Incorporating Oceanographic Data into Stock Assessments of Longline-Caught Fishes

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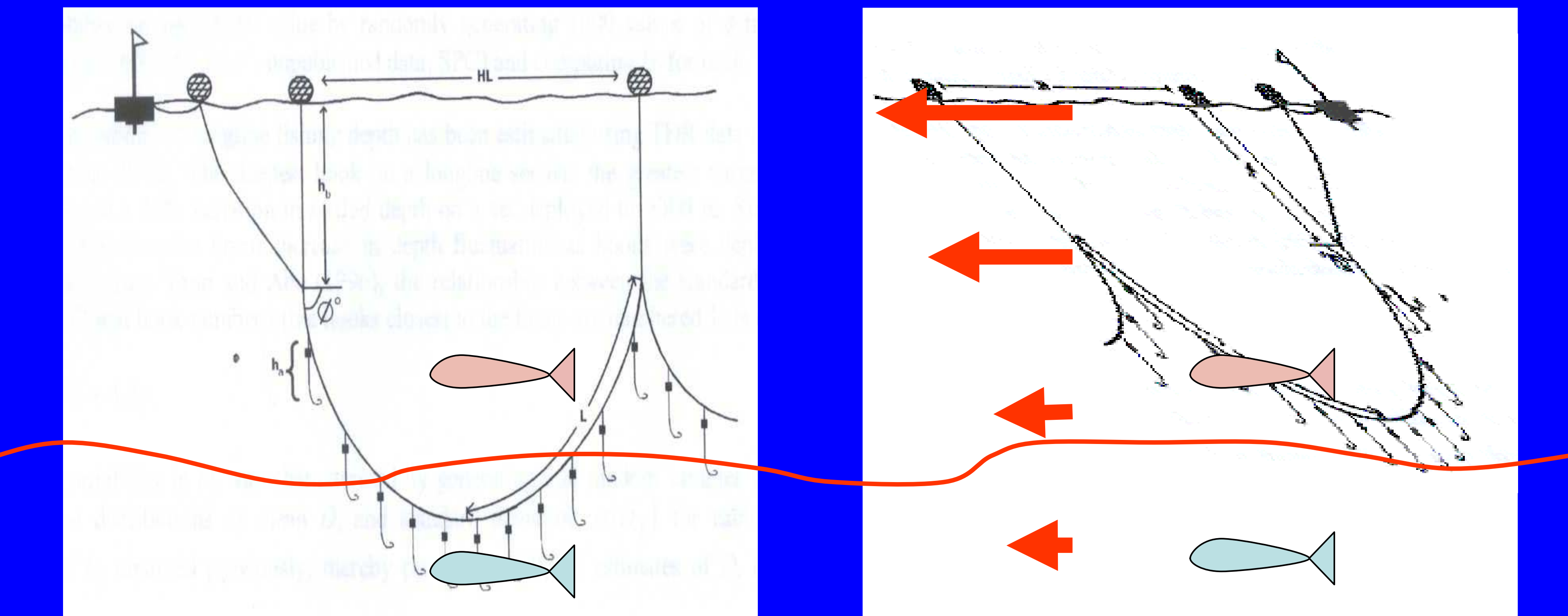
Background

To incorporate oceanographic information into stock assessments, need to consider:

- Environmental effects on fish
  - Recruitment , mortality, movement, vertical distribution,…
- Environmental effects on fishing gear
  - Shoaling, tangling,…

Specific task is to standardize fishing effort by accounting for various environmental effects

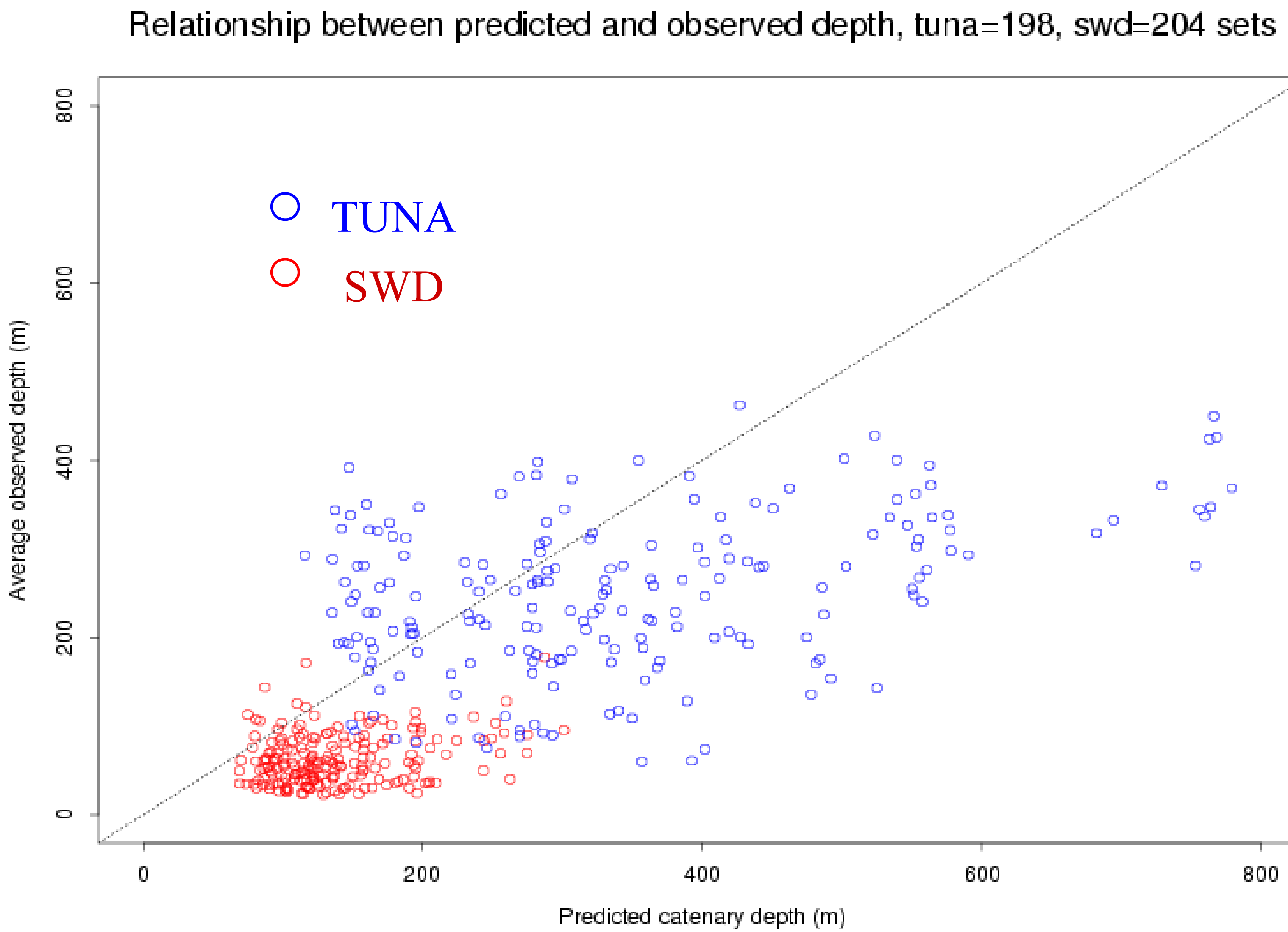
Shoaling of longline hooks due to Current Shear



