Towards effort quantification through VMS and observers' data:
the case of shrimp trawlers in Mauritanian waters

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MOTIVATION

The Spanish shrimp trawlers is one of the most important fleets operating in Mauritania. They target 3 species:

- *Penaeus notialis* (at 20-80 m depth)
- *Parapenaeus longirostris* (at 100-350 m depth)
- *Aristeus varidens* (at 400-800 m depth)

in 3 types of fishing operations that can be carried out during the same day.

A critical challenge is to define suitable metrics of effective fishing effort since logbooks only provide information of catches by day. Accurate CPUE obtained from these vessels could be considered good abundance indices of its target stocks, which is of paramount importance for assessment purposes.

METHODOLOGY

The objective of this analysis was to use Vessel Monitoring System (VMS) information to robustly infer fleet activity as well as estimate units of effort directed to each of the three target species of the Spanish trawlers operating within the EEZ of Mauritania. The methodology comprised:

1) discrimination between non-fishing and fishing points in VMS data;
2) computation of effort to each target species with respect to depth;
3) comparison with fisheries-dependent as observers' data for its validation.

As instantaneous speed is known to be uninformative, averaged speed was calculated from the Euclidian distance and time interval between consecutive VMS records. Fishing activity (no fishing, fishing and steaming) was identified by applying a segmented regression to the cumulative frequency distribution of speeds based in the package VMStools. Speed boundaries were then used to select those records where the vessels were identified to be fishing. VMS positions were linked to GEBCO bathymetry to determine each of the three target species according to depth-ranges. We focus on estimating effort as the time spent fishing based on a point summation method. Effort was estimated for each VMS record as the interval since the previous record and validated by checking the results against observers on-board datasets.

RESULTS

The segmented regression indicated that the use of a 2.2-3.3 knots speed filter could provide an effective means of distinguishing the fishing activity for trawling.
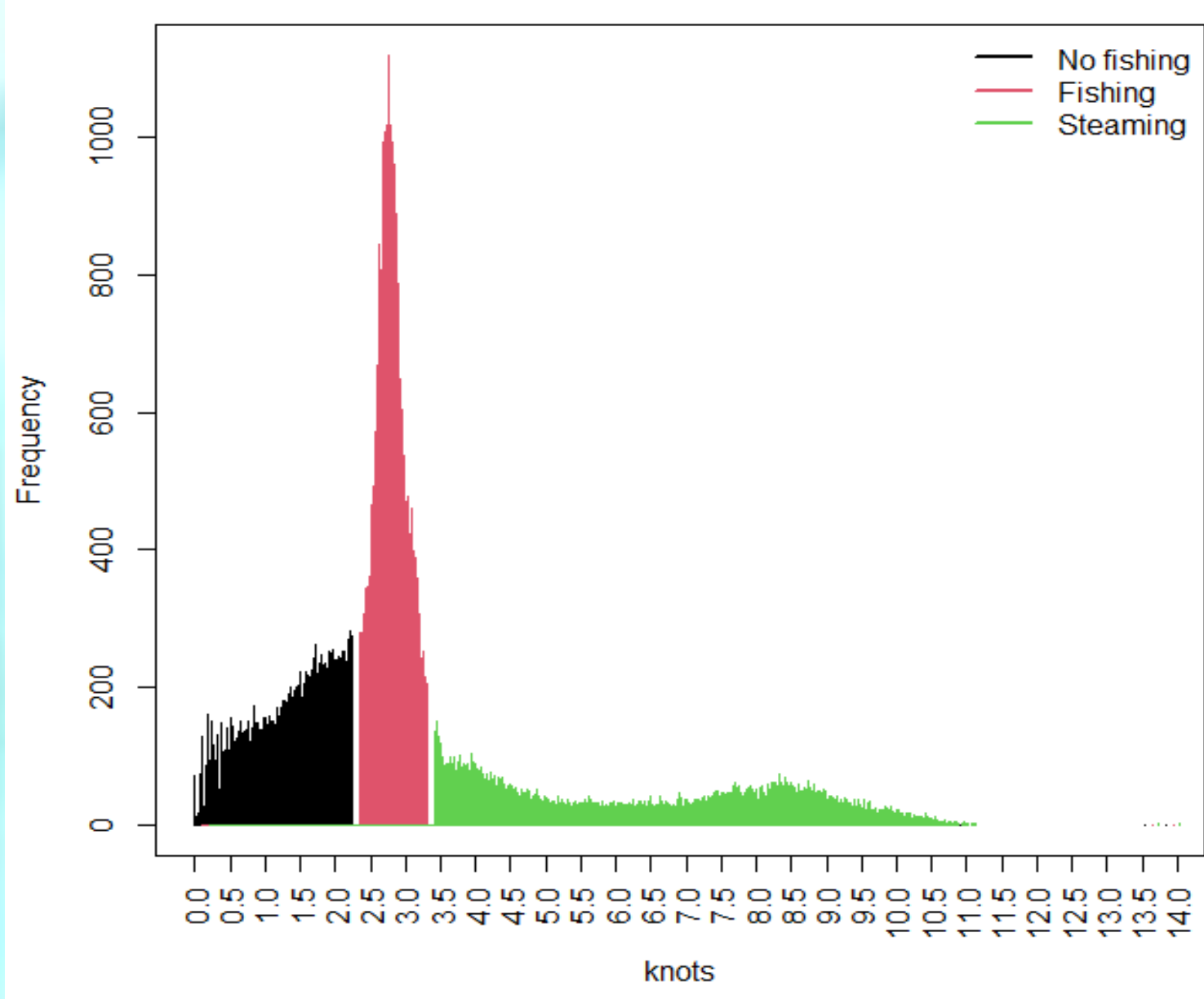

