

Comisión Interamericana del Atún Tropical  
Inter-American Tropical Tuna Commission



## AN ELECTRONIC MONITORING SYSTEM FOR TUNA FISHERIES IN THE EPO: STRUCTURE, IATTC WORKPLAN, AND PILOT EM STUDIES

AD HOC WORKING GROUP ON THE DEVELOPMENT OF ELECTRONIC MONITORING  
PROGRAMME STANDARDS (WGEMS)

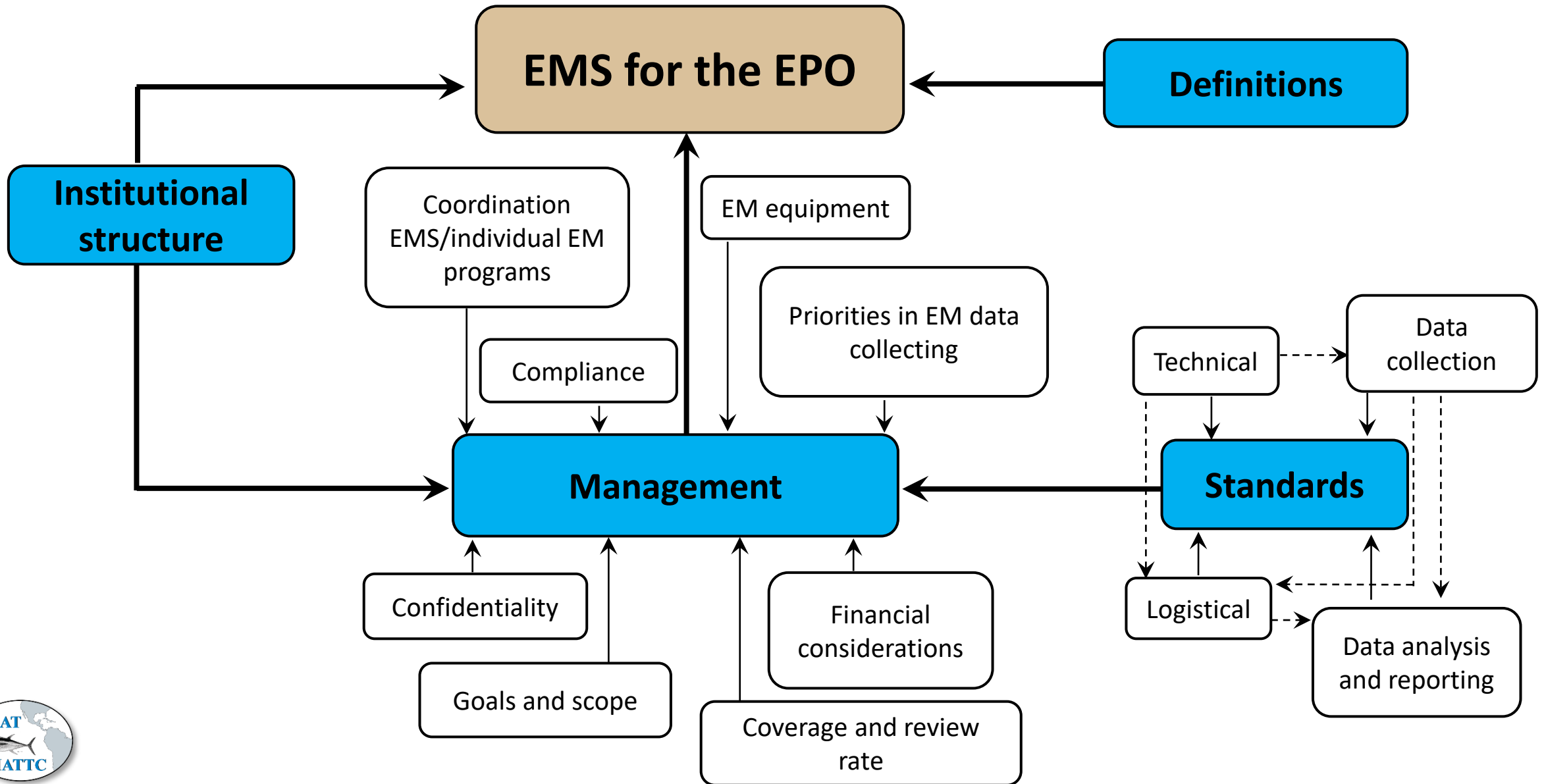
- **Steps taken for the implementation of an EMS for the tuna fisheries in the EPO.**
  - Proposed structure of the EMS.
  - Proposed workplan activities.
- **EM standards on data collection.**
  - Tuna purse-seine vessels in the EPO (Emphasis in small vessels).
  - Tuna longline vessels in the EPO.

# EMS for the tuna fisheries in the EPO. Background

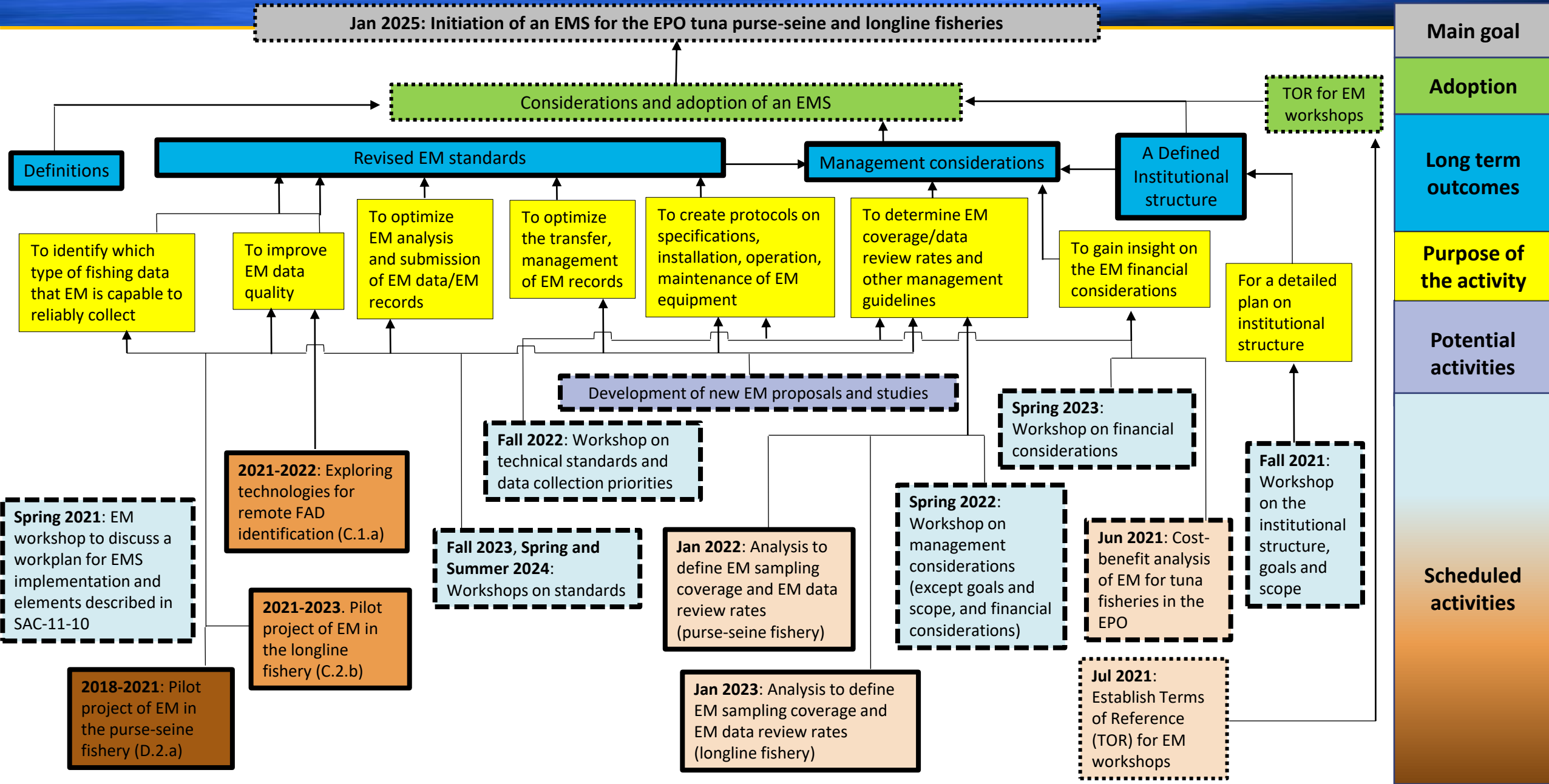
- During SAC-10, and pursuant to **C-19-08**, the IATTC staff was requested to draft minimum standards and data collection and reporting requirements for EMS for the EPO tuna fishery.
- Document **SAC-11-10** was presented by VC in the SAC-11.
- 11<sup>th</sup> Scientific Advisory Committee proposed the staff to organize an EM workshop in 2021 to further discuss SAC-11-10, as well as a workplan for EMS implementation in the EPO. The proposal was endorsed in the IATTC 96<sup>th</sup> meeting.
- 1<sup>st</sup> EM workshop on Implementation of an Electronic Monitoring System (EMS). (22-23 Apr 2021):
  - An overall structure of the proposed EMS framework was presented (SAC-11-10 and **EMS-01-01**).
  - Immediate actions recommended for adoption by the Commission (document EMS-01-01):
    - Adopt the definitions of EMS-01-01. Adopted during 98<sup>th</sup> IATTC Meeting (Res. **C-21-03**).
    - Adopt the proposed workplan of document **EMS-01-02**. Adopted during 98<sup>th</sup> IATTC Meeting.
    - Establish Terms of Reference for the EM workshops. Adopted during 98<sup>th</sup> IATTC Meeting (Res. **C-21-02**).