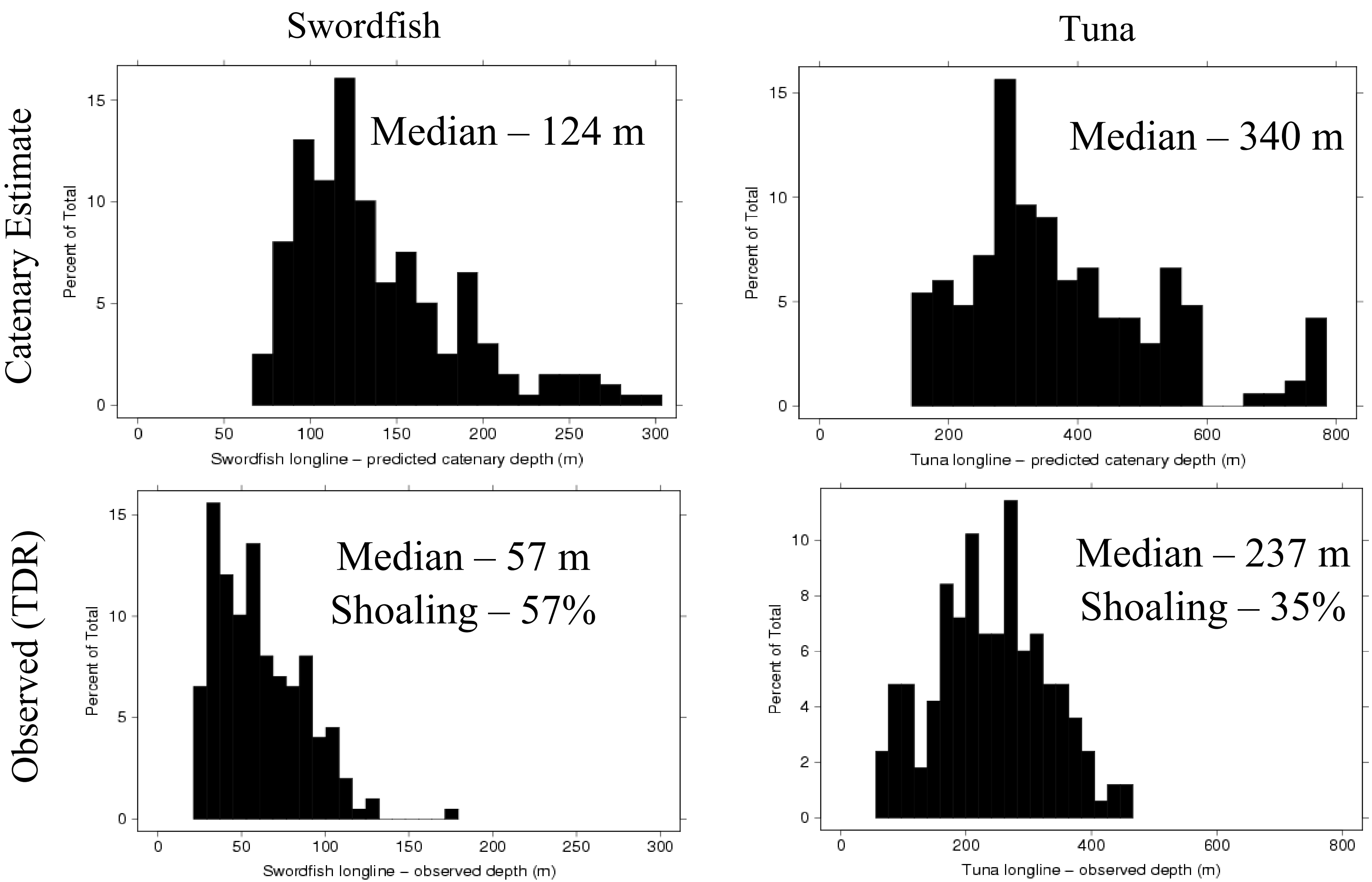
Data on Depth of Hooks and Fish

- 600 TDRs deployed in the Hawaii-based swordfish and tuna longline fishery
  - estimation of gear shoaling
  - development of gear shoaling model with oceanographic variables (wind stress & current shear)
- vertical distribution for 10 HMS species; 19,400 individuals from 600 longline sets

