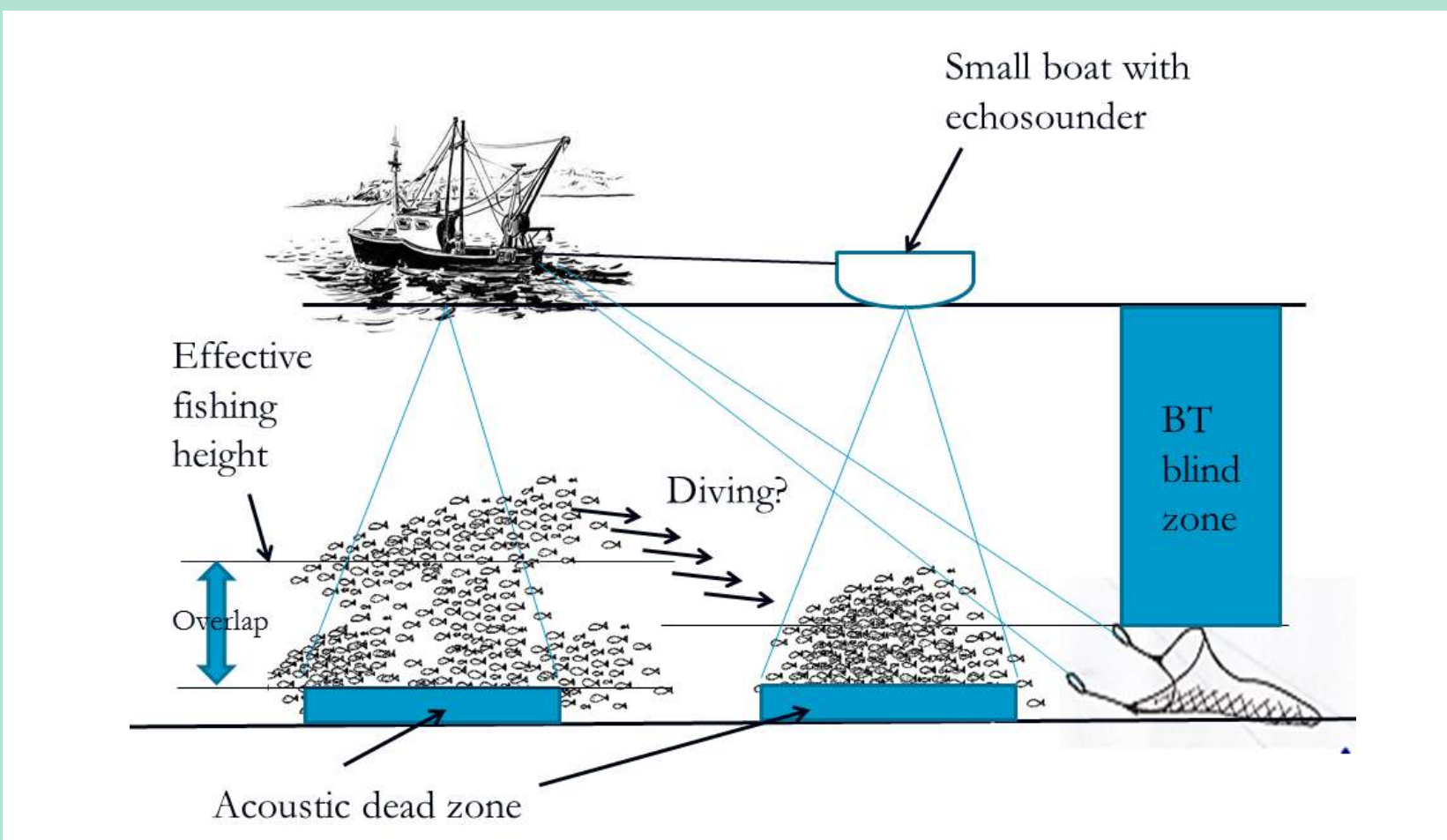


Figure 4. Experimental observations of pollock behavior between fishing vessel and the bottom trawl. Note that small boat will be able to observe pollock aggregations at any point between survey vessel and mouth of the trawl.