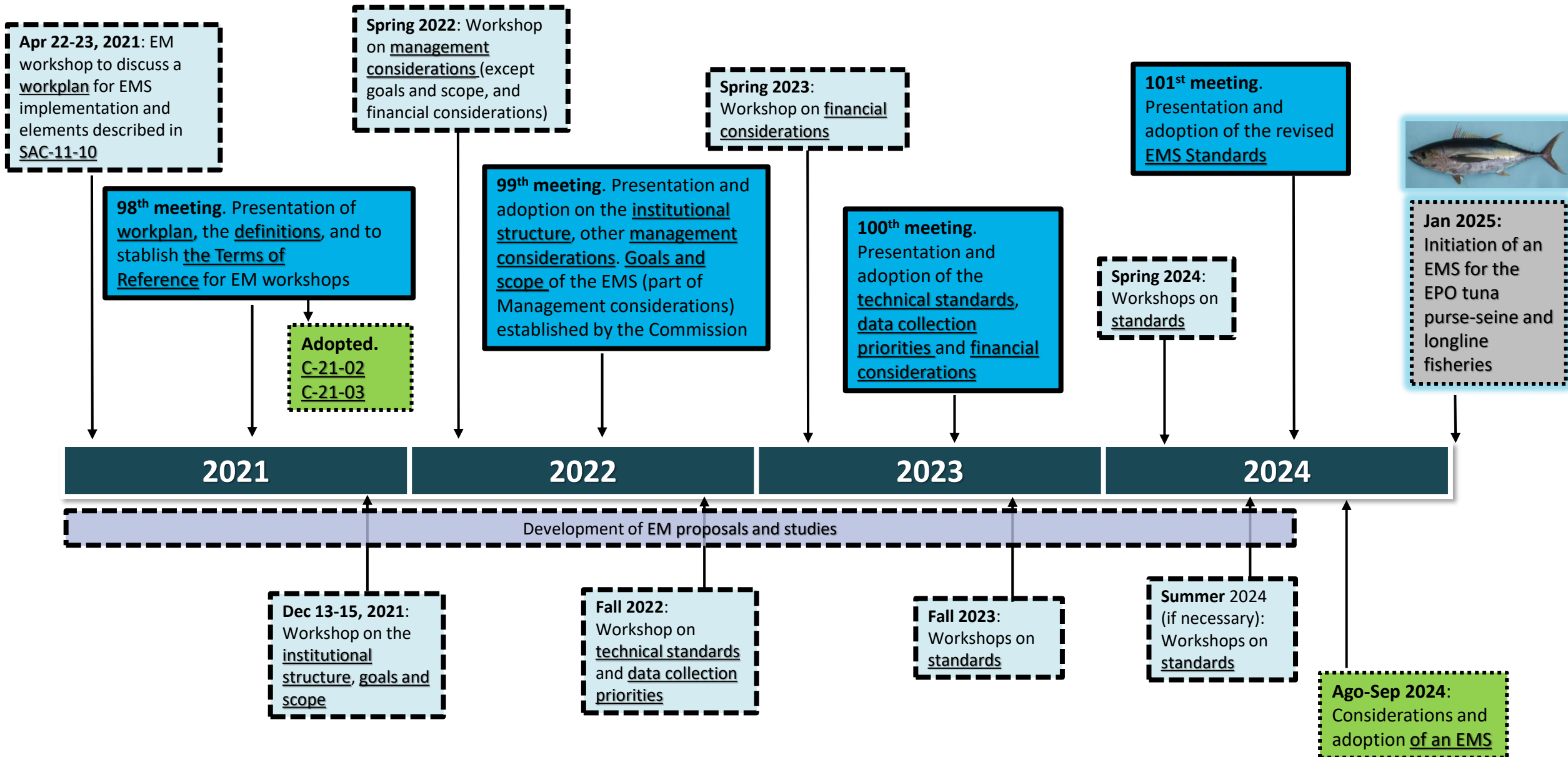
# Proposed structure of the EMS for the tuna fisheries in the EPO



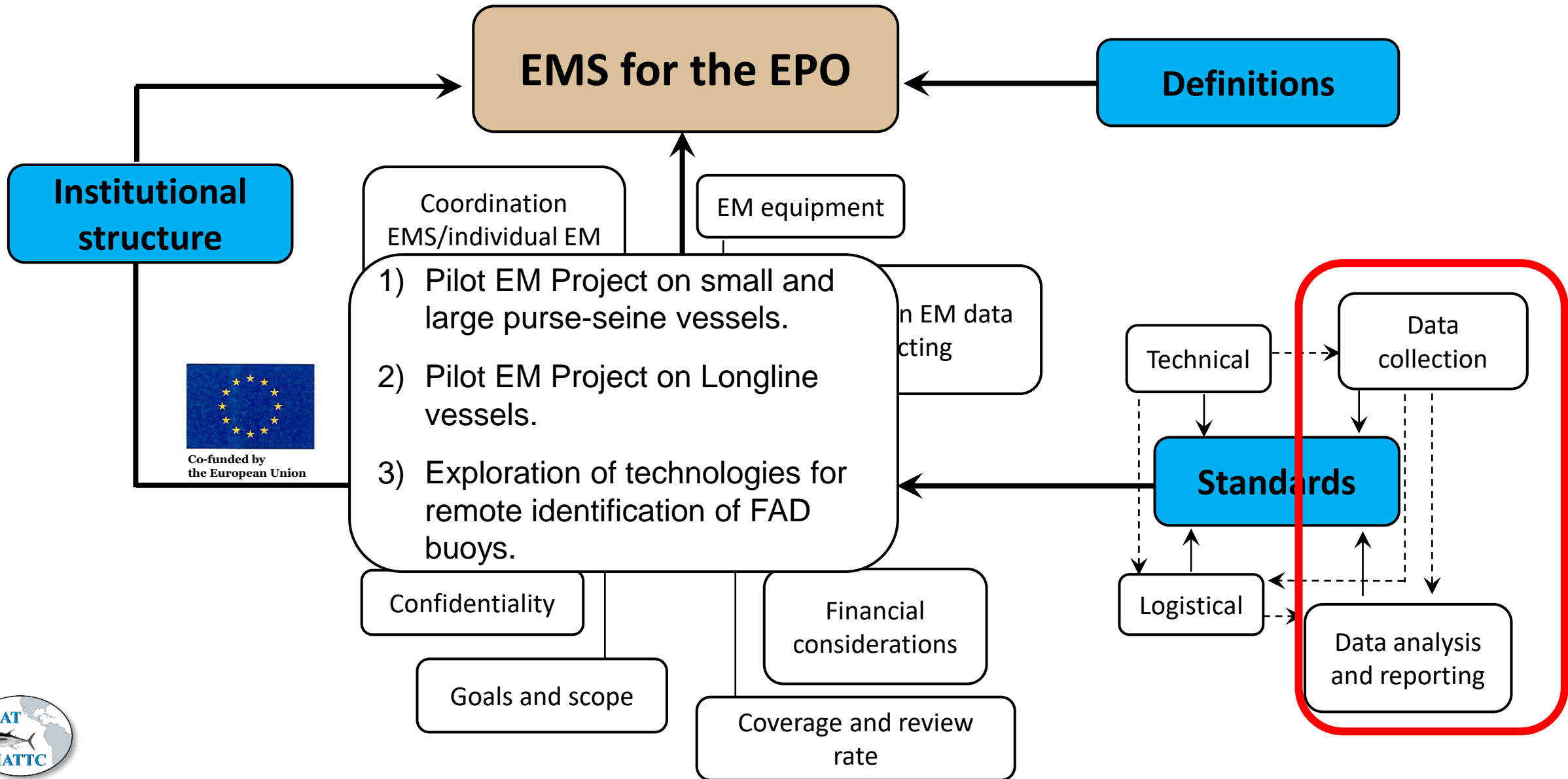
# Adopted workplan for an EMS in the EPO



# Timeline of workshops plan and milestones



# Proposed structure of the EMS for the tuna fisheries in the EPO



# Small tuna purse-seine fleet (Class 1-5 vessels)

- High-quality data from fisheries e.g., catch composition and CPUE required for science-based fisheries management.
- **Current sources of detailed data:** Observers, vessel logbooks, port sampling
  - Vessel logbooks (Class 1-5 vessels): limited information on non-target species, and none on discards of target species. Information present is not debriefed.
  - Port sampling: Species and size composition data for target species only.
  - Observers (mostly Class-6 vessels): Rarely on Classes 1-5 vessels.
- EM may tackle these challenges. Evaluate if EM can be used to collect reliable information on set type, FAD deployments, catches, and bycatches.
- Collecting and comparing human observer and EM required to get a preliminary evaluation of EM performance.





