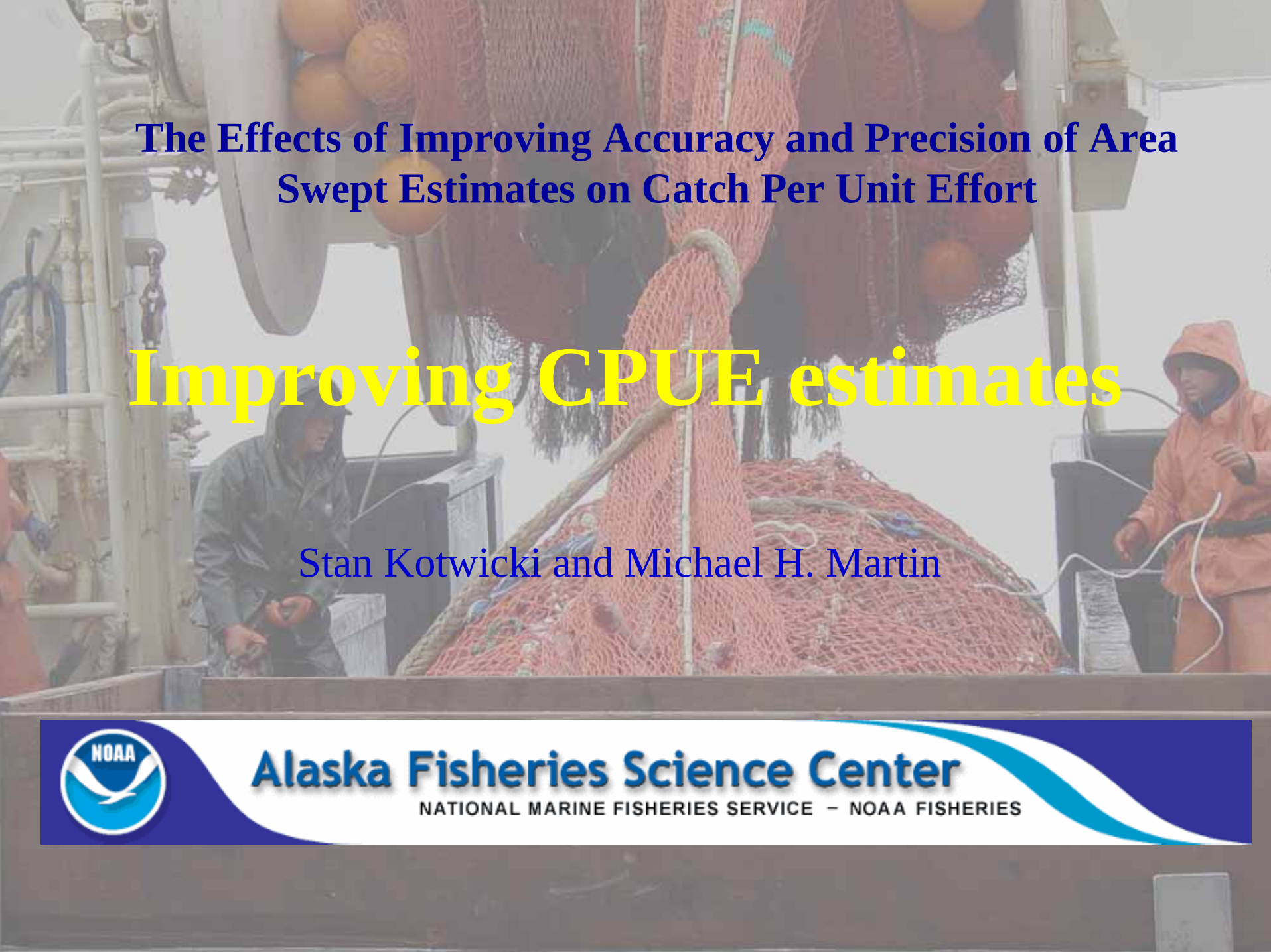
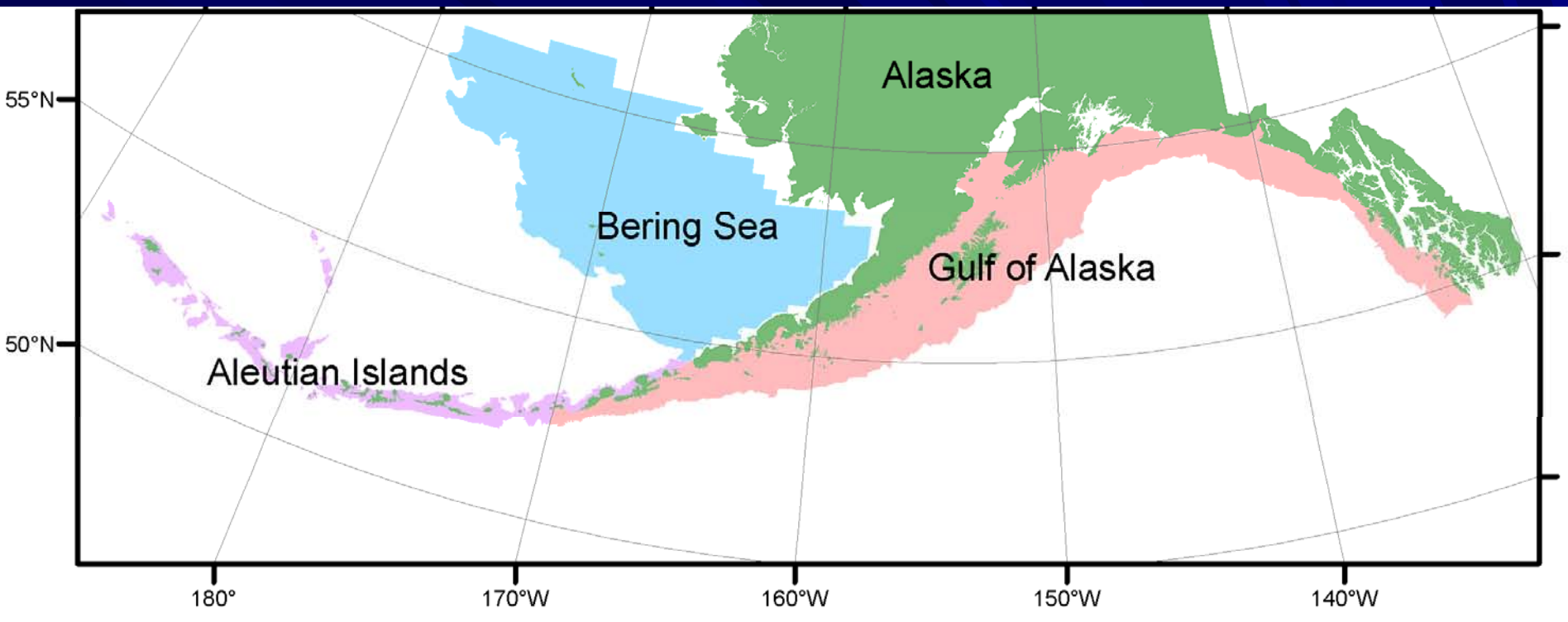


The Effects of Improving Accuracy and Precision of Area Swept Estimates on Catch Per Unit Effort

Improving CPUE estimates

Stan Kotwicki and Michael H. Martin

Alaska Fisheries Science Center
NATIONAL MARINE FISHERIES SERVICE – NOAA FISHERIES



Survey Areas

- Bering Sea – mostly flat, sand and mud, relatively shallow

- Gulf of Alaska & Aleutian Islands - more diverse substrate and bathymetry, many untrawlable areas

