

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)



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

# Outline

- **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.