Figure 1. Speed distribution calculated given the Euclidian distance and time interval between successive VMS pings of the Spanish shrimp trawlers operating within EEZ Mauritania in 2016 and 2018, where colors represent the speed categories identified by the segmented regression.

Using the speed range 2.2-3.3 knots to signify fishing, 49% of records were classified as fishing in each of the years analyzed.
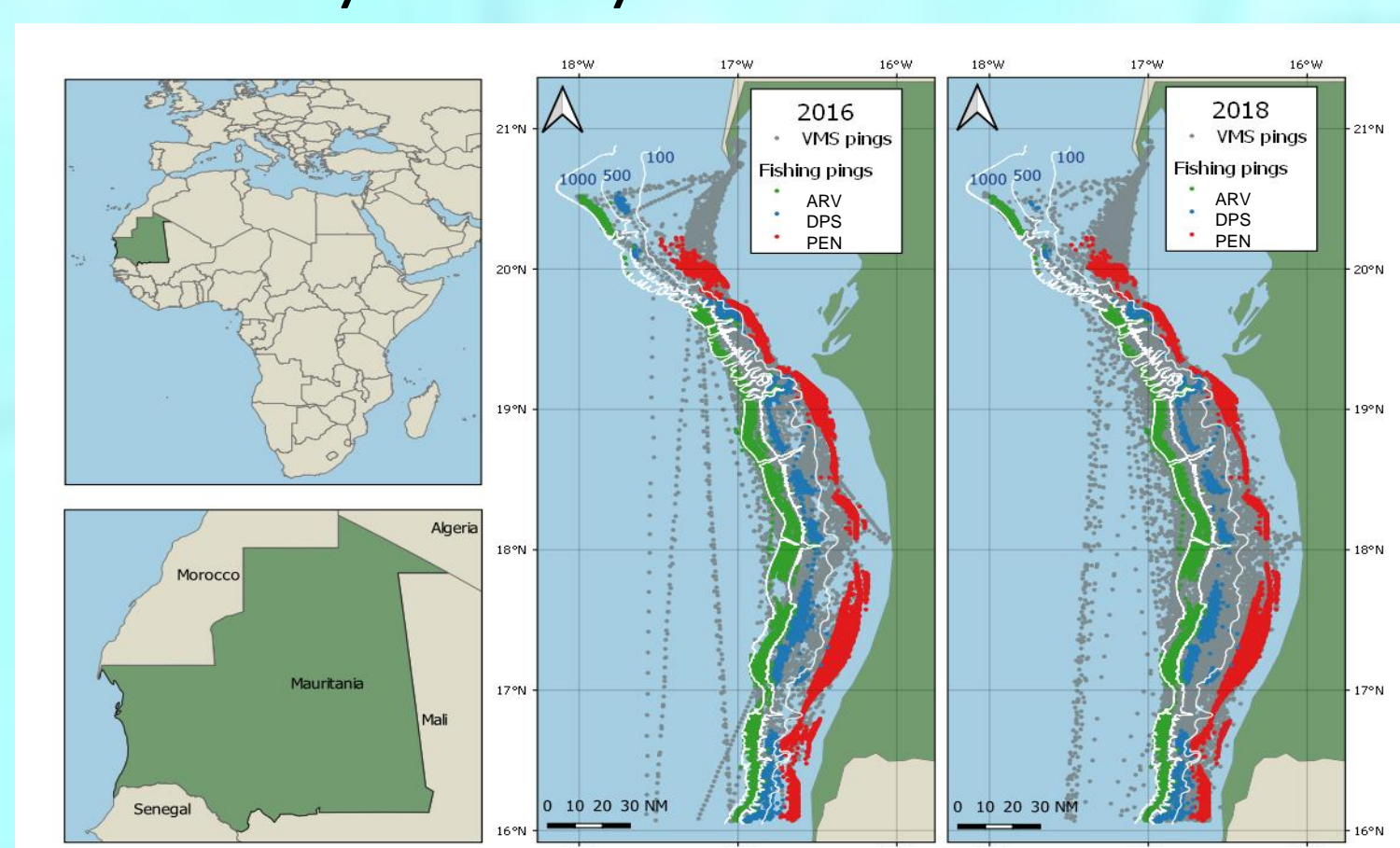