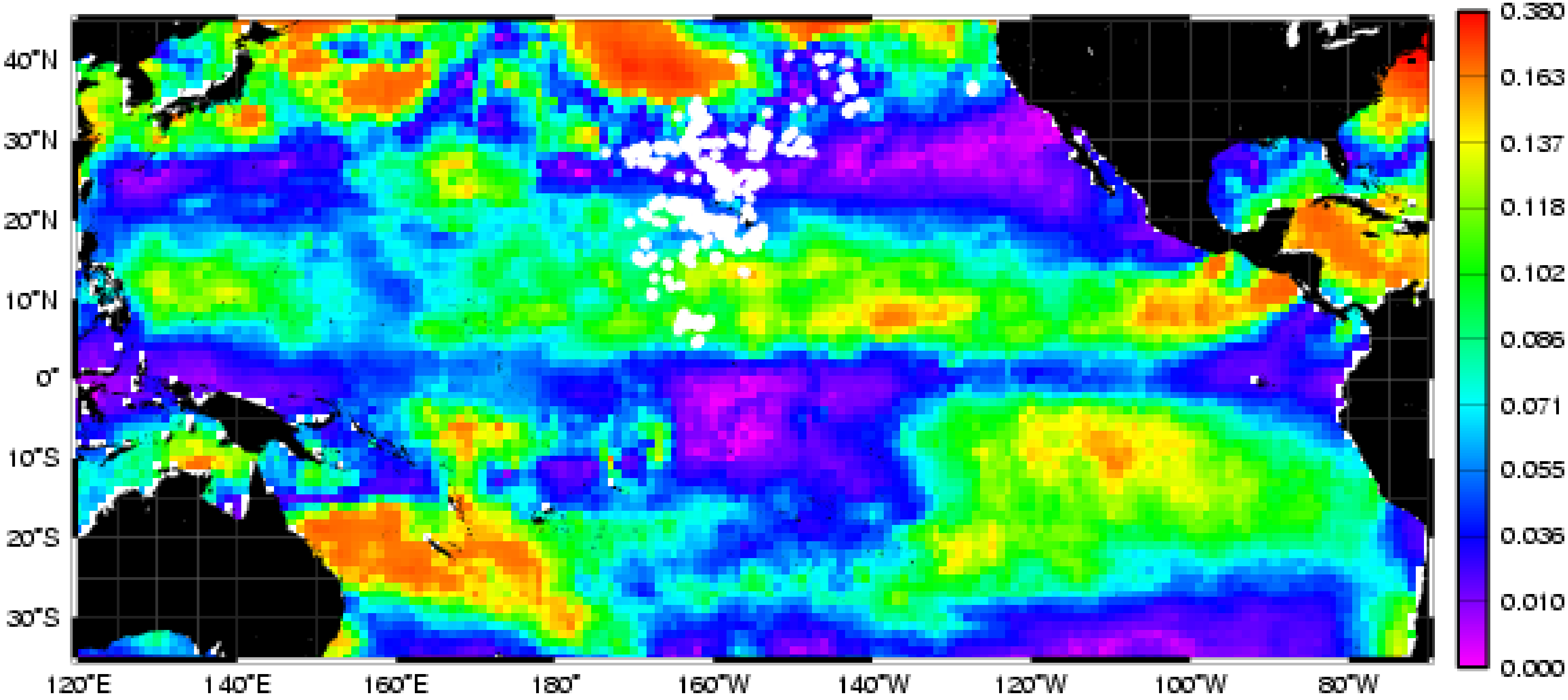
Results: Longline Shoaling: TDR v.s Catenary