# Small tuna purse-seine fleet (Class 1-5 vessels)

## Survey on infrastructure and fishing operations of Class 1-5 vessels

- Group small vessels into clusters of vessels with similar operational characteristics that may be important with respect to EM.
- Provide data with which to select vessels for the pilot study.

### Survey questions

#### Well loading and catch handling

- How are the wells loaded from the main deck?
- How are the marketable fish sorted on the main deck?
- How are billfish, mantas and large sharks removed from the sack?
- Can people work on the wet deck when the wells are being loaded?
- What is the brail capacity?

#### Set type and no. of speed boats

- For what percentage of floating-objects sets does the object remain in the net after encirclement?
- What is the number of speed boats used in a typical floating-object set?
- What is the number of speed boats used in a typical unassociated set?
- How many operable speed boats are onboard?

#### FAD deployment

- By what method are FADs deployed from the vessel?
- From where on the vessel are FADs deployed?

#### Vessel infrastructure

- Is the wet deck accessible to people?
- What is the height of the crow's nest?
- What is the total number of wells in the vessel?

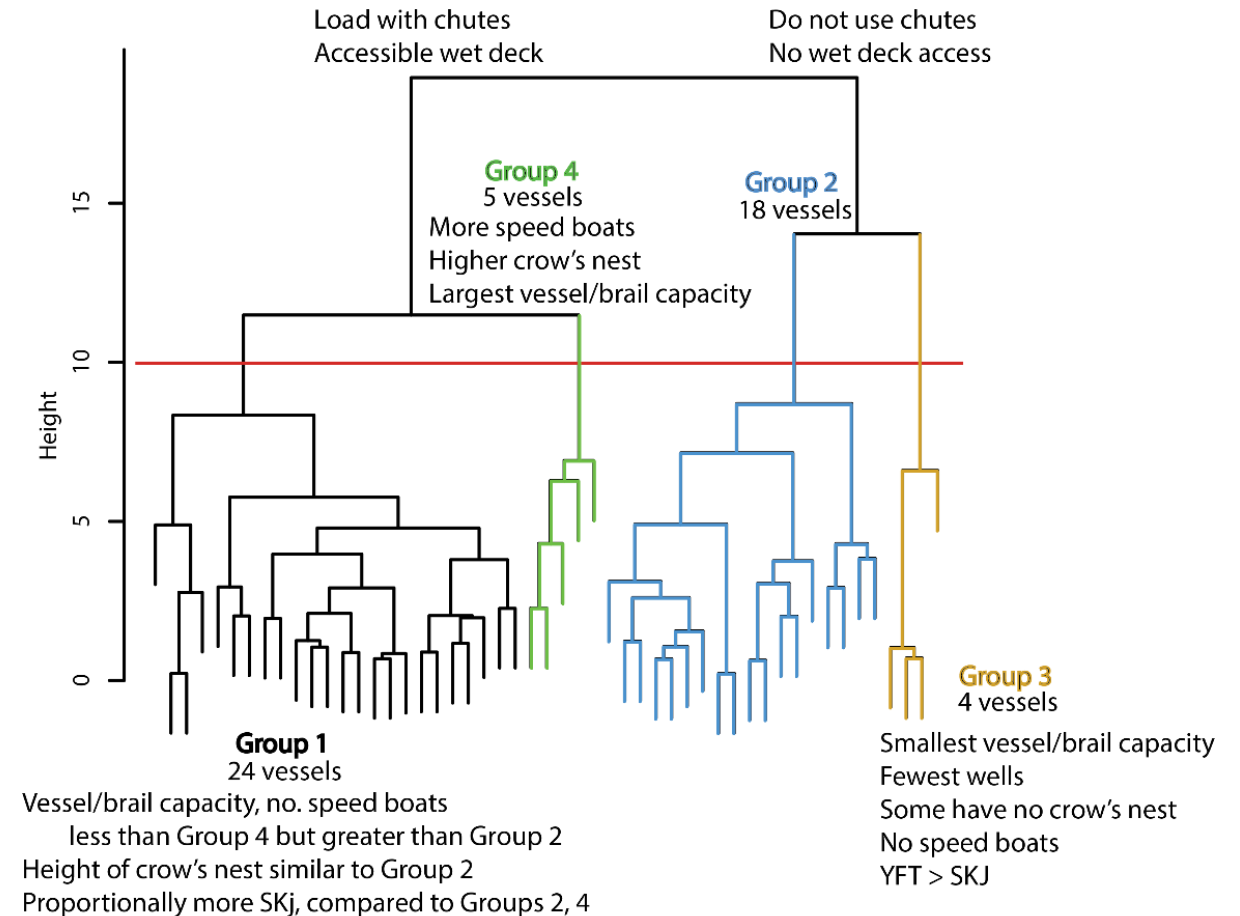
### Responses received by flag: (58 out of 69 active vessels were surveyed)

	COL	ECU	MEX	PAN	PER	USA
<b>Total number of active vessels</b>	2	46	6	1	5	9
<b>Number of vessels surveyed</b>	2	38	6	1	3	8
<b>Percentage surveyed</b>	100	82.6	100	100	60	88.9
<b>Percentage among those surveyed</b>	3.5	65.5	10.3	1.7	5.2	13.8



# Cluster analysis of Class 1-5 survey data

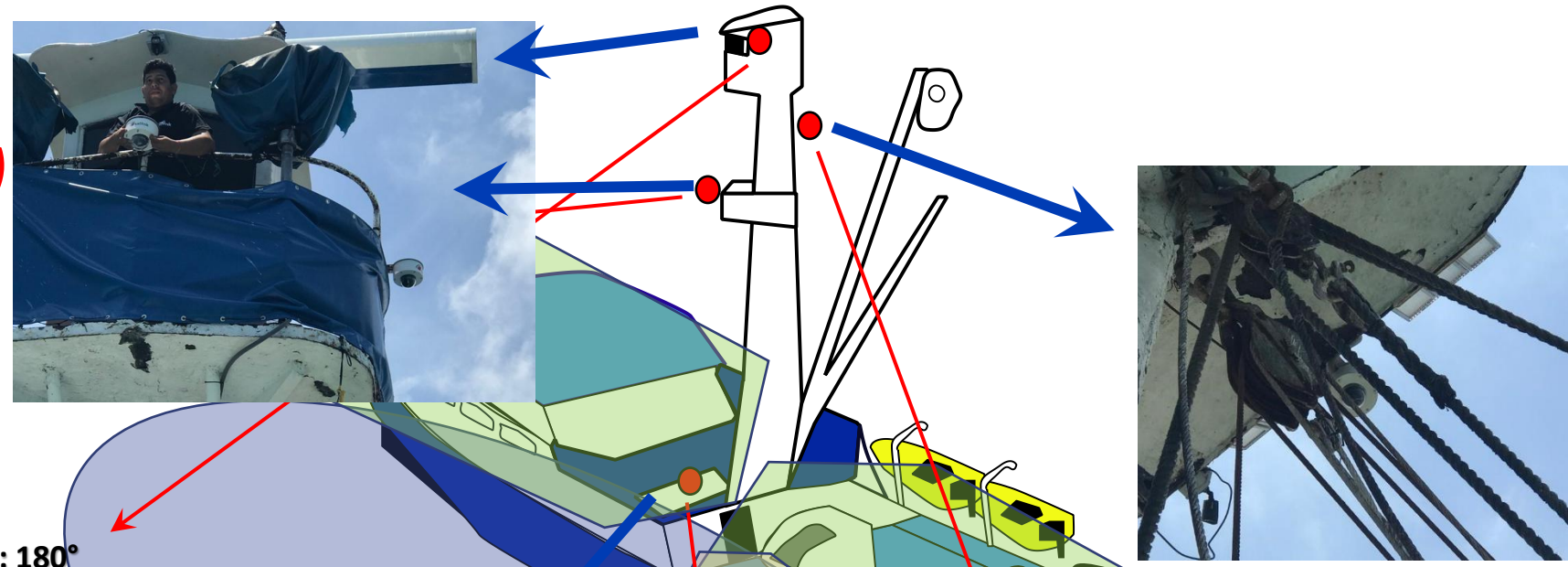
- Four large groups of vessels identified
- Primary split based on:
  - Use of chutes, accessibility of wet deck
- Smaller splits based on other variables
- For example:
  - Group 4 contains vessels with:
    - Largest vessels/brail capacity
    - Higher crow's nests
    - More speed boats
    - But catch composition similar to Groups 1-2
  - Group 3 contains vessels with:
    - Smallest vessels/brail capacity
    - Some have no crow's nest
    - No speed boats
    - YFT > SKJ



# Participating vessel – Class-2

## Small vessel

- 4 cameras (Main deck)



**C1: 180°**

- Floating object presence/absence for set type determination
- FAD deployment



**C3 : 104°**

- FAD deployment
- Preliminary species ID?
- Preliminary sp. size composition?
- Bycatch fate
- Discards

**C2: 104°**

- Species ID?
- Bycatch fate
- Discards
- sp. size composition?
- No. speedboats used in the set



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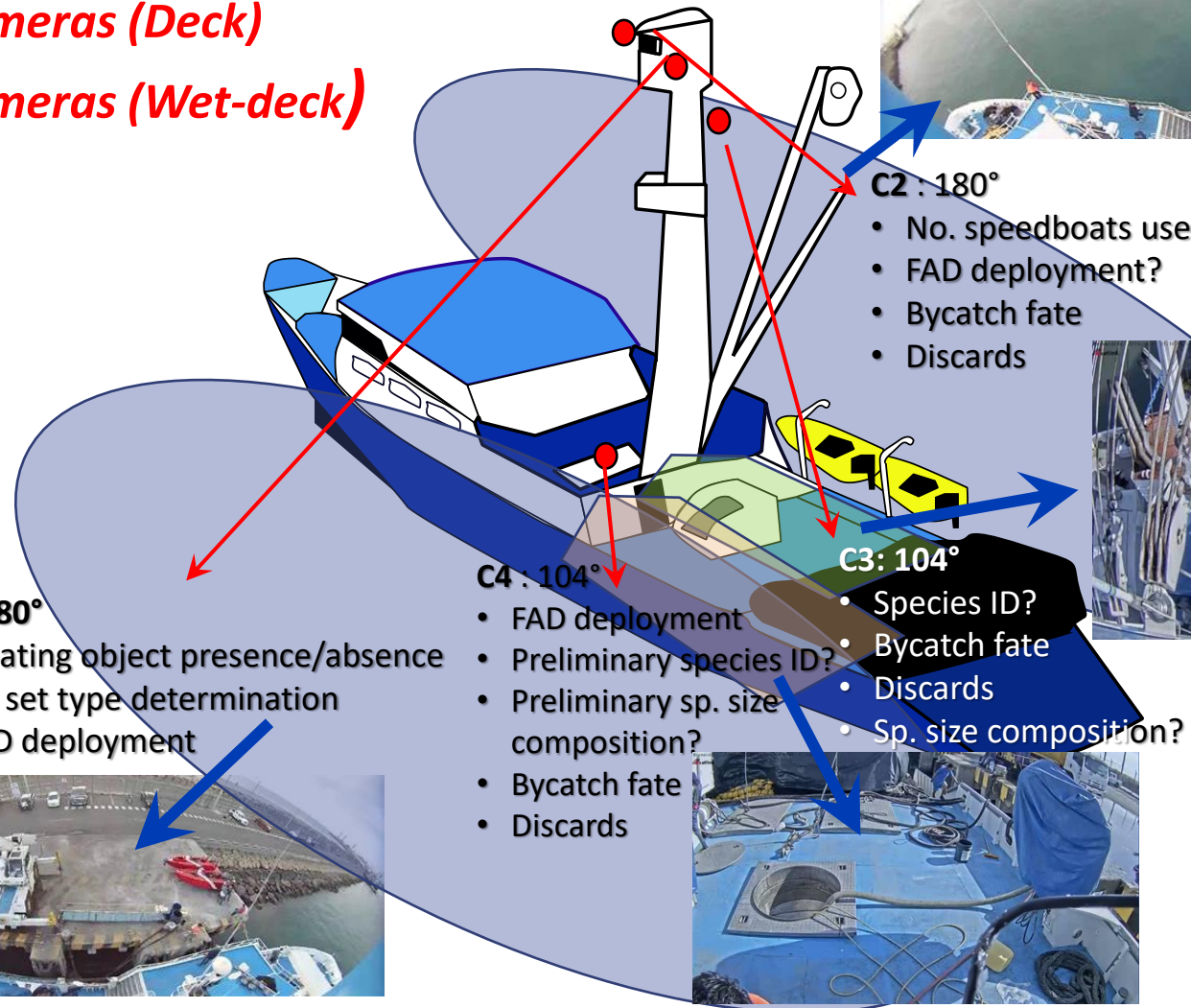
# Participating vessel – Class-5

## Bernardita B.

- 4 cameras (Deck)
- 2 cameras (Wet-deck)



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- C2 : 180°**
- No. speedboats used in the set
  - FAD deployment?
  - Bycatch fate
  - Discards



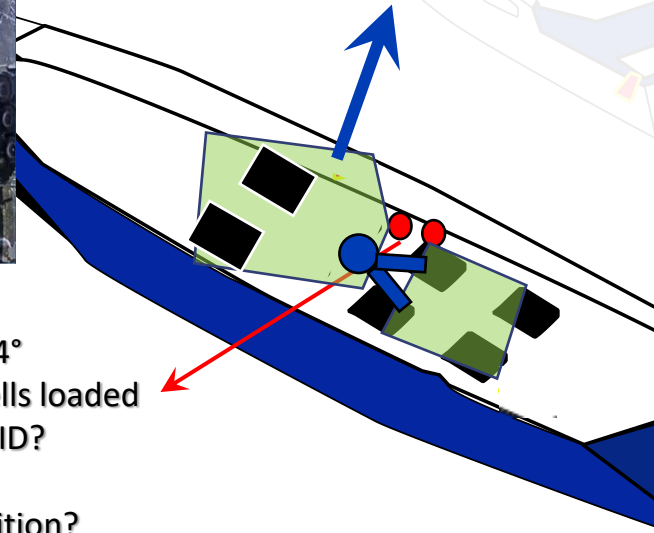
- C3: 104°**
- Species ID?
  - Bycatch fate
  - Discards
  - Sp. size composition?

- C1: 180°**
- Floating object presence/absence for set type determination
  - FAD deployment

- C4 : 104°**
- FAD deployment
  - Preliminary species ID?
  - Preliminary sp. size composition?
  - Bycatch fate
  - Discards



- C5-C6 : 104°**
- ID of wells loaded
  - Species ID?
  - Sp. size composition?



# EM data collection current capabilities: Purse-seine



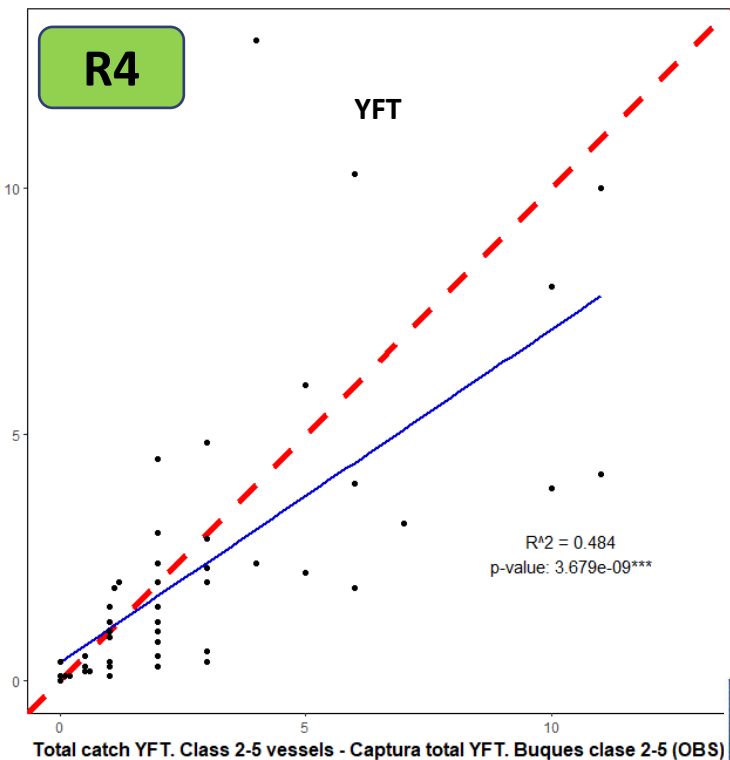
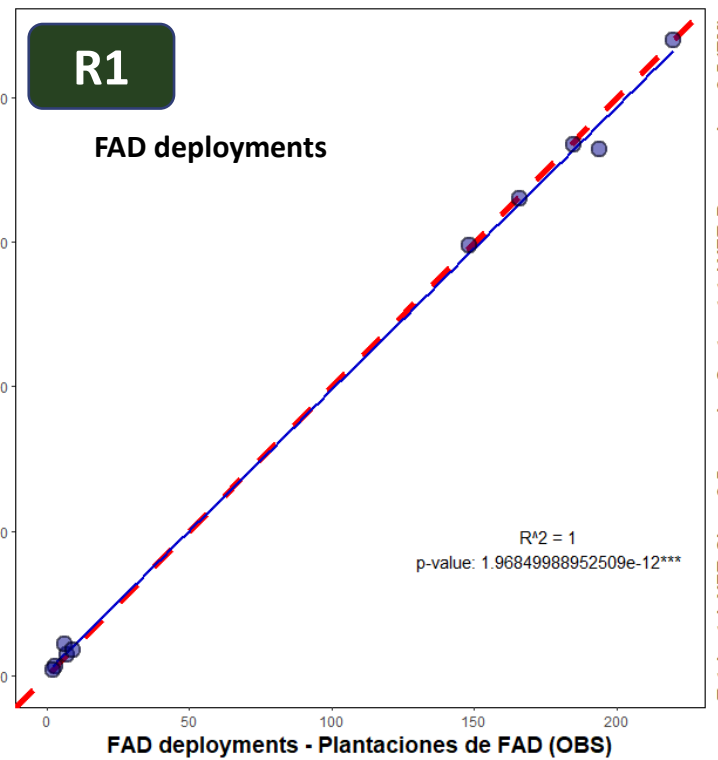
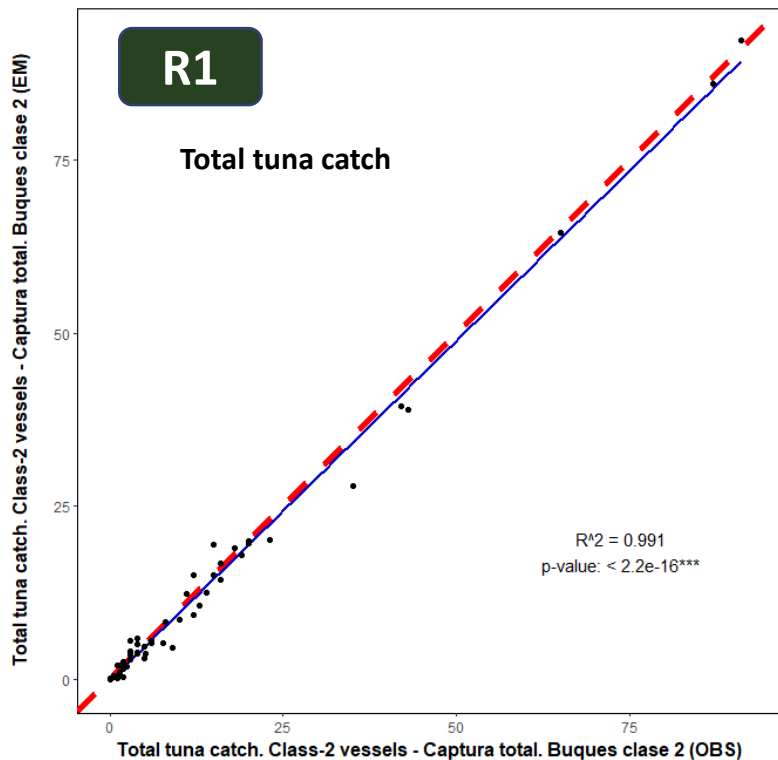
R1
R2
R3
R4

Ready - Listo

For example:  
Total catch, FAD  
deployments,  
Bycatch of large-sized  
individuals.

P1	Possible - Posible
P2	
NP	Not possible - No posible

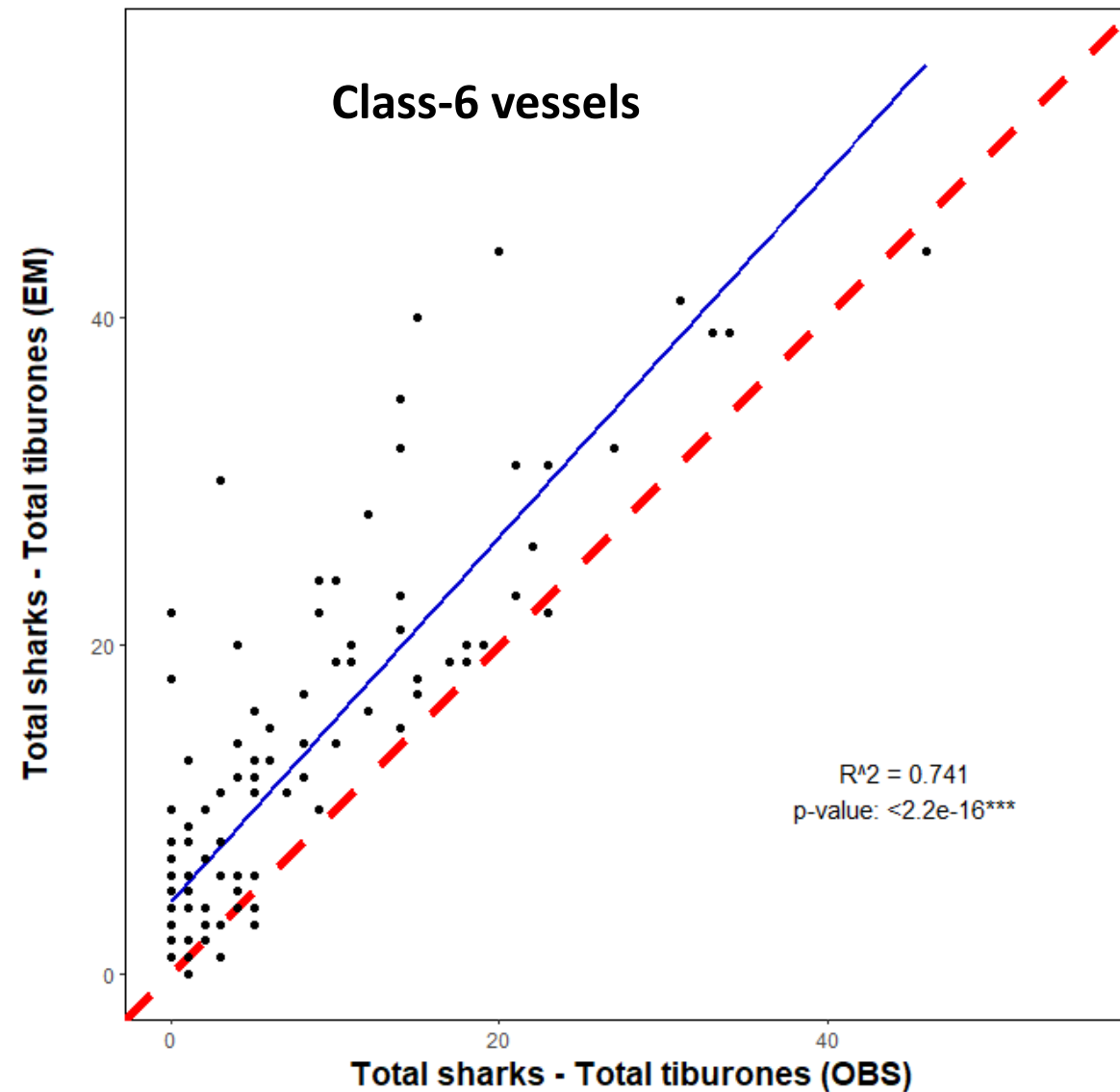
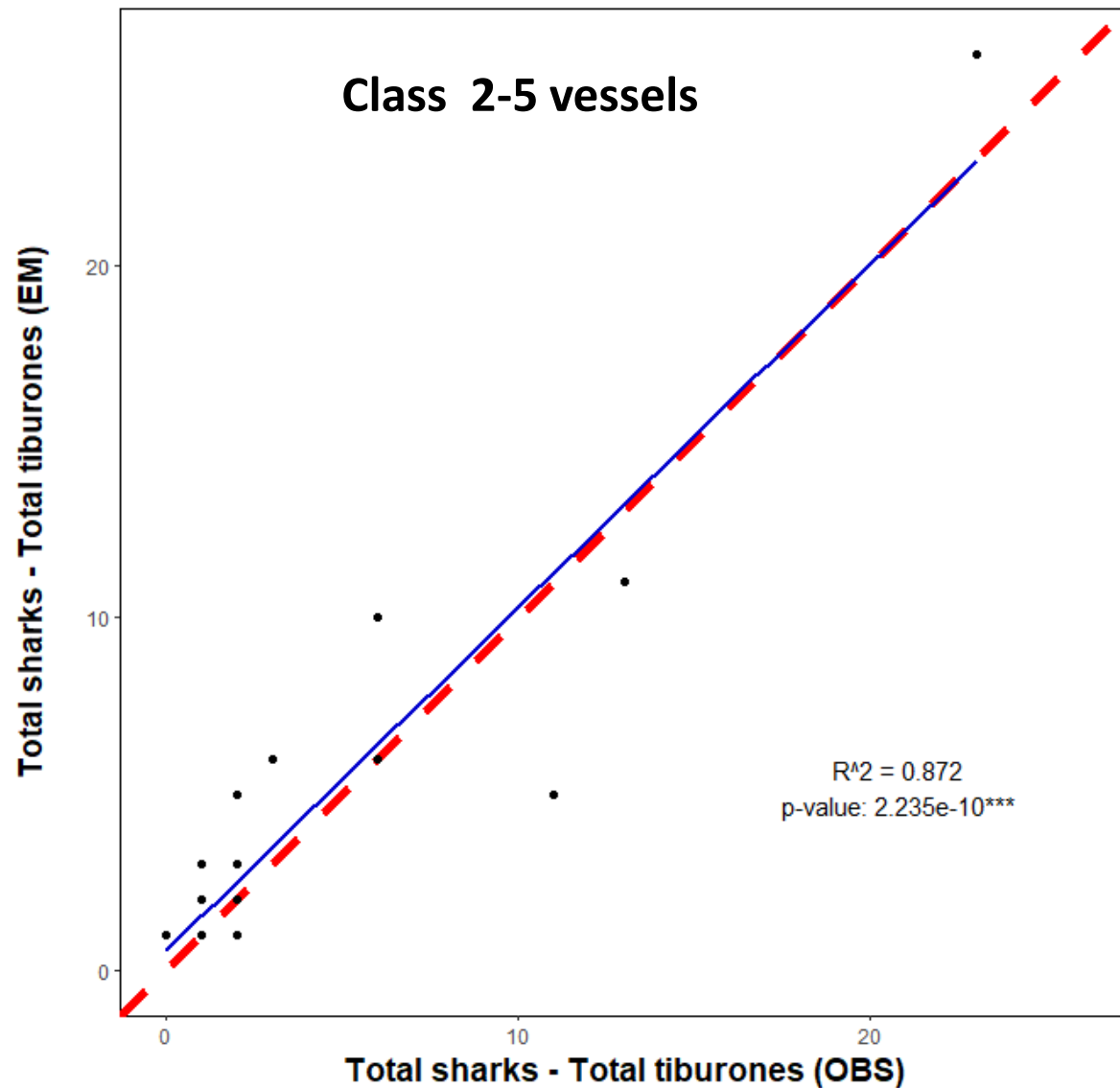
For example:  
FAD ID, size  
composition.



■ EM seems to be ready to collect 83.4% of the data. 16.4% would require extra work or is not possible.

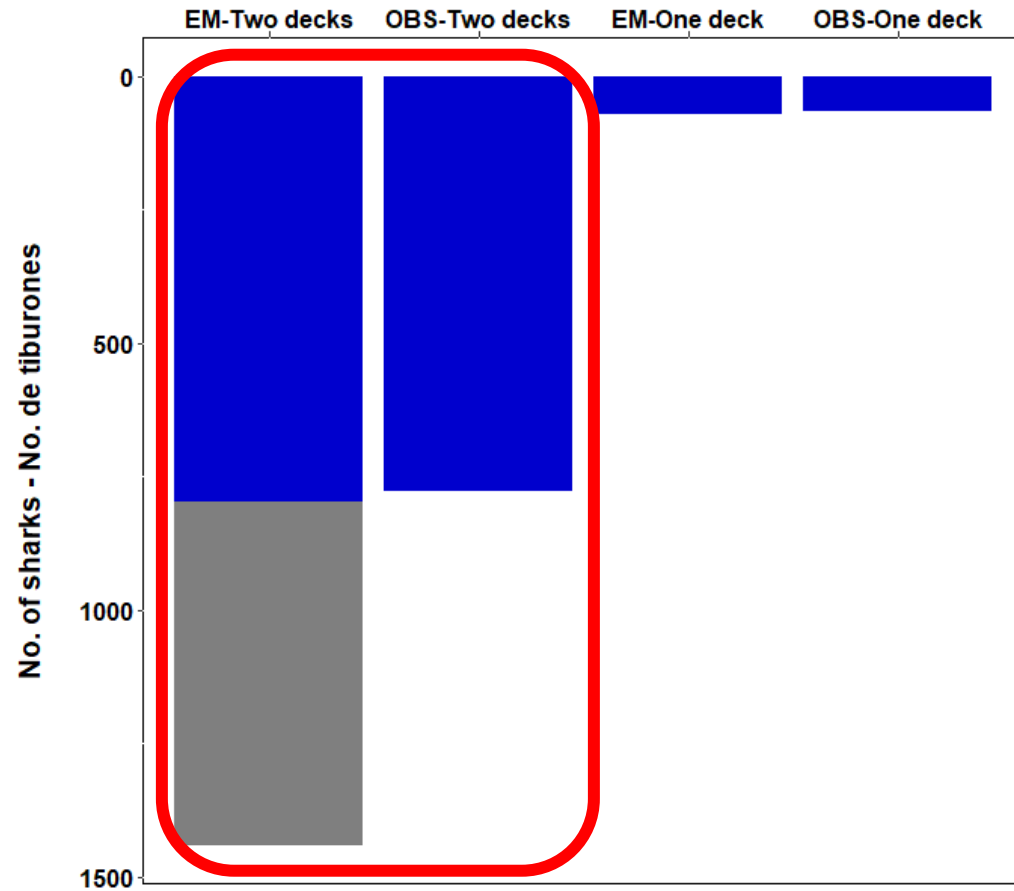


# Preliminary results - Shark comparison



# Preliminary results - Shark sightings by vessel location

Observer type - Decks accessibility - Tipo observador - acceso a cubiertas

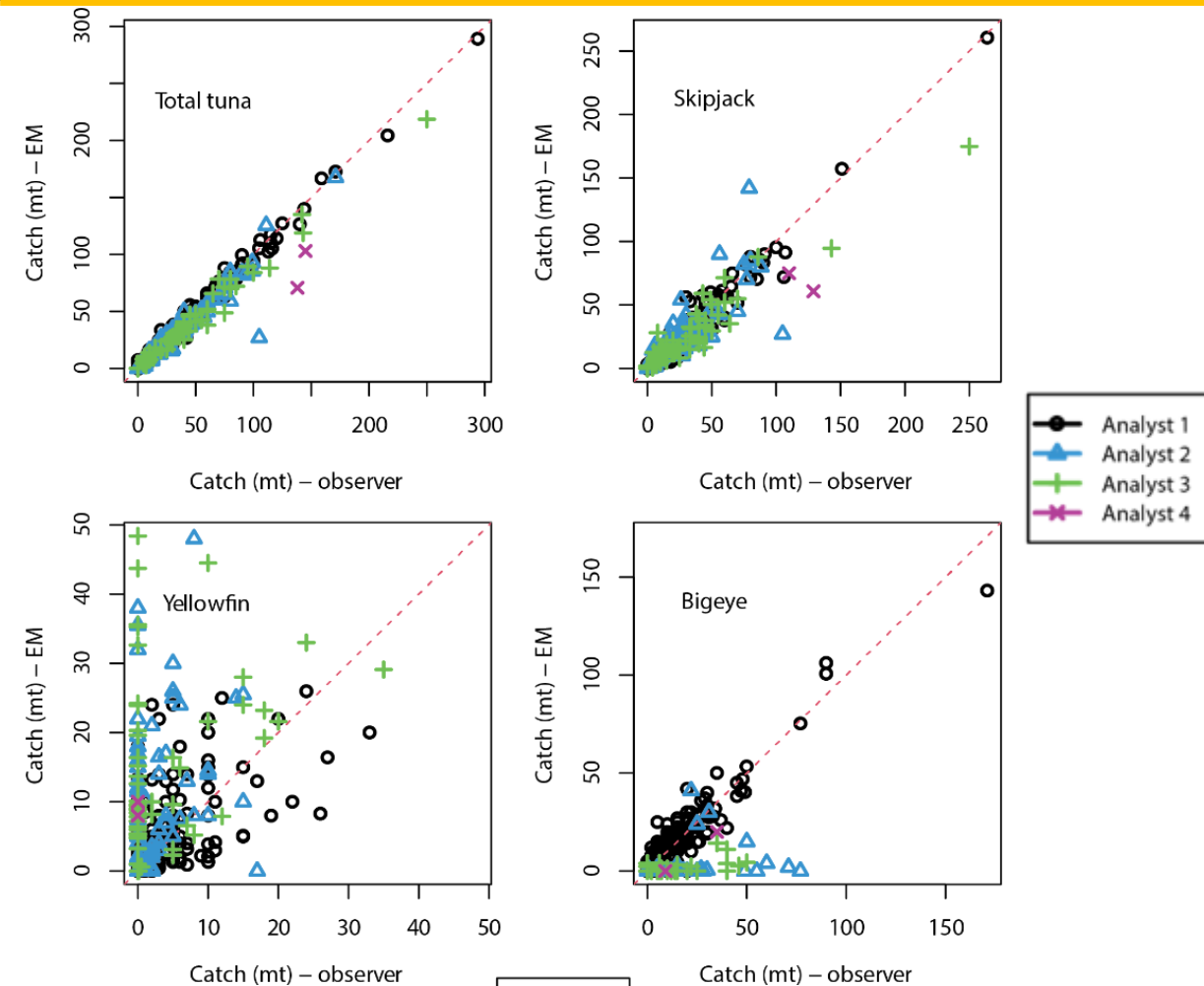


Vessel location  
Ubicación en el buque

- Main deck - Cubierta principal
- Wet deck - Cubierta de bodegas



# EM analyst comparison



1. Observer and EM data similar for total tuna catch, and for catch of SKJ.
2. Relationship degrades for YFT. Although slope for Analyst 1 is close to 1.0, SE is large.
3. Poor relationship for BET, except for one EM analyst, despite the fact that the model fit to the data is acceptable.

```
tmp.gamobj<-gam(em_BETTotalCT~(-1)+reviewer.fac+obs_BETTotalCT:reviewer.fac,data=frm)
Results (first 3 rows are intercepts; next 3 are slopes)
```

### Total tuna

	Estimate	Std. Error	t value	Pr(> t )
reviewer.2	0.31284	0.67636	0.463	0.64393
reviewer.3	0.37896	1.06334	0.356	0.72173
reviewer.1	1.35884	0.48039	2.829	0.00489 **
reviewer.2:obsTotcatch	0.89778	0.01637	54.838	< 2e-16 ***
reviewer.3:obsTotcatch	0.87024	0.01723	50.504	< 2e-16 ***
reviewer.1:obsTotcatch	0.97371	0.00931	104.583	< 2e-16 ***

R-sq.(adj) = 0.975 Deviance explained = 98.7%  
GCV = 31.261 Scale est. = 30.833 n = 438

### SKJ

	Estimate	Std. Error	t value	Pr(> t )
reviewer.2	1.36480	1.00639	1.356	0.1758
reviewer.3	2.90927	1.41864	2.051	0.0409 *
reviewer.1	-0.40231	0.67150	-0.599	0.5494
reviewer.2:obs_SKJTotalCT	0.84421	0.03519	23.993	<2e-16 ***
reviewer.3:obs_SKJTotalCT	0.71302	0.02861	24.919	<2e-16 ***
reviewer.1:obs_SKJTotalCT	0.94291	0.01917	49.193	<2e-16 ***

R-sq.(adj) = 0.893 Deviance explained = 93.5%  
GCV = 71.106 Scale est. = 70.132 n = 438

### YFT

	Estimate	Std. Error	t value	Pr(> t )
reviewer.2	5.14955	0.75505	6.820	3.08e-11 ***
reviewer.3	10.96698	1.07803	10.173	< 2e-16 ***
reviewer.1	2.25204	0.53335	4.222	2.95e-05 ***
reviewer.2:obs_YFTTotalCT	0.96742	0.19967	4.845	1.77e-06 ***
reviewer.3:obs_YFTTotalCT	0.63340	0.13371	4.737	2.94e-06 ***
reviewer.1:obs_YFTTotalCT	0.64035	0.09422	6.796	3.58e-11 ***

R-sq.(adj) = 0.274 Deviance explained = 51.9%  
GCV = 55.723 Scale est. = 54.96 n = 438

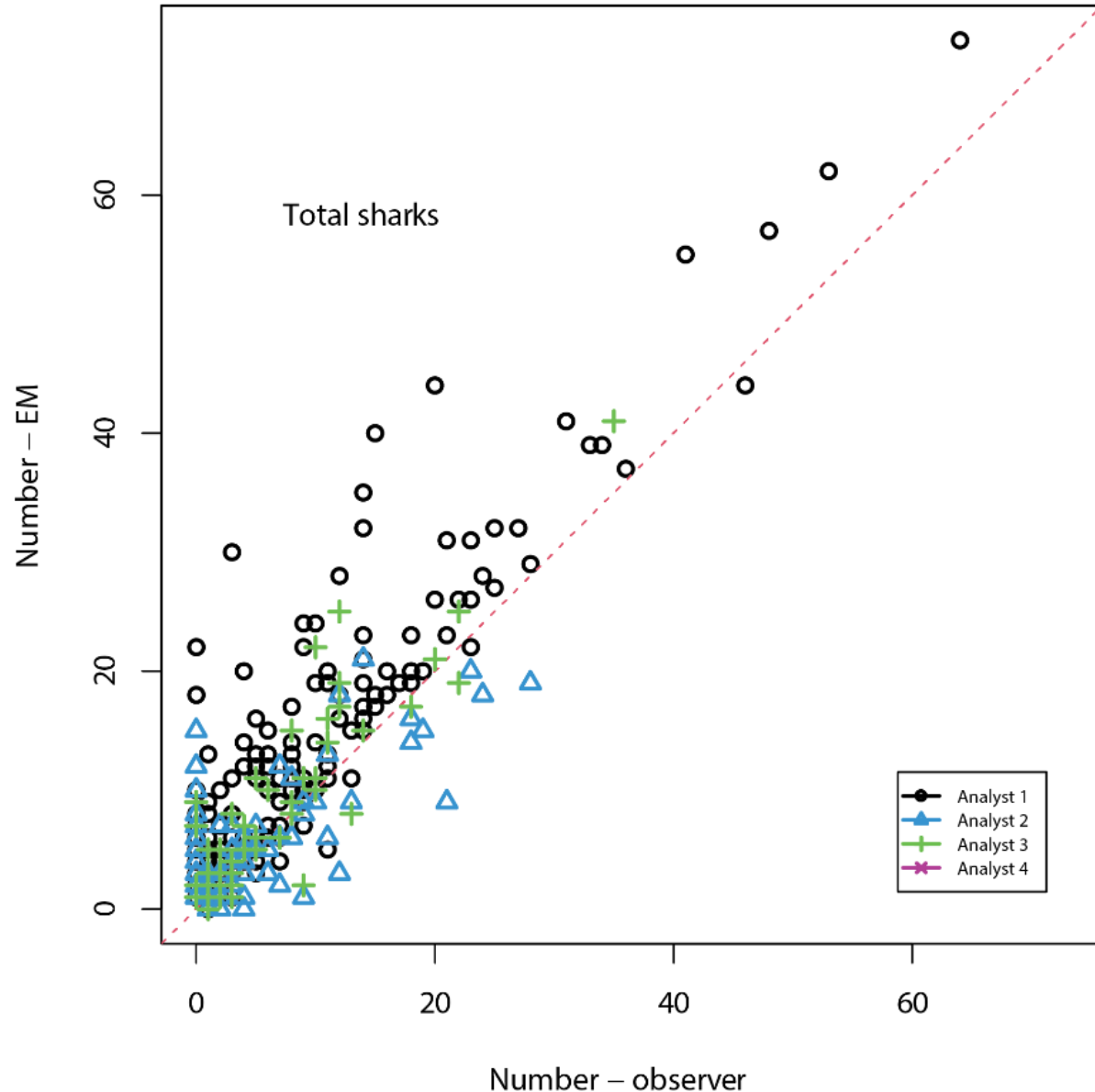
### BET

	Estimate	Std. Error	t value	Pr(> t )
reviewer.2	0.27089	0.49179	0.551	0.582042
reviewer.3	-0.14796	0.80258	-0.184	0.853819
reviewer.1	1.61860	0.36501	4.434	1.17e-05 ***
reviewer.2:obs_BETTotalCT	0.10774	0.03044	3.540	0.000444 ***
reviewer.3:obs_BETTotalCT	0.11020	0.05032	2.190	0.029064 *
reviewer.1:obs_BETTotalCT	0.92826	0.01812	51.232	< 2e-16 ***

R-sq.(adj) = 0.878 Deviance explained = 90.5%  
GCV = 24.49 Scale est. = 24.155 n = 438



# EM analyst comparison



Model:  
tmp.gamobj<-gam(em\_tsharks~reviewer+s(obs\_tsharks,  
by=reviewer.fac,k=3),data=frm,family=nb(link="identity"))

Results:  
Parametric coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	7.6676	1.0384	7.384	1.53e-13 ***
Reviewer2	0.8801	1.2875	0.684	0.4942
Reviewer1	2.8870	1.1429	2.526	0.0115 *

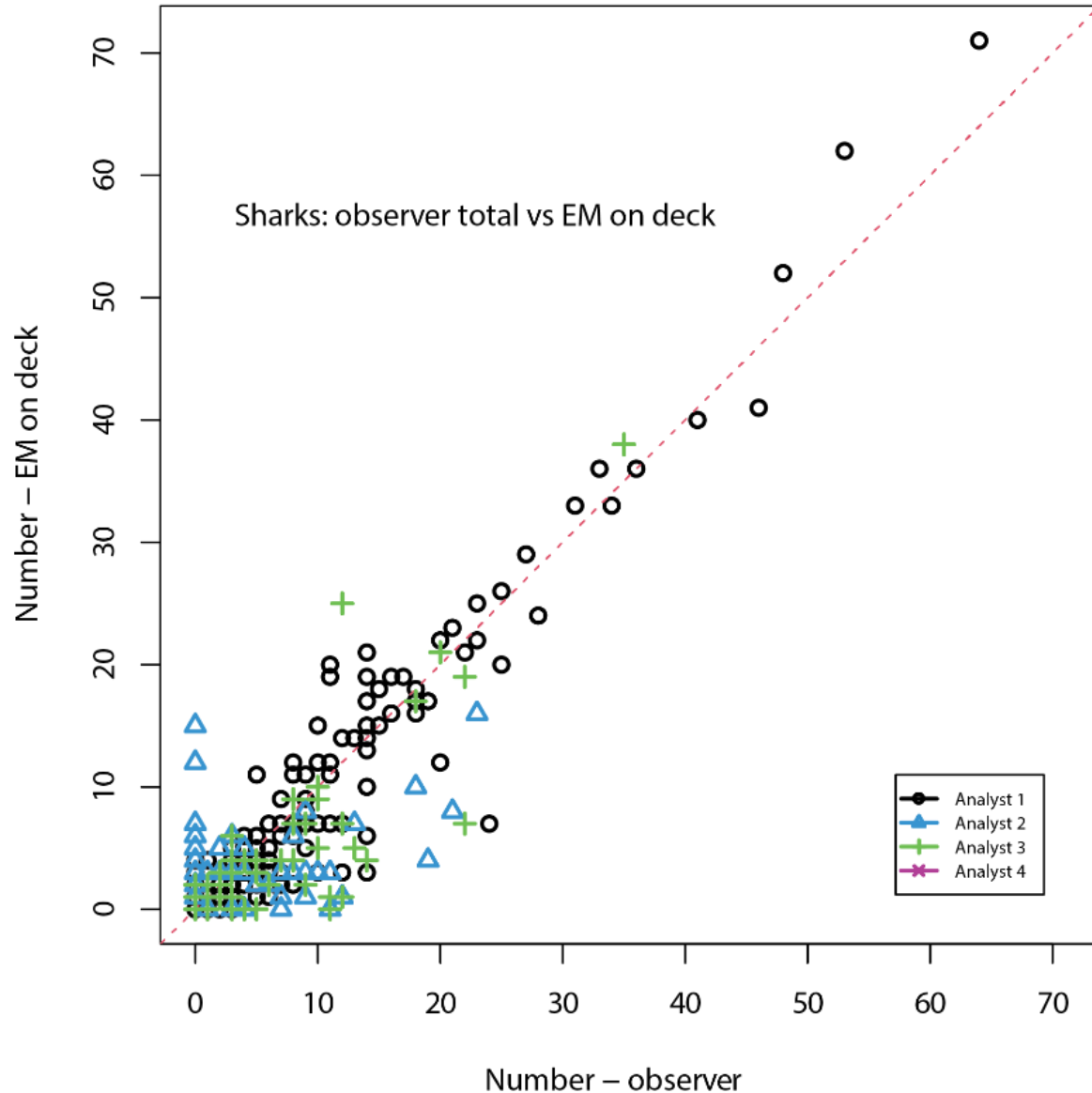
Approximate significance of smooth terms:

	edf	Ref.df	Chi.sq	p-value
s(obs_tsharks):reviewer.2	1.805	1.962	26.63	2.57e-05 ***
s(obs_tsharks):reviewer.3	1.000	1.000	42.49	< 2e-16 ***
s(obs_tsharks):reviewer.1	1.000	1.000	188.22	< 2e-16 ***

R-sq.(adj) = 0.817 Deviance explained = 63.4%  
-REML = 944.84 Scale est. = 1 n = 336

1. Significant positive relationship between the observer counts of sharks between Observer and EM.
2. Relationship varies among EM analysts.
3. Spike at 0 (observed count) for all reviewers and a high proportion of the data are above the 1-to-1 line (EM total counts are often greater than observer counts).

# EM analyst comparison



Model:  
Parametric coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	7.2488	1.1923	6.080	1.2e-09 ***
reviewer.2	-1.4376	1.4594	-0.985	0.325
reviewer.1	-0.4017	1.2370	-0.325	0.745

Approximate significance of smooth terms:

	edf	Ref.df	Chi.sq	p-value
s(obs_tsharks):reviewer.2	1.935	1.996	12.42	0.00171 **
s(obs_tsharks):reviewer.3	1.759	1.942	66.44	< 2e-16 ***
s(obs_tsharks):reviewer.1	1.764	1.944	360.76	< 2e-16 ***

R-sq.(adj) = 0.891 Deviance explained = 75.8%  
-REML = 654 Scale est. = 1 n = 288

1. EM shark data counted "On Deck" appears to explain the 'above the 1-to-1 line' tendency shown for total sharks.
2. Differences between EM analysts (at least for < 20 sharks).

# Pilot EM Project on longline vessels

- February 2021 to May 2023
- Three vessels participating (2 flag-countries confirmed)



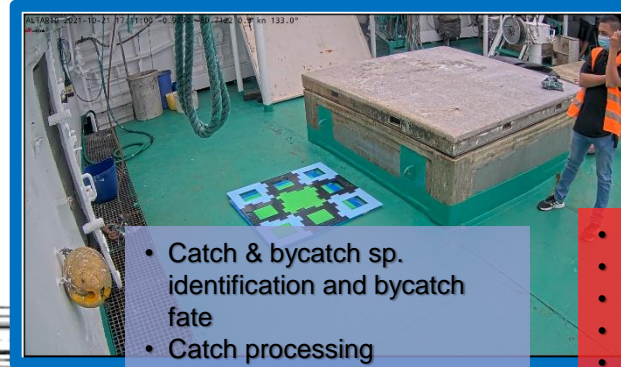
# Pilot EM Project on longline vessels

- February 2021 to May 2023
- Four-camera EM system installed



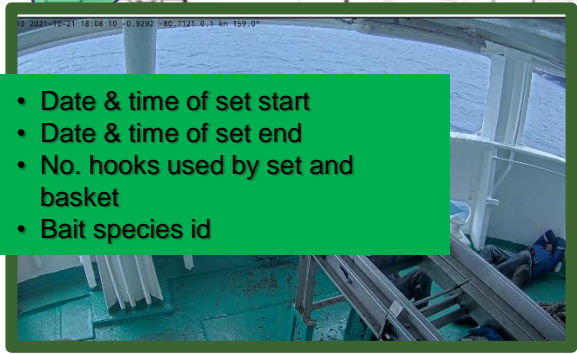
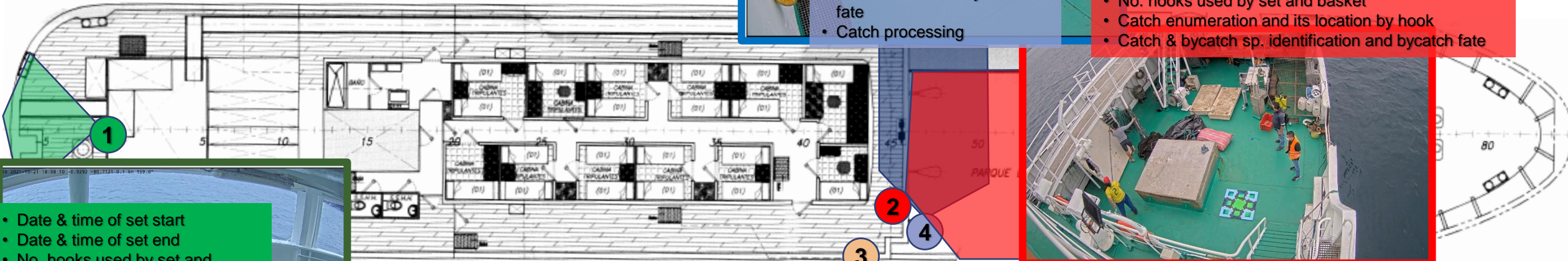
# Pilot EM Project on longline vessels

- Four-camera EM system installed
- Currently collecting EM records at sea



- Catch & bycatch sp. identification and bycatch fate
- Catch processing

- Date & time of hauling start
- Date & time of hauling end
- No. hooks used by set and basket
- Catch enumeration and its location by hook
- Catch & bycatch sp. identification and bycatch fate



- Date & time of set start
- Date & time of set end
- No. hooks used by set and basket
- Bait species id



- Catch and bycatch sp. identification
- Fate of bycatch species



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# Pilot EM Project on longline vessels

## Next steps

- Generate EM data.
- EM data will be compared with observer data.
- Results will indicate whether EM could be reliably used in the longline fishery of the EPO.



# Some conclusions

- EM can collect key data fields for the tuna purse-seine fishery.
  - Useful for collecting data in different vessel areas occurring at the same time.
- EM analysis costly and time consuming.
  - Optimize the time of analysis (AI).
  - Define priorities for EM data to be collected-analyzed.
- Some data not ready to be collected by EM.
  - Exploring technologies for remote FAD Id.
  - Explore technologies for accurate electronic measuring.
- Data analysis and reporting standards should take into account an adequate experience/training of EM analysts.



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# Complementary information

Resolution on scientific observers for longline vessels (C-19-08).

[https://www.iattc.org/PDFFiles/Resolutions/IATTC/English/C-19-08-Active\\_Observers%20on%20longliners.pdf](https://www.iattc.org/PDFFiles/Resolutions/IATTC/English/C-19-08-Active_Observers%20on%20longliners.pdf)

An electronic monitoring system for the tuna fisheries in the eastern Pacific Ocean: objectives and standards (Document SAC-11-10). [https://www.iattc.org/Meetings/Meetings2020/SAC-11/Docs/English/SAC-11-10\\_Standards%20for%20electronic%20monitoring%20\(EM\).pdf](https://www.iattc.org/Meetings/Meetings2020/SAC-11/Docs/English/SAC-11-10_Standards%20for%20electronic%20monitoring%20(EM).pdf)

Staff recommendations for the implementation of an electronic monitoring system for the tuna fisheries in the eastern Pacific Ocean (Document EMS-01-01). [https://www.iattc.org/Meetings/Meetings2021/WSEMS-01/English/WSEMS-01-01\\_Staff%20recommendations%20EMS%20standards.pdf](https://www.iattc.org/Meetings/Meetings2021/WSEMS-01/English/WSEMS-01-01_Staff%20recommendations%20EMS%20standards.pdf)

A proposed workplan for the implementation of an electronic monitoring system for the tuna fisheries in the eastern Pacific Ocean (Document EMS-01-02). [https://www.iattc.org/Meetings/Meetings2021/WSEMS-01/English/WSEMS-01-02\\_IATTC%20Workplan%20for%20the%20Implementation%20of%20Electronic%20Monitoring%20System%20\(EMS\)%20in%20the%20EPO.pdf](https://www.iattc.org/Meetings/Meetings2021/WSEMS-01/English/WSEMS-01-02_IATTC%20Workplan%20for%20the%20Implementation%20of%20Electronic%20Monitoring%20System%20(EMS)%20in%20the%20EPO.pdf)

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AD HOC WORKING GROUP ON THE DEVELOPMENT OF ELECTRONIC MONITORING  
PROGRAMME STANDARDS (WGEMS)



Indian Ocean Tuna Commission - IOTC  
15-17 November 2021 (videoconference)