Figure 2. The spatial distribution in 2016 and 2018 of raw VMS positions and "fishing" positions after having applied the speed segmented regression rule and assigned to target species according to depth-ranges. ARV: *A. varidens* (green), DPS: *P. longirostris* (blue), PEN: *P. notialis* (red).

Table 1. Observers' trips used for detailed comparison and validation of VMS analysis.

| trip	initial date	final date	hauls	total pings	fishing pings	% fishing pings to total pings	correct fishing pings	%correct fishing pings to total fishing pings
0116	21/03/2016	29/03/2016	46	407	216	53.1	192	88.9
0216	03/04/2016	24/05/2016	274	2327	1317	56.6	1157	87.9
0316	27/05/2016	27/07/2016	321	2733	1470	53.8	1316	89.5
0416	19/08/2016	20/09/2016	217	771	328	42.5	287	87.5
0516	20/11/2016	20/12/2016	182	739	328	44.4	219	66.8
0118	10/01/2018	13/03/2018	292	4806	2901	60.4	2677	92.3
0218	07/05/2018	14/07/2018	357	1629	961	59.0	825	85.8
0318	26/09/2018	12/11/2018	218	1134	509	44.9	462	90.8
0418	19/12/2018	31/12/2018	63	310	151	48.7	134	88.7
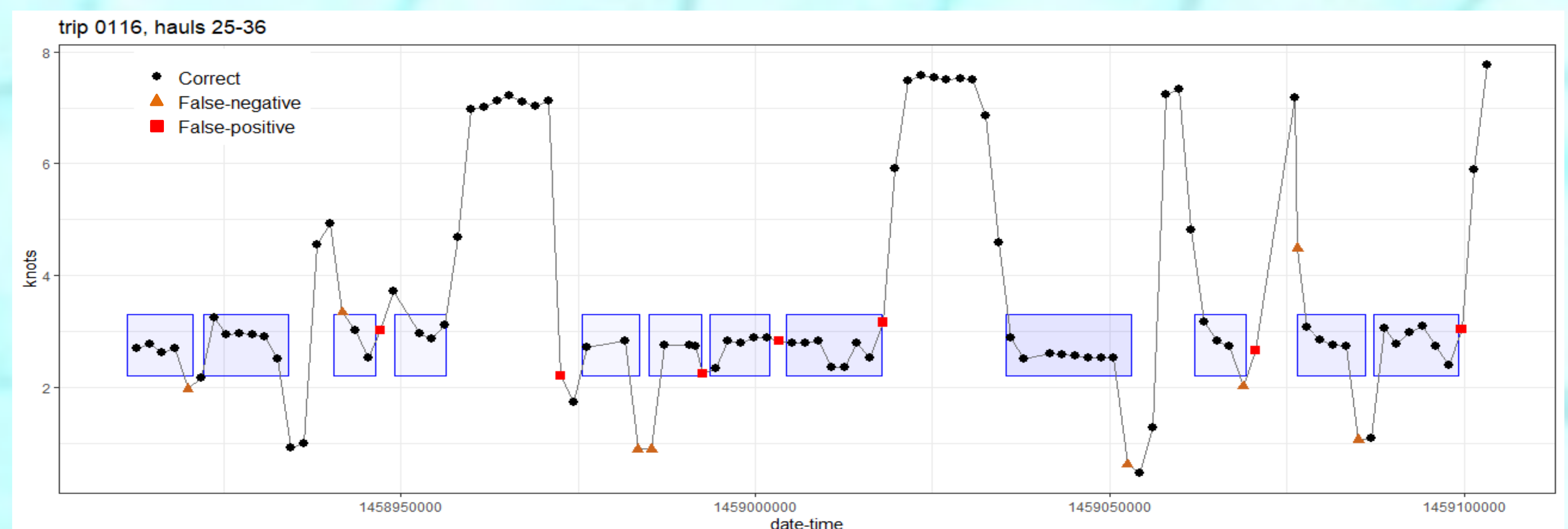