Results: Longline Shoaling

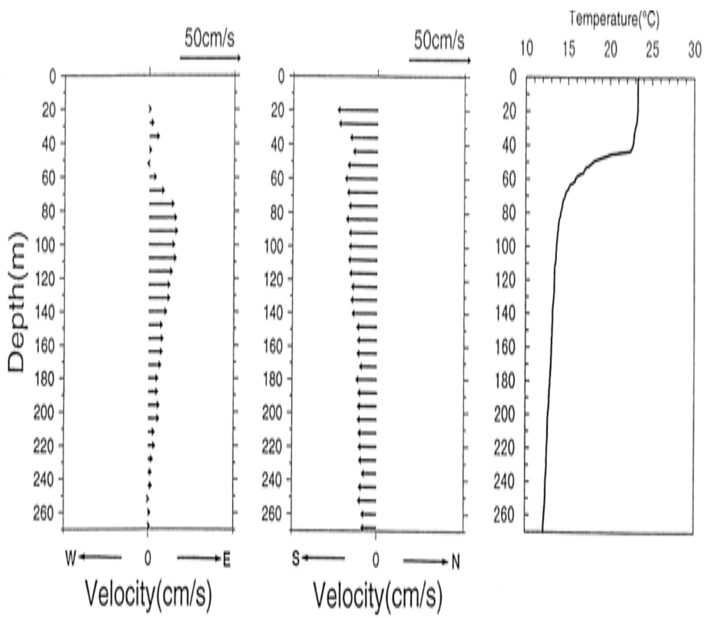


Wind Stress

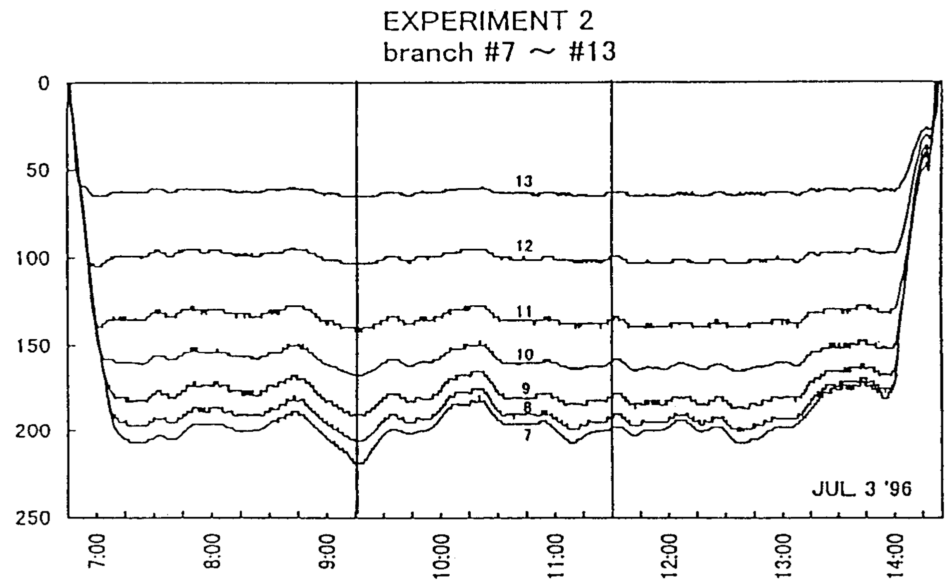


40°N
30°N
20°N
10°N
0°
10°S
20°S
30°S
120°E
140°E
160°E
180°
160°W
140°W
120°W
100°W
80°W
0.380
0.163
0.137
0.118
0.102
0.086
0.071
0.055
0.036
0.010
0.000

Vertical Shear of the Horizontal Current Component



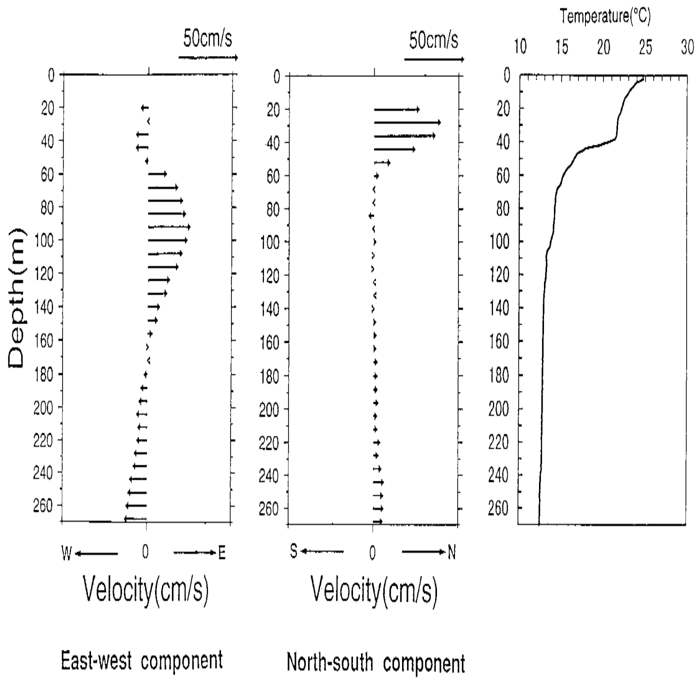
East-West component North-South component

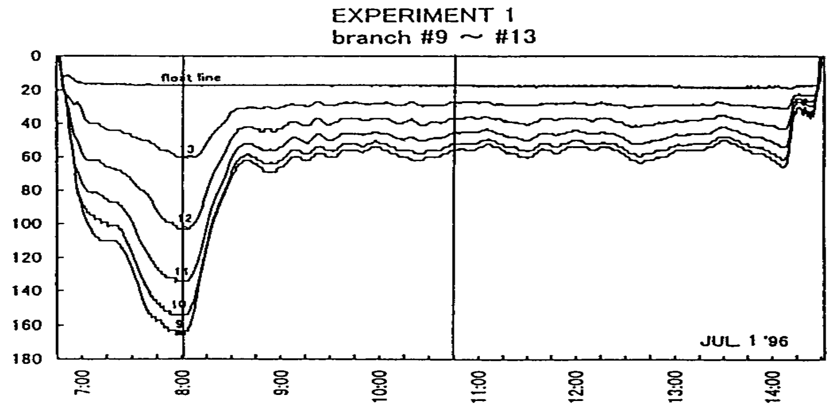


$$K = \log\left(\frac{\int_0^Z \left\| \frac{\partial \bar{u}}{\partial z} \right\| dz}{Z}\right)$$

$$\tilde{K} = \log\left\{\frac{\sum_{n=1}^{N}\left[\left(\frac{u_{n+1}-u_n}{z_{n+1}-z_n}\right)^2+\left(\frac{v_{n+1}-v_n}{z_{n+1}-z_n}\right)^2\right]^{\frac{1}{2}}(z_{n+1}-z_n)}{\sum_{n=1}^{N}(z_{n+1}-z_n)}\right\}$$