Modeling

EFH can be estimated from conceptual model combining simultaneously collected bottom trawl (BT) and acoustic (A; Figure 2) data:

$$BT = \sum_{ADZ}^{EFH} A + ADZ$$

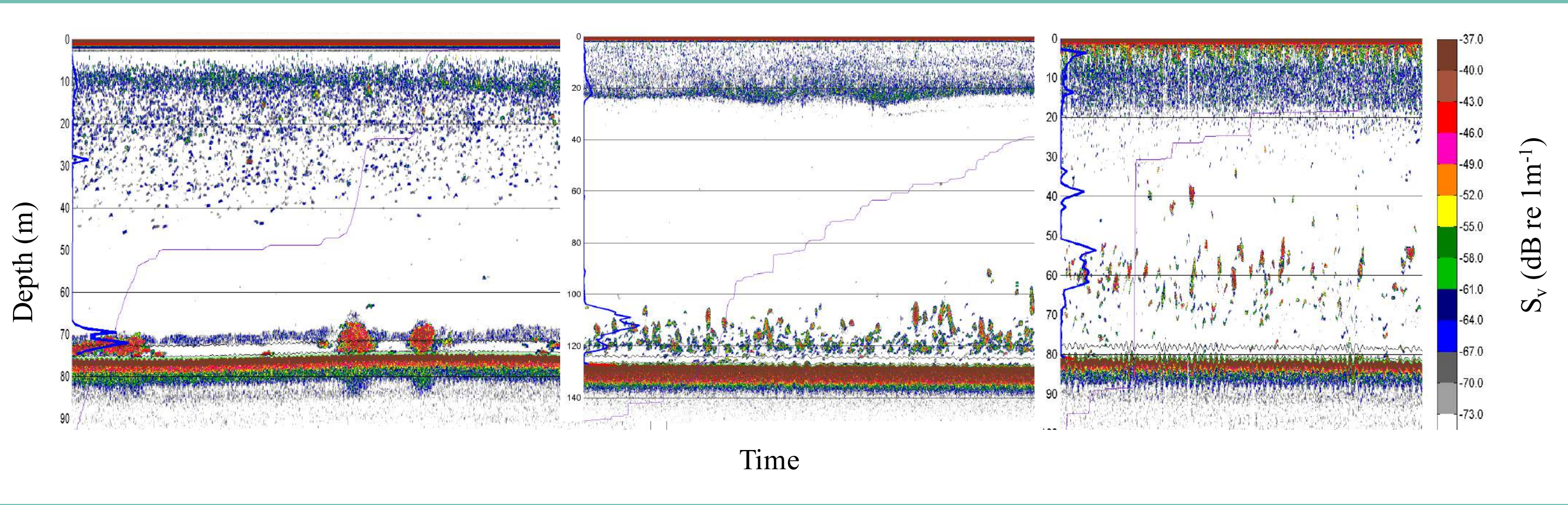


Figure 2. Examples of acoustic echograms of pollock vertical distribution as detected by echosounders mounted on the fishing vessel. Note that pollock can be distributed anywhere between bottom and the sea surface.

EFH of the survey bottom trawl was estimated using this model and simultaneously collected bottom trawl and acoustic data, resulting in the EFH estimate of 16m (Kotwicki et al., 2013). Before this estimate can be used to obtain whole water column pollock abundance it needs to be confirmed by observations.

Results from combining bottom trawl and acoustic data have also been used to obtain estimates of availability of pollock to the bottom trawl and acoustic gear in relation to environmental variables and fish size (Kotwicki et al., 2015). It was found that probability of detecting pollock by BT and acoustic surveys (i.e. availability) depends on these variables (Figure 3).

For example pollock availability to the bottom trawl is high (close to 1) in shallow waters, but it decreases and becomes more variable in deeper waters. Pollock availability to the bottom trawl also decreases and becomes more variable under low-light conditions. Large pollock are usually more available to the bottom trawl than smaller pollock. The finding of variable availability to the survey gears indicates an existence of presently unaccounted source of uncertainty in abundance estimates from both bottom trawl and acoustic surveys. Whole water column estimates of abundance from combined BT and acoustic data have a potential to reduce this uncertainty, because every fish in the water column is available to one of these methods.