CPUE

CPUE = Catch / Area swept

Constant - catchability measurement error

- Constant or random error is OK
- Error, which varies in space or time is not

Area swept = Distance fished * Wing spread

Past improvements

- Measurements of distance fished (using Loran) straight line– 1978
- Measurements of net spread – 1989 (1991 - PC)
- Measurements of actual time on bottom with depth sensors (MBT) - 1992
- Improved distance fished measurements (GPS) smooth line for GOA and AI- 1992
- Measurements of actual time on bottom using bottom contact sensor – 1996

Proposed improvements:

Distance fished:

• smooth vessel track with cubic spline smoother

• change distance algorithm from Euclidian to Haversine (Sinnott, 1984)

• addition of distance fished due to wire retrieval between haulback and off bottom

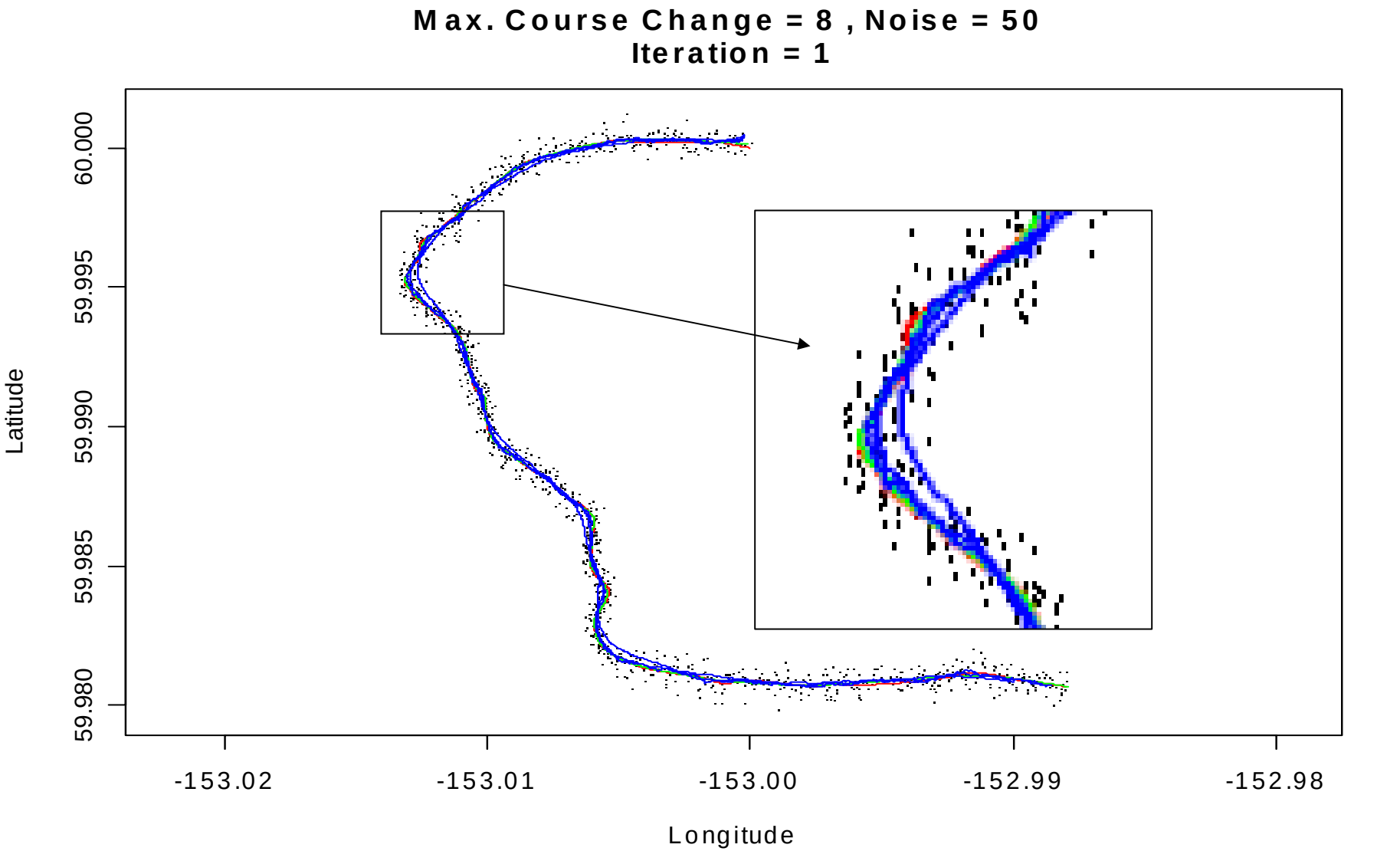
Net spread

• more accurate estimate of sound speed

• sequential outlier rejection

• calculation of mean from smoothed data

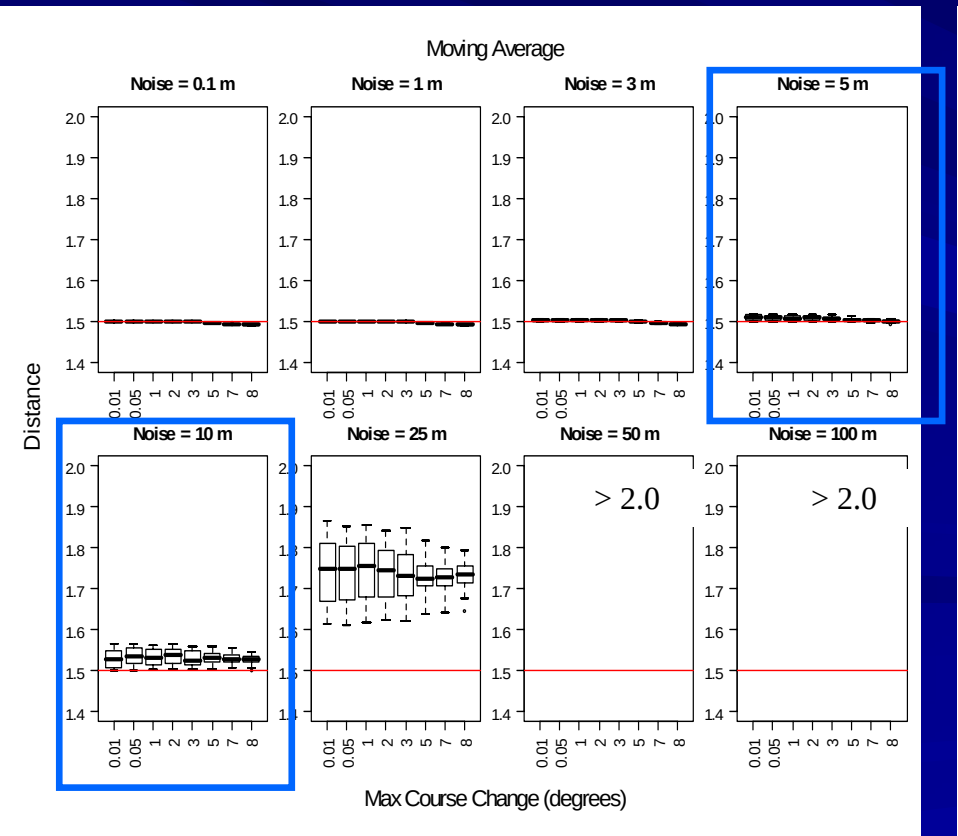
Vessel track example

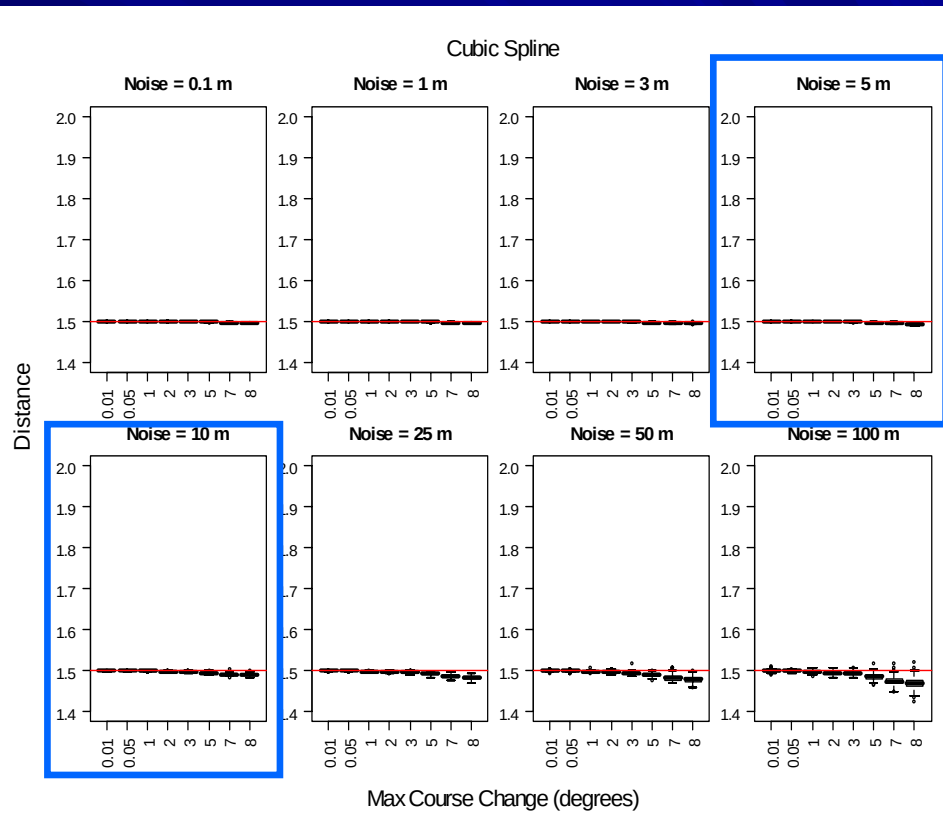


Distance Fished

Current moving average smoother overestimates true distance with “noisy” GPS.

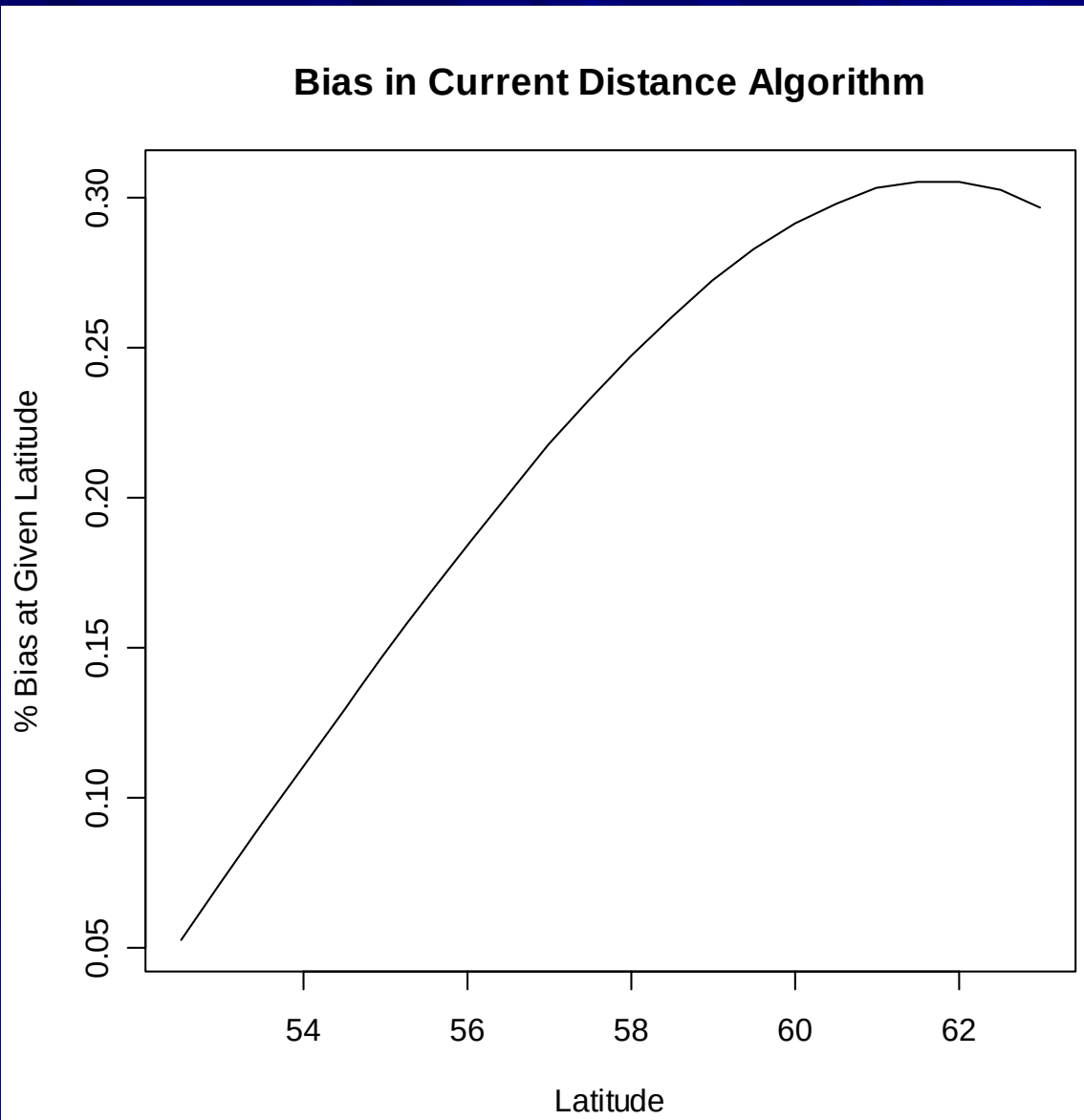
Cubic spline smoothing is more robust to noisy data – **eliminates bias due to GPS noise.**





Distance Fished

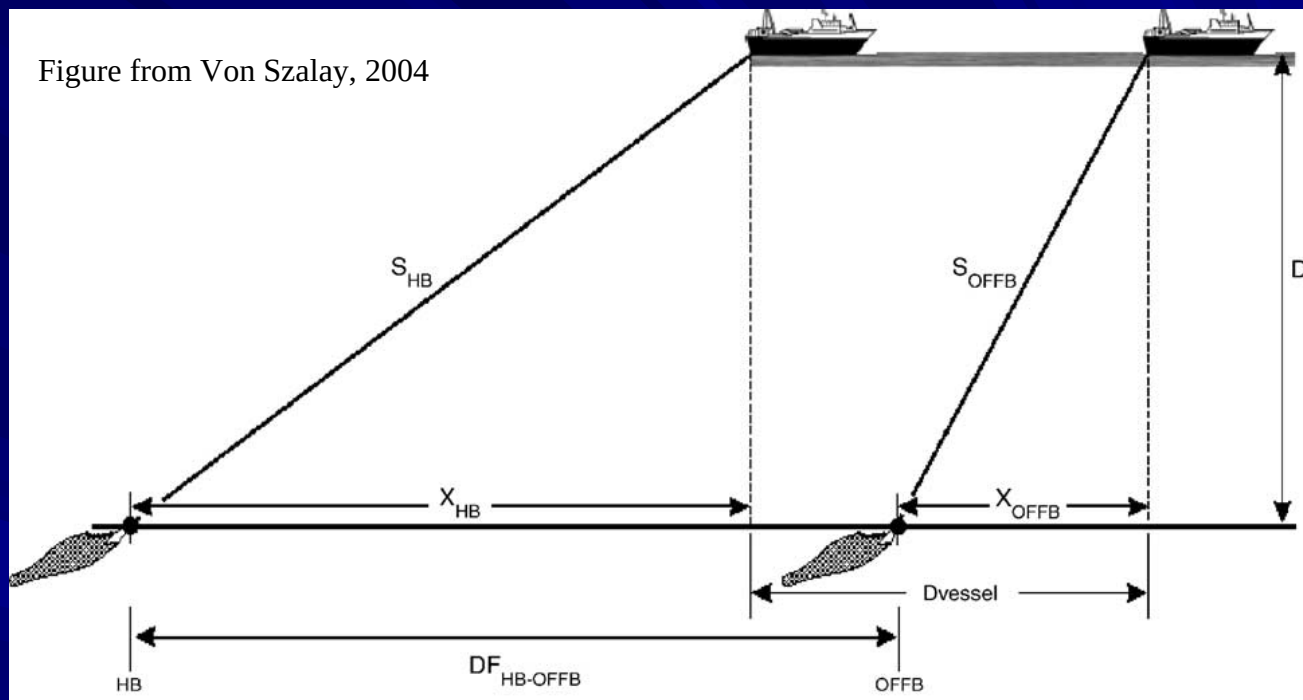
Haversine distance algorithm eliminates latitudinal bias of Euclidean algorithm