Vertical Shear of the Horizontal Current Component





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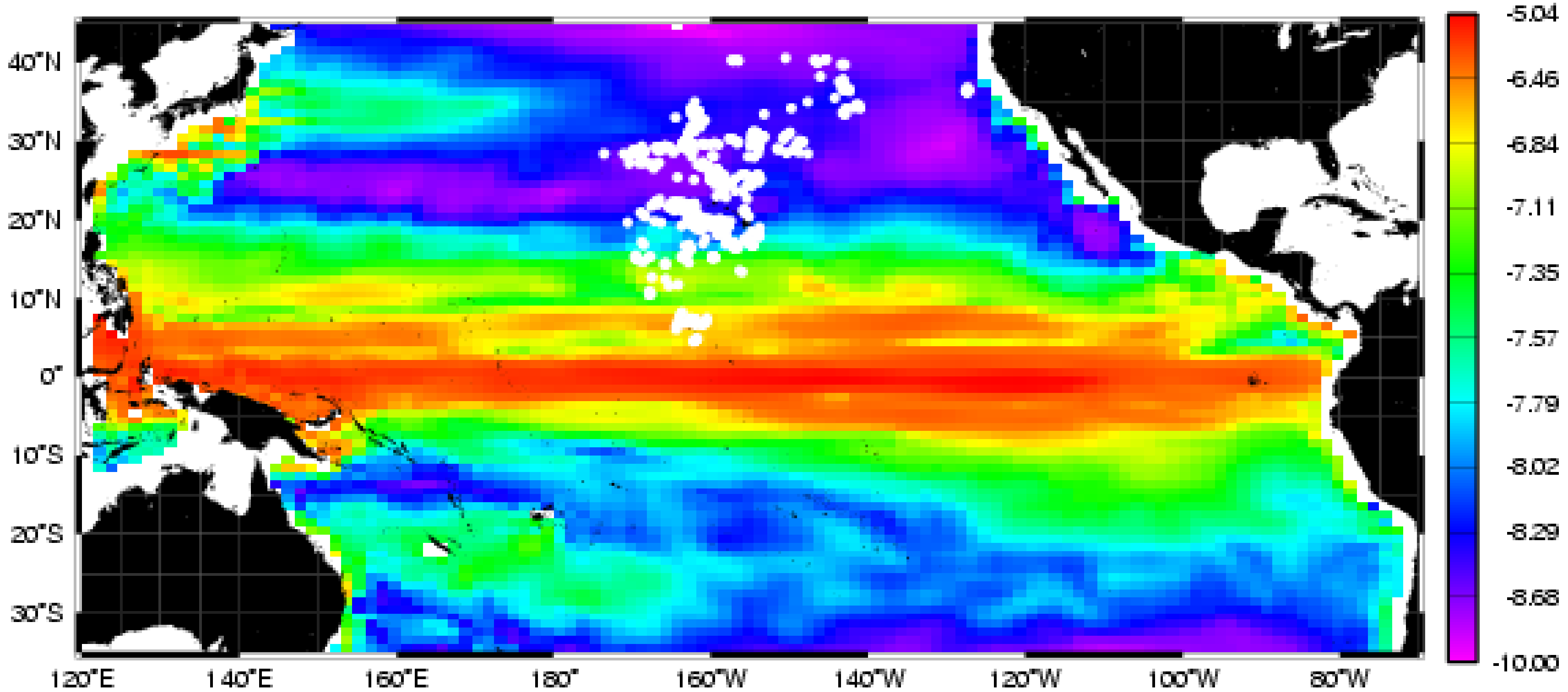
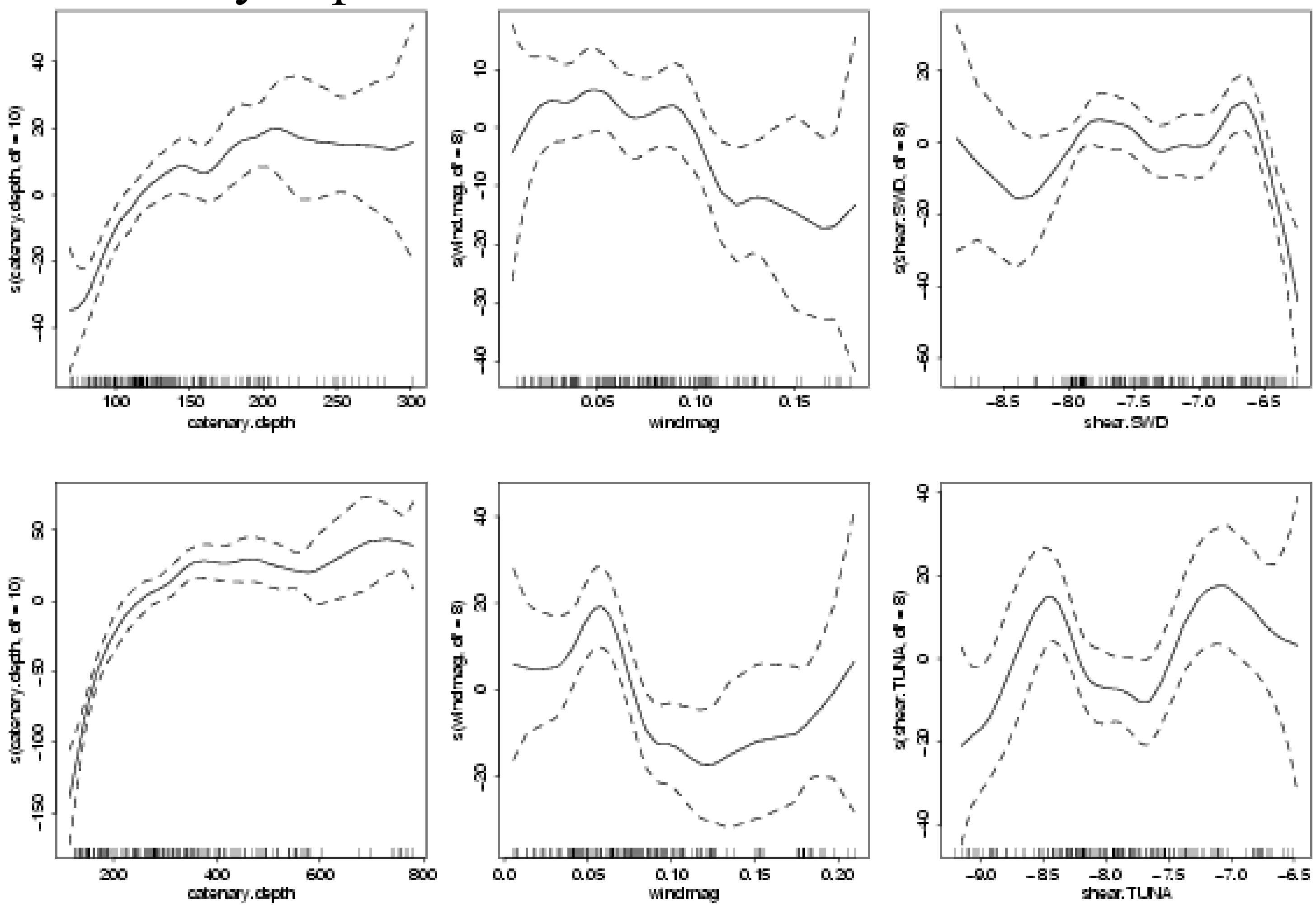
Vertical Shear of the Horizontal Current Component (OGCM)