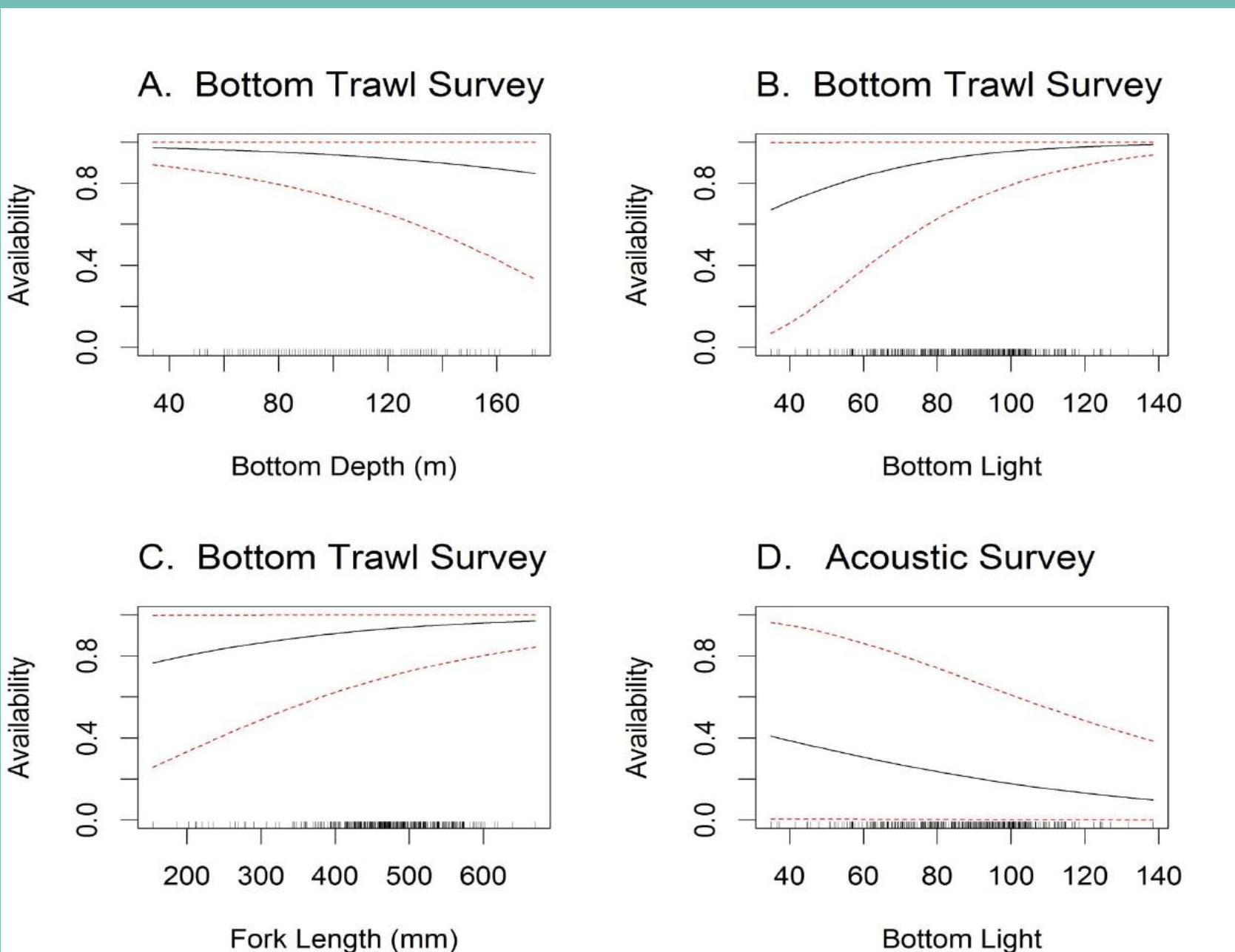


Figure 3. Examples of model-derived relationship between pollock availability the bottom trawl and acoustic surveys and environmental variables and pollock size. Red lines indicate 95% confidence bands.

Pilot studies

Sea trials:

In July 2015 feasibility trials were conducted on the FV *Vesteraalen* by towing a Zodiac inflatable boat (Figure 5). A rudder and a center board were attached to the zodiac to assess the ability of the rudder to move the towed zodiac from side to side behind the towing vessel. Side to side movements are necessary to observe pollock behavior in the plane between bottom trawl wings (average spread 18m) and doors (average spread 50m). It was found that when the tow attachment point was at the center of the Zodiac the rudder had only a limited capability to move the Zodiac from side to side ($\pm 10m$). However, when the attachment point was changed to the side of the Zodiac, the Zodiac movement to the side increased to $> 30m$.

Lake trials:

A model catamaran boat was built to test the tow angle in relation to the tow point position (Figure 6). The model was tested successfully in the lab and on Lake Washington. The conclusion of this work was that position of the tow attachment point could control movements of the catamaran from side to side even without the rudder.

In September 2015, lake trials were performed with a Hobie Wave catamaran (Figure 7). The catamaran was towed at 3 knots. Various tow attachment points were tested to assess the effect of the position of the towing point on the sideways drift of the towed boat. The trials indicated that a catamaran would be a good platform to perform pollock observations behind the fishing vessel. Side-to-side navigation will require construction of a remotely controlled moving towing point located in front of the catamaran.



Figure 5. Zodiac trials aboard FV *Vesteraalen*.