Distance Fished

Addition of distance fished due to wire retrieval between haulback and off bottom improves accuracy of estimate of actual distance covered by trawl.

Figure from Von Szalay, 2004



S_{HB} = scope at haul-back of trawl

S_{OFFB} = scope when trawl lifts off the bottom

X_{HB} = horizontal distance between the trawl and the vessel at HB

X_{OFFB} = horizontal distance between the trawl and the vessel at OFFB

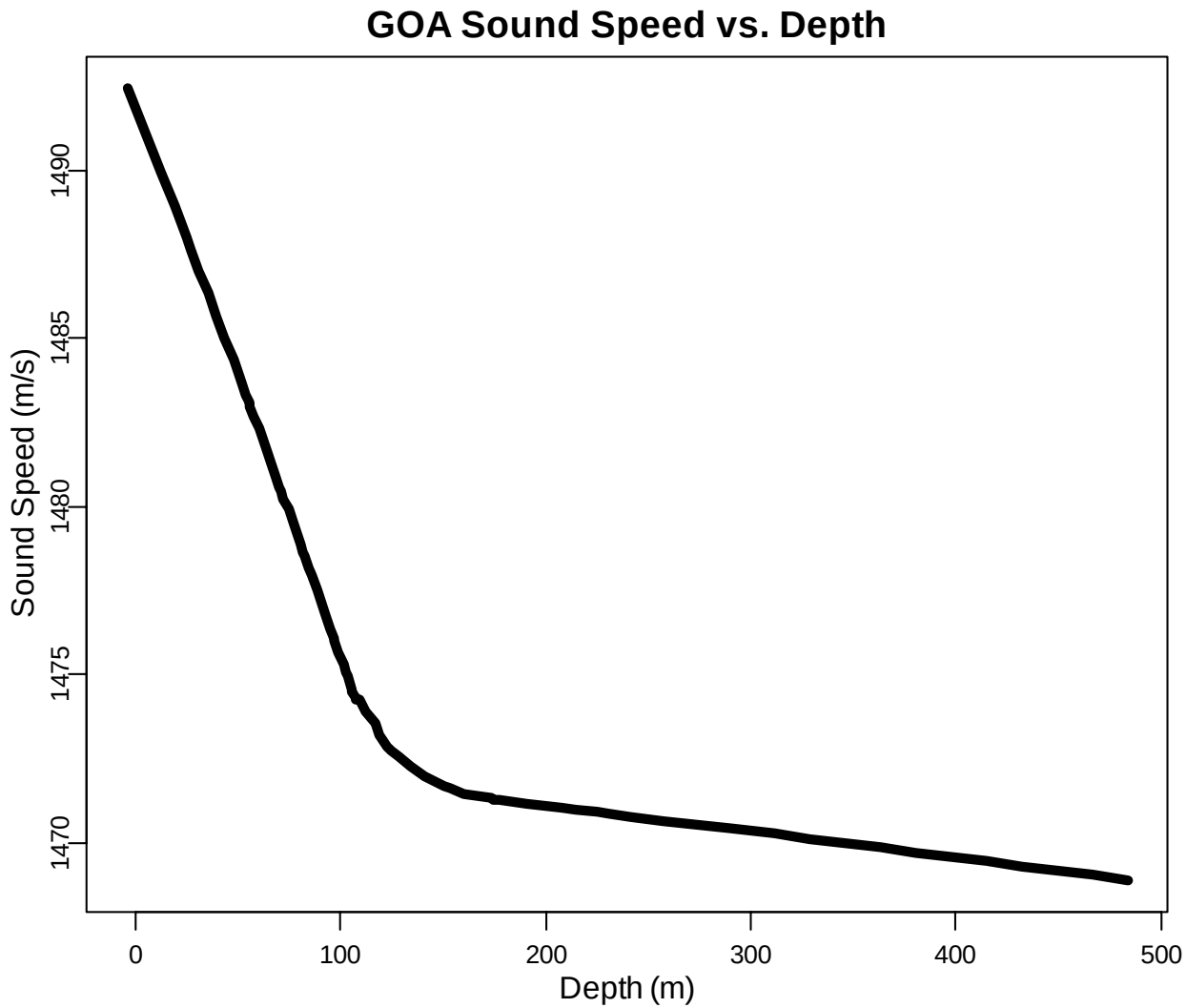
D = bottom depth

$DF_{HB-OFFB}$ = distance fished by the trawl between HB and OFFB

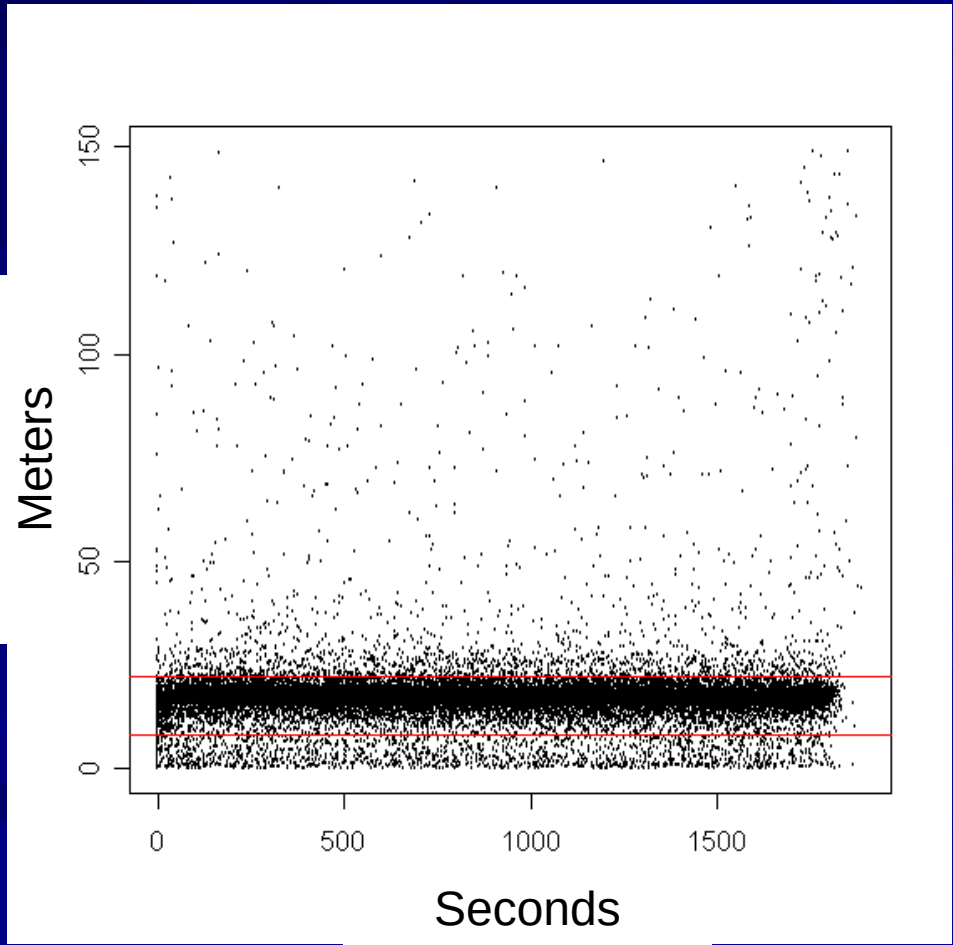
D_{vessel} = distance traversed by the vessel between HB and OFFB

Wing Spread

Using accurate estimate of sound speed eliminates bias due to assumption of constant sound speed through water.