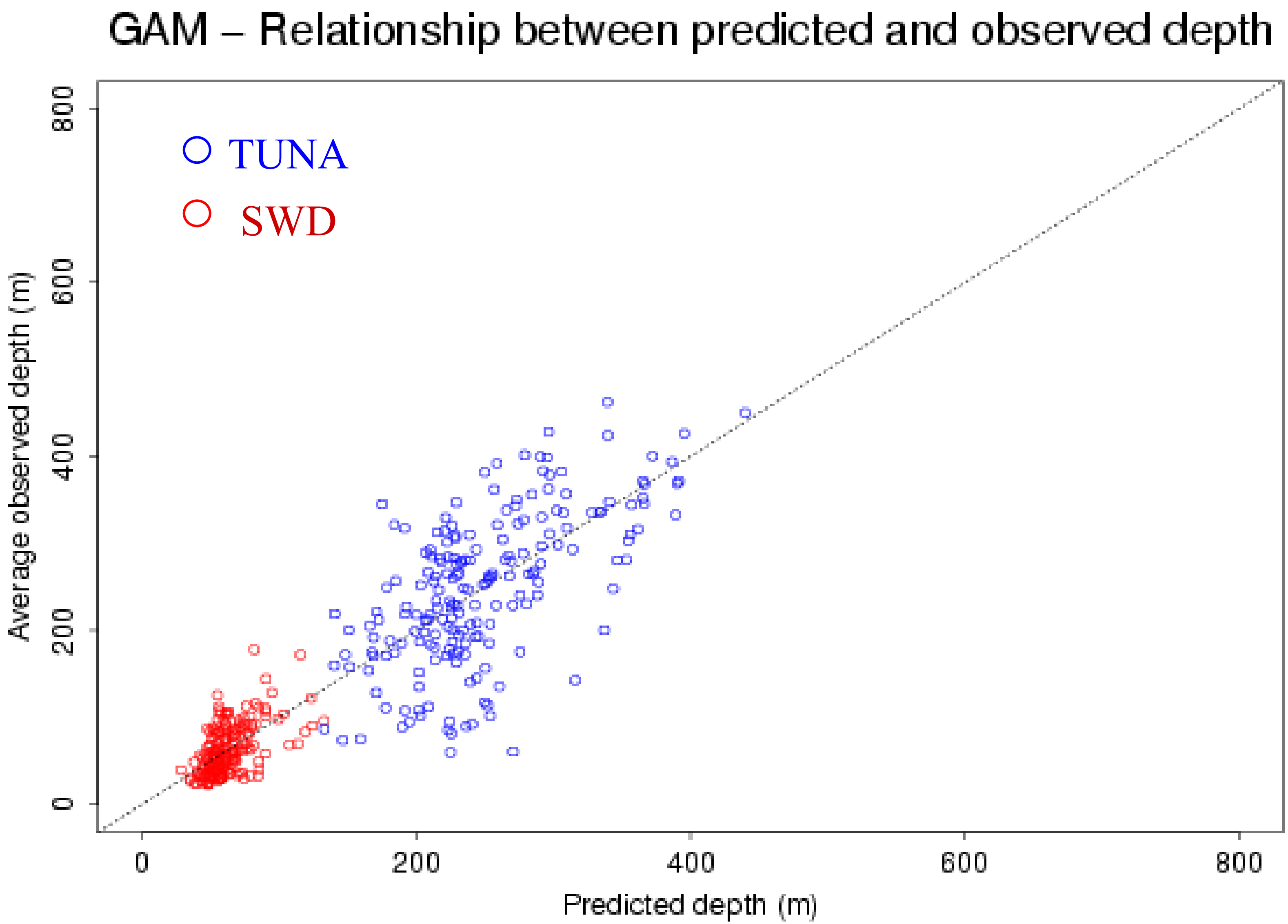


Gam: shoaling% ~ s(catenary.depth)+s(wind.stress)+s(vertical.shear)

	catenary depth	wind.stress	vertical.shear
SWD R^2=0.47			
Tuna R^2=0.69			



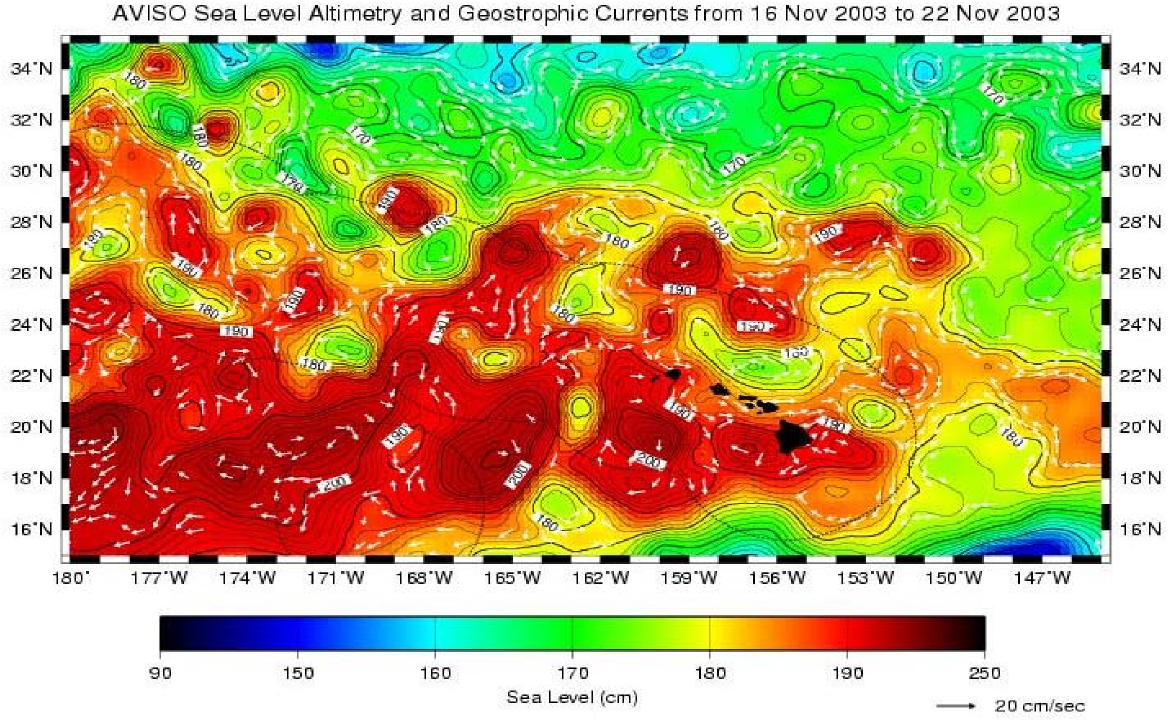
Results: GAM Predicted Depth



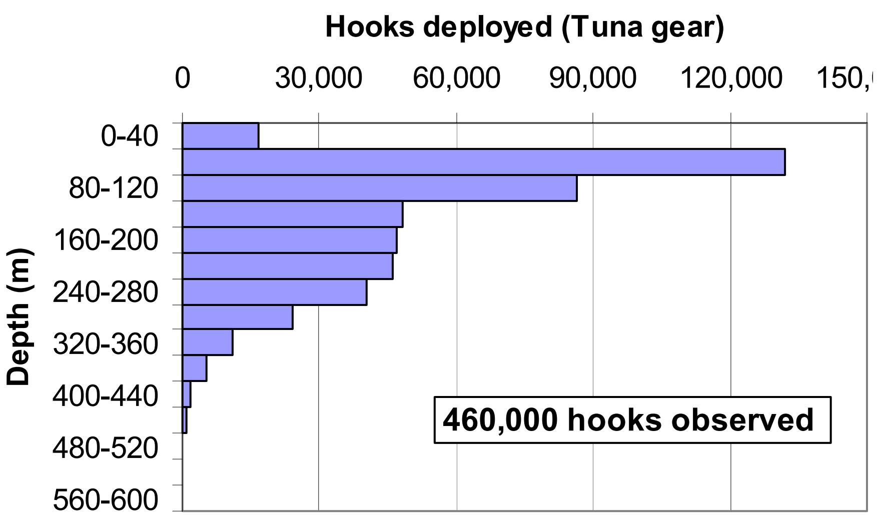
Problems of Scale

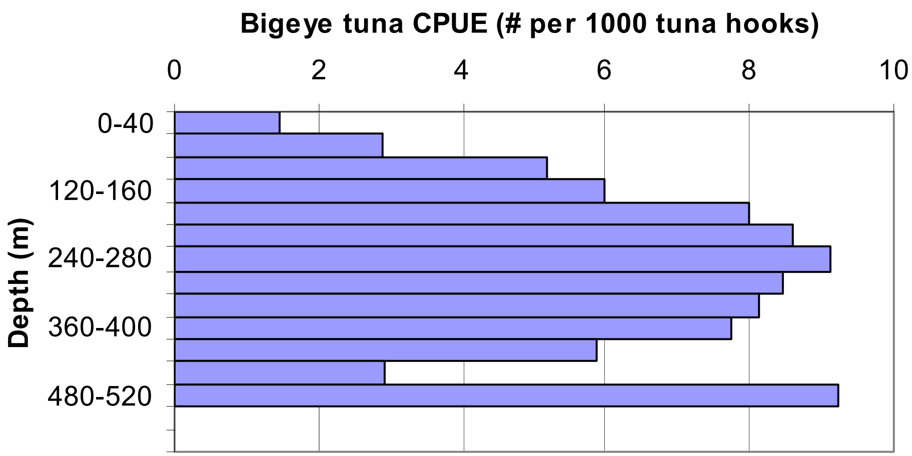
Shear estimated from OGCM with a scale of 1°x 1.5°. Long-term (1950-present) estimates can be calculated; however the subtropics are dominated by mesoscale eddies which are not resolved in the NCEP or IPRC OGCM.

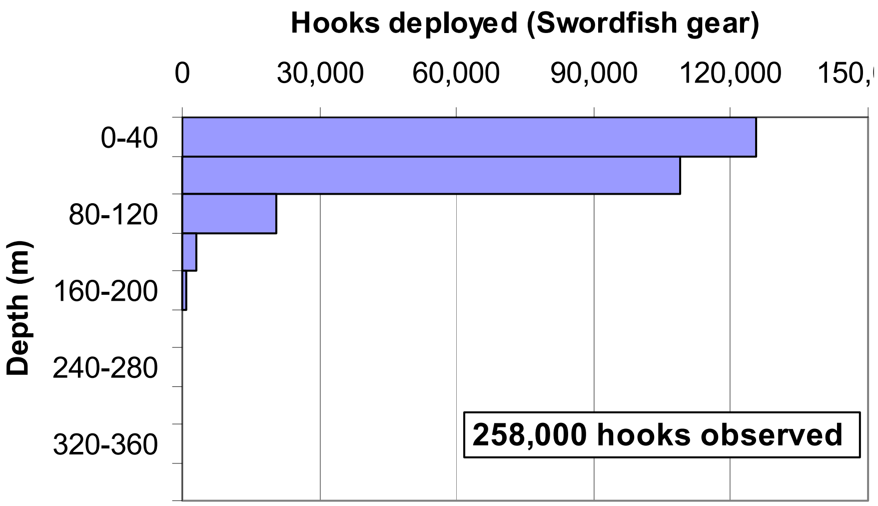
Dynamic height could be used as an alternative to estimate current and shear. Applicable to the Hawaii longline fishery, but not to equatorial areas.

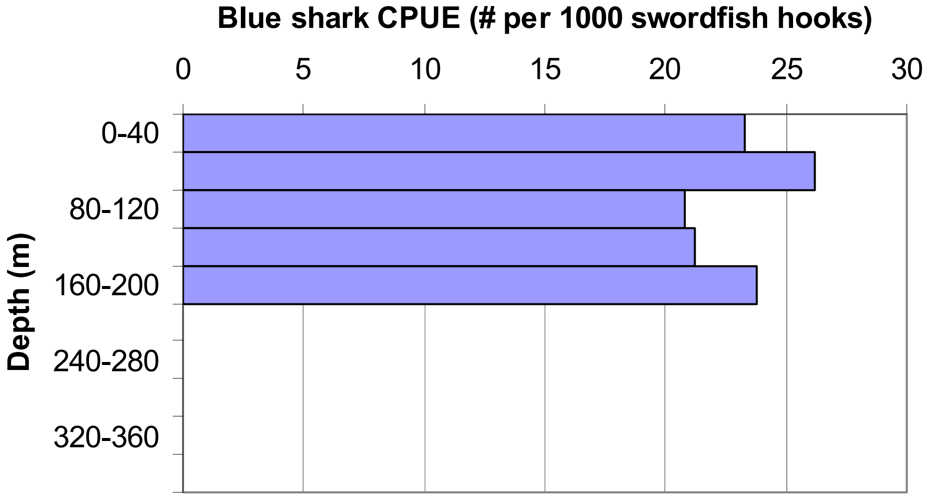


Vertical Distribution of Blue Shark and Bigeye Tuna









Standardizing Effort

Catch in assessment model:

$$C_i = qA_i E^{\text{St}}{}_i$$

where:

$$E_i^{\text{St}} \sim E_i + \overline{\text{depth}_i} + \text{shear}_i + \ldots + \varepsilon_i$$

Conclusions

- Longline shoaling – 57% for swordfish gear; 35% for tuna gear.
- Preliminary gear shoaling model with catenary depth, wind stress and shear as explanatory variables is encouraging.
- Longline depth and temperature at capture are available for 10 HMS. Collaboration with other PFRP projects to compare with PSAT vertical distribution.

Future Work

- Comparison of shoaling estimates from equatorial areas where international tuna longline fisheries predominantly operate. Collaboration with other fishery agencies.
- Incorporating additional oceanographic information such as current and shear estimated from dynamic height.
- Deal with variable vertical distribution by size
- Further develop statistical habitat-based effort standardization models

- Further development of MULTIFAN-CL