Figure 3. An example of VMS and observer data for one trip (0116, hauls 25 to 36), each point representing one VMS record. The blue boxes represent the fishing activity recorded by the observer (hauls). Calculated vessel speeds between 2.2 and 3.3 knots were assumed to correspond to fishing. False-positive results are VMS records that fall within the speed criteria for fishing, but for which no fishing activity was recorded. False-negative results are VMS records that fall outside the speed criteria for fishing, but which took place during fishing operations.
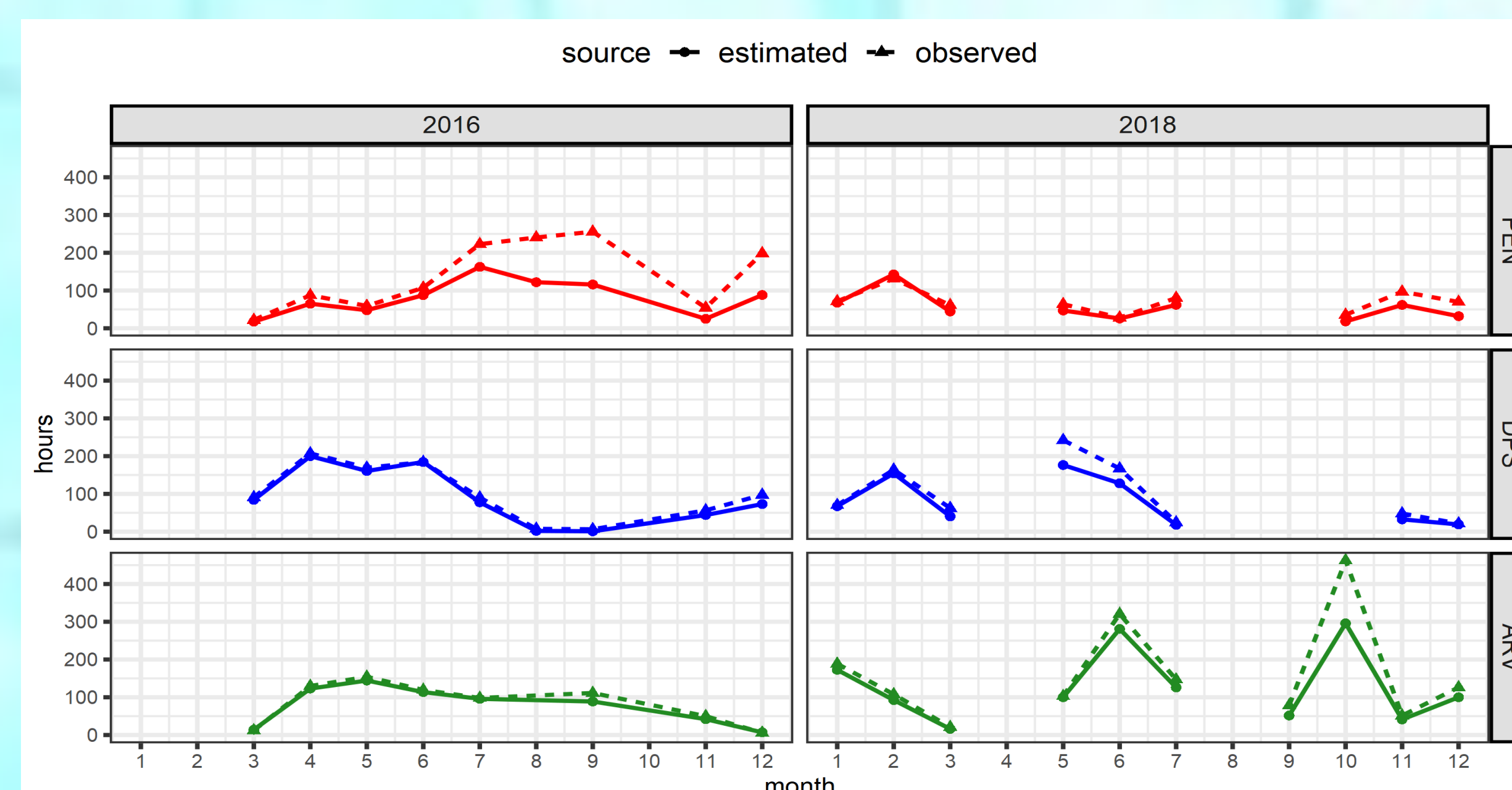

Figure 4. Monthly time series of estimated (from VMS) and observed (registered by observers on-board) effort (hours) in 2016 and 2018 by target species. PEN: *P. notialis*, DPS: *P. longirostris*, ARV: *A. varidens*.

In CONCLUSION:

- The speed criteria (i.e. 2.2-3.3 knots) provides a simple method for identifying trawling activity of the shrimpers in Mauritanian waters
- The estimates of trawling effort by target species obtained from VMS data show consistency in both values and temporal trends with those registered by observers on-board
- The adoption of a consistent method for analysing VMS data will help to ensure that calculations of trawling effort are repeatable and comparable among studies

NEXT

- Link with logbook data to obtain CPUE (kg/h) by target species
- Input for stock assessment as abundance indicator