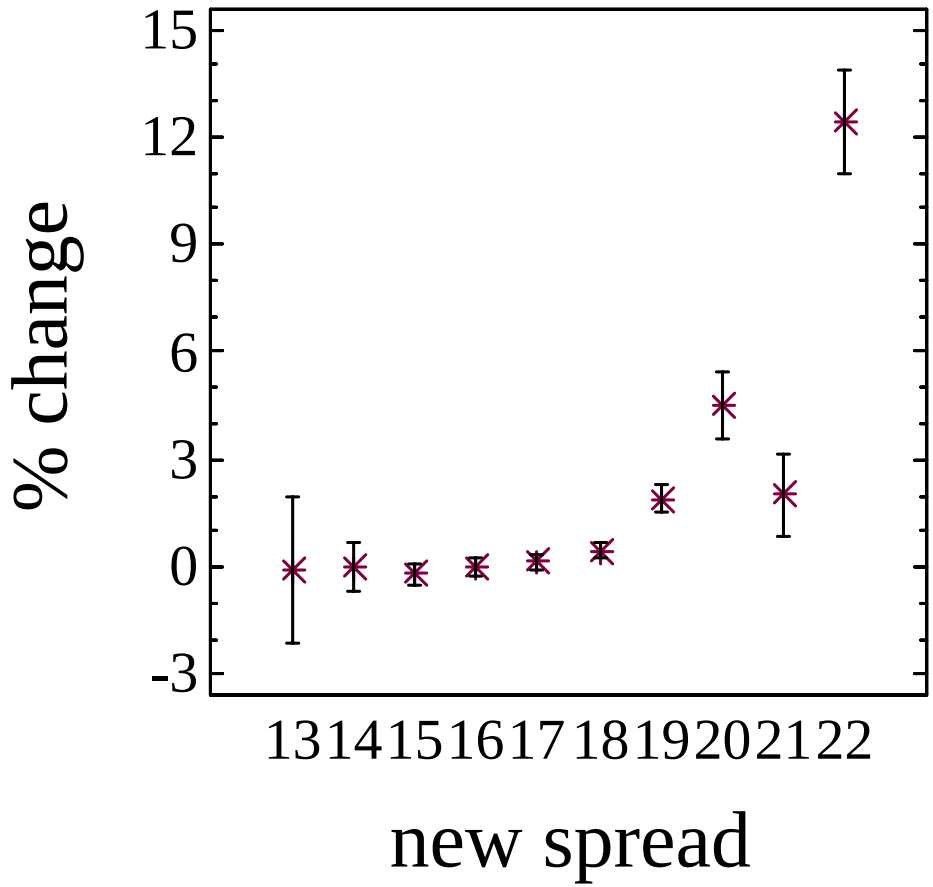


Spread data



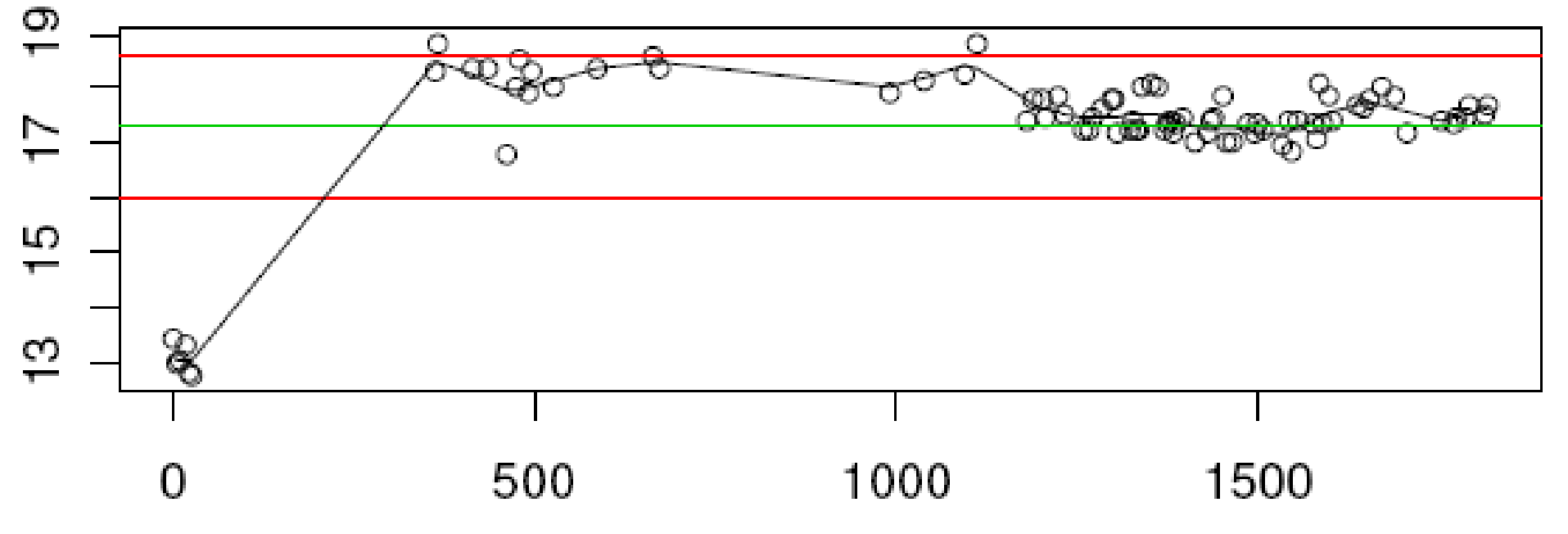
Wing Spread

Using sequential outlier rejection eliminates bias due to asymmetrical distribution of outliers in spread data.

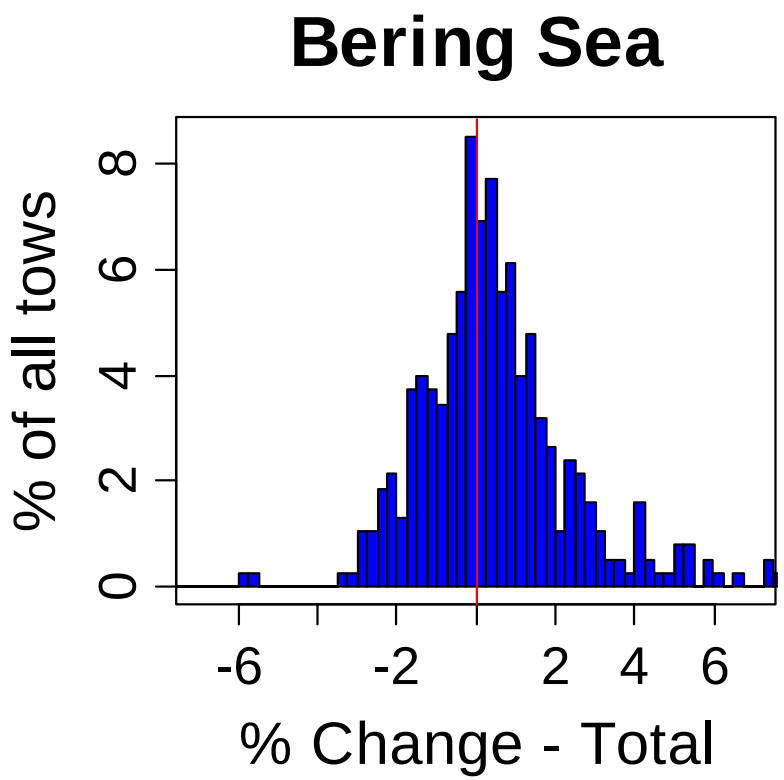


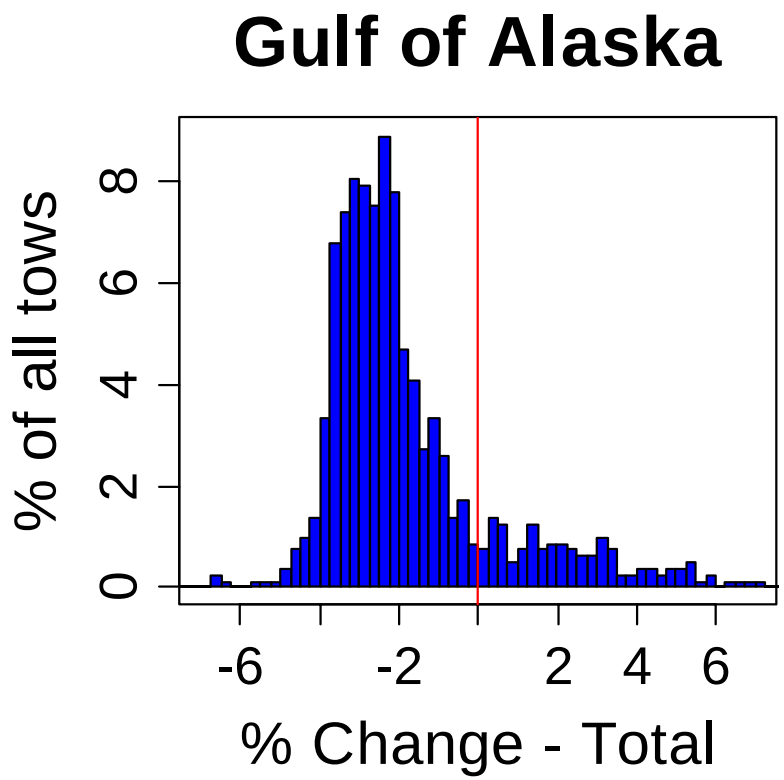
Wing Spread

Using smoothed mean eliminates bias due to unequal density of incoming data throughout the tow



Results

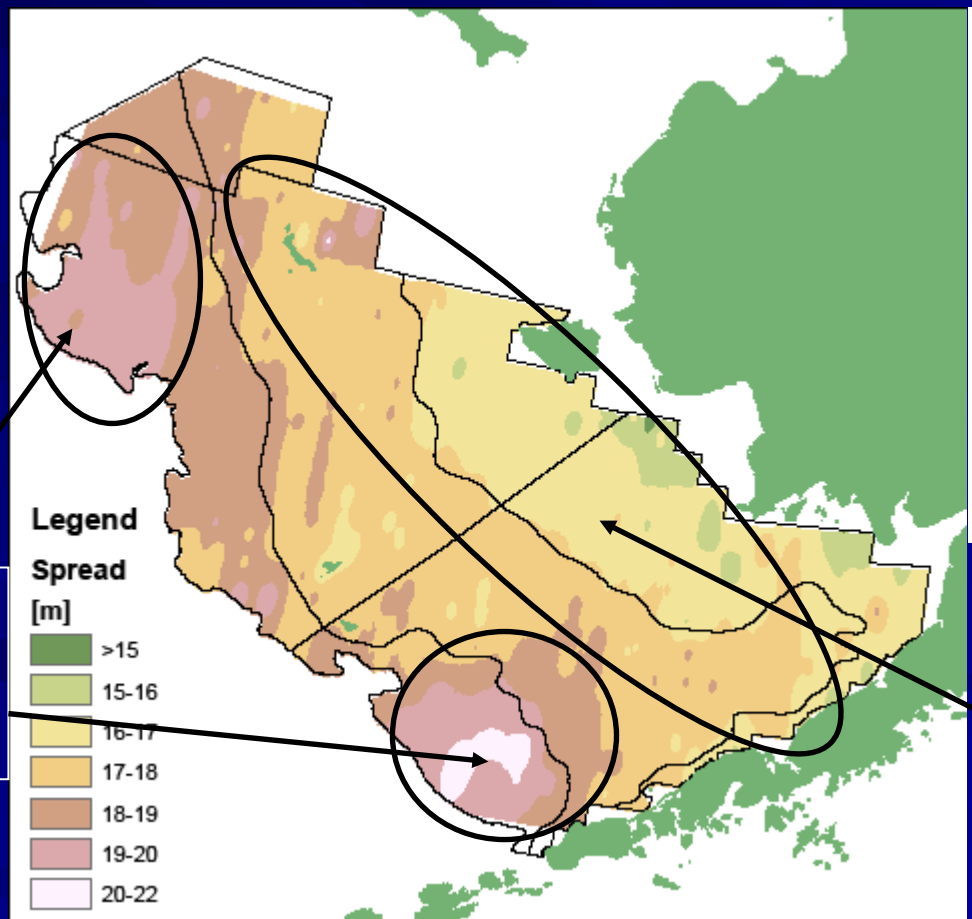


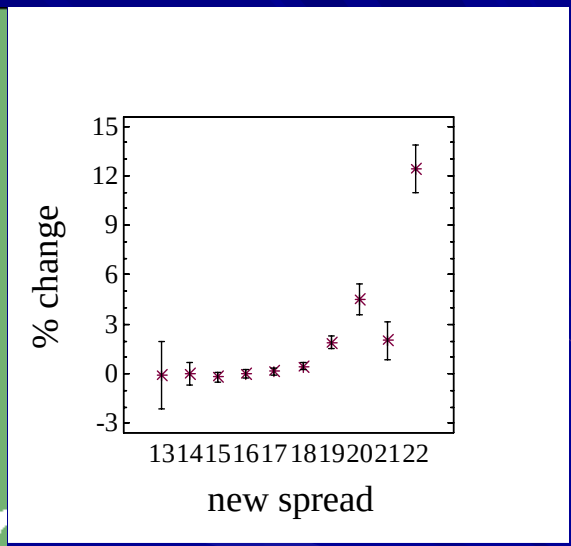


Constant - catchability measurement error

Why is it important to correct for non random sources of bias?

Spatial variation in bias:



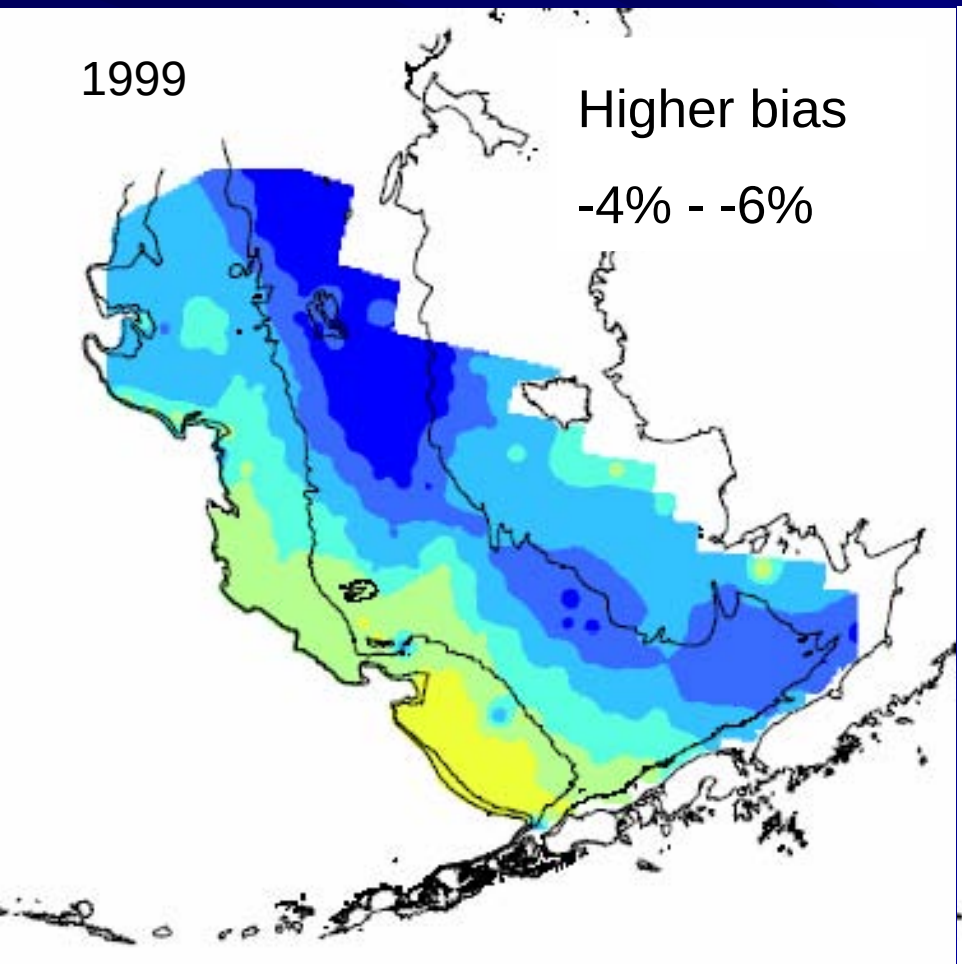


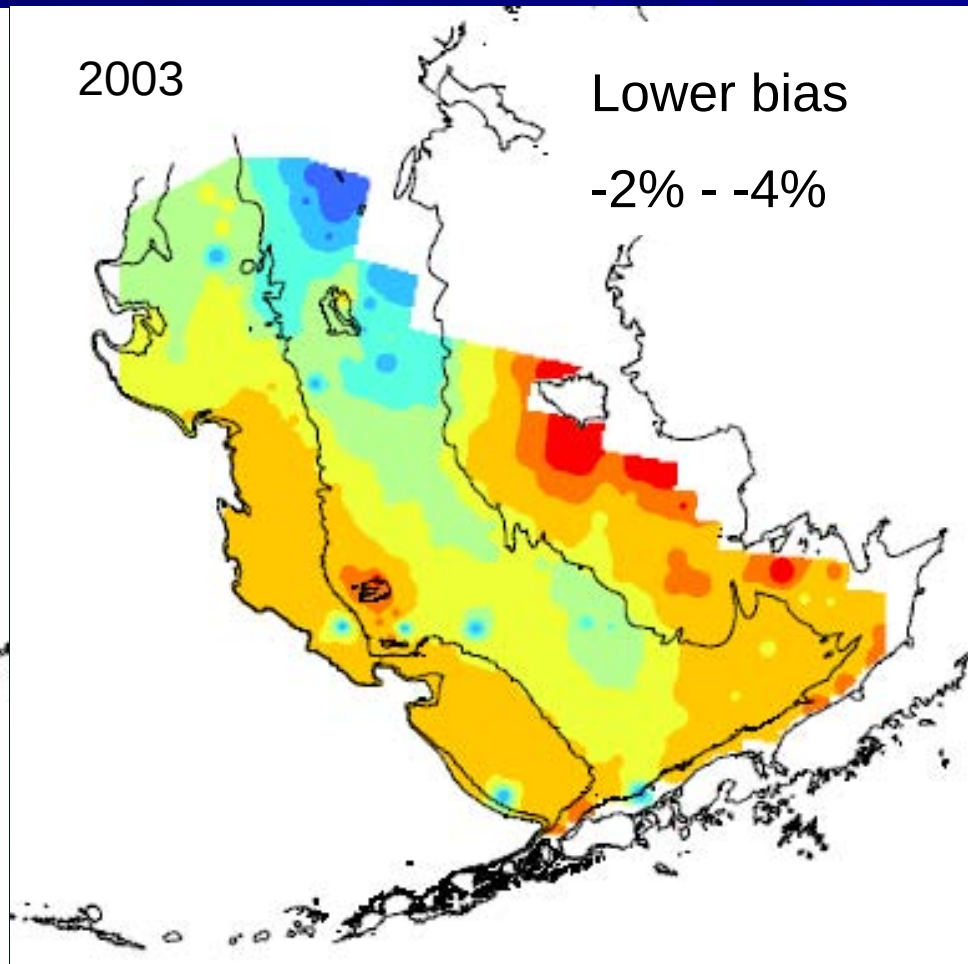
High negative bias

Low bias

Why is it important to correct…

Year to year variation in bias due to temperature effect on sound speed:





Acknowledgments

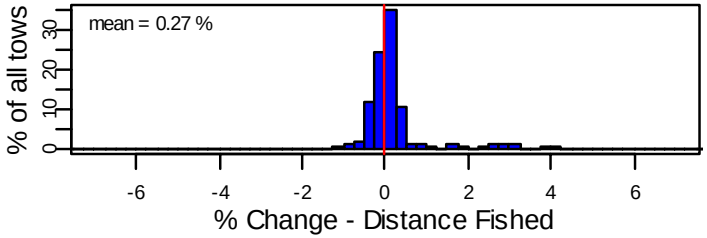
Thanks to all members of AFSC Working Group on Bottom Trawl Survey Improvement – **Dave Somerton, Ken Weinberg, Bob Lauth and Mark Wilkins** for many discussions and sharing knowledge about survey data.

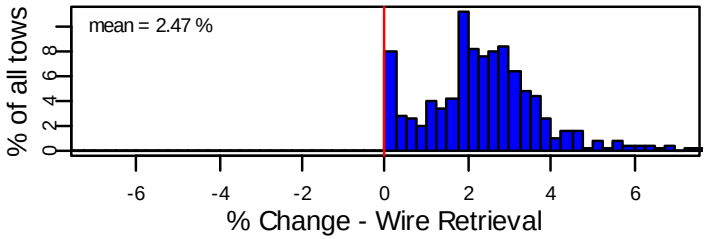
Thanks to **Ned Laman** for highlighting importance of many presented issues and for making data sources easily available to us.

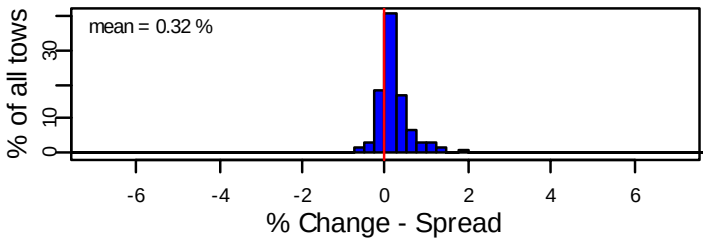
Future Work

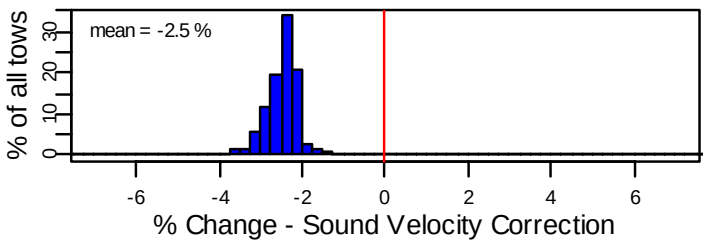
- Simulation analysis of spread method ("gaps" and SOR stopping rule)
- Analysis of more years data

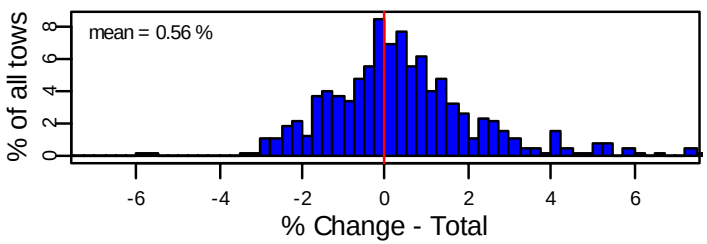
Bering Sea



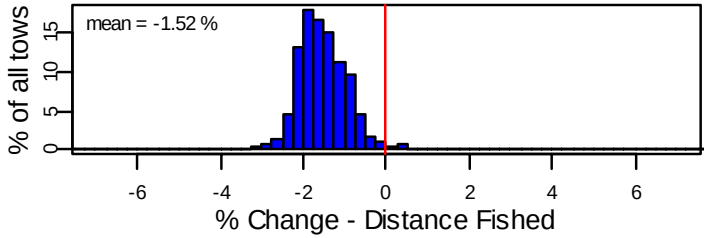


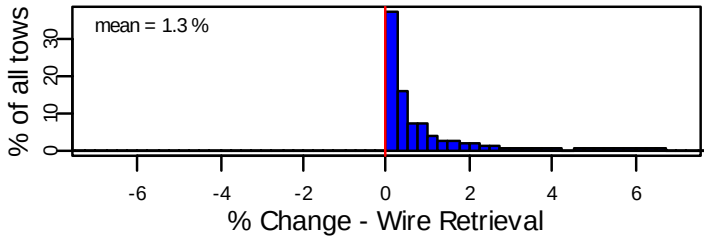


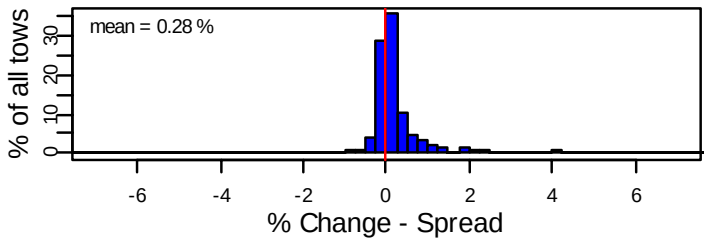


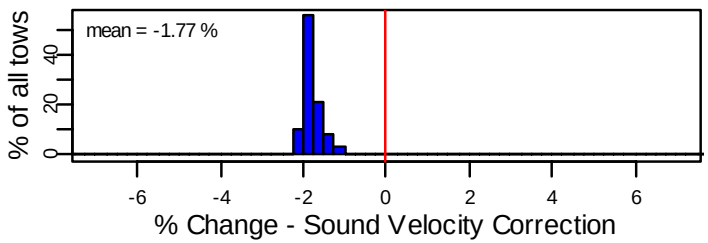


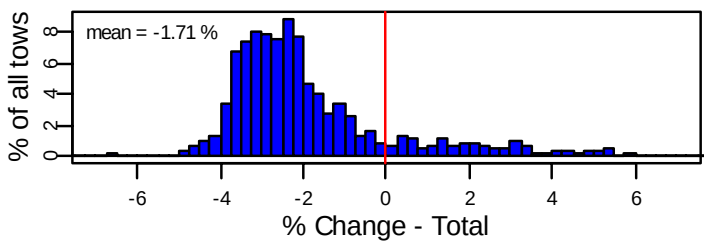
Gulf of Alaska

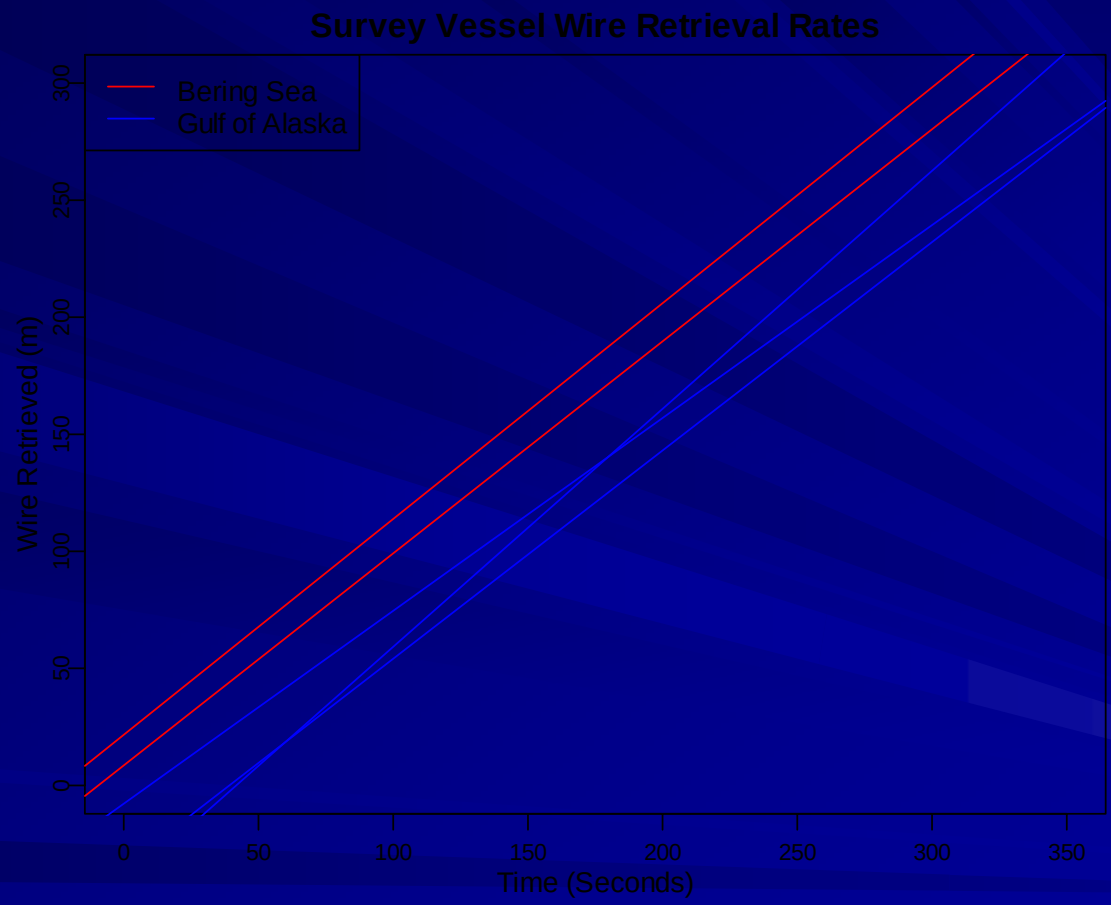











Survey Vessel Wire Retrieval Rates
Bering Sea
Gulf of Alaska
Wire Retrieved (m)
0
50
100
150
200
250
300
0
50
100
150
200
250
300
350
Time (Seconds)

Spread data examples