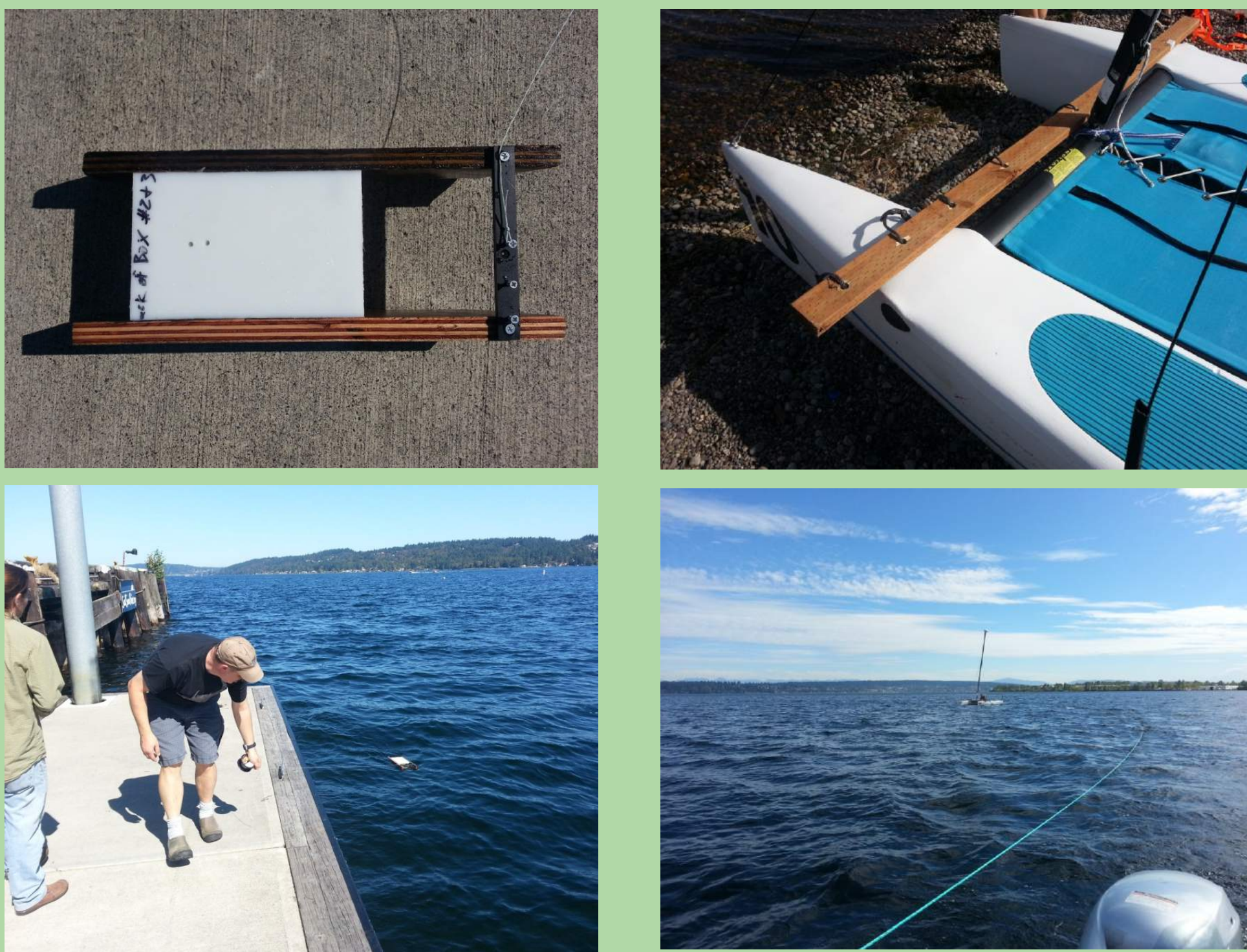


Figure 6. Lake Washington trials with a small model catamaran.

Figure 7. Lake Washington trials with a Hobie Wave catamaran.

References:
Kotwicki, S., De Robertis, A., Ianelli, J. N., Punt, A. E., and Horne, J. K. 2013. Combining bottom trawl and acoustic data to model acoustic dead zone correction and bottom trawl efficiency parameters for semi-pelagic species. *Canadian Journal of Fisheries and Aquatic Sciences*, 70: 208–219.
Kotwicki, S., Horne, J. K., Punt, A. E., and Ianelli, J. N. 2015. Factors affecting the availability of walleye pollock to acoustic and bottom trawl survey gear. *ICES J. Mar. Sci.* 72: 1425–1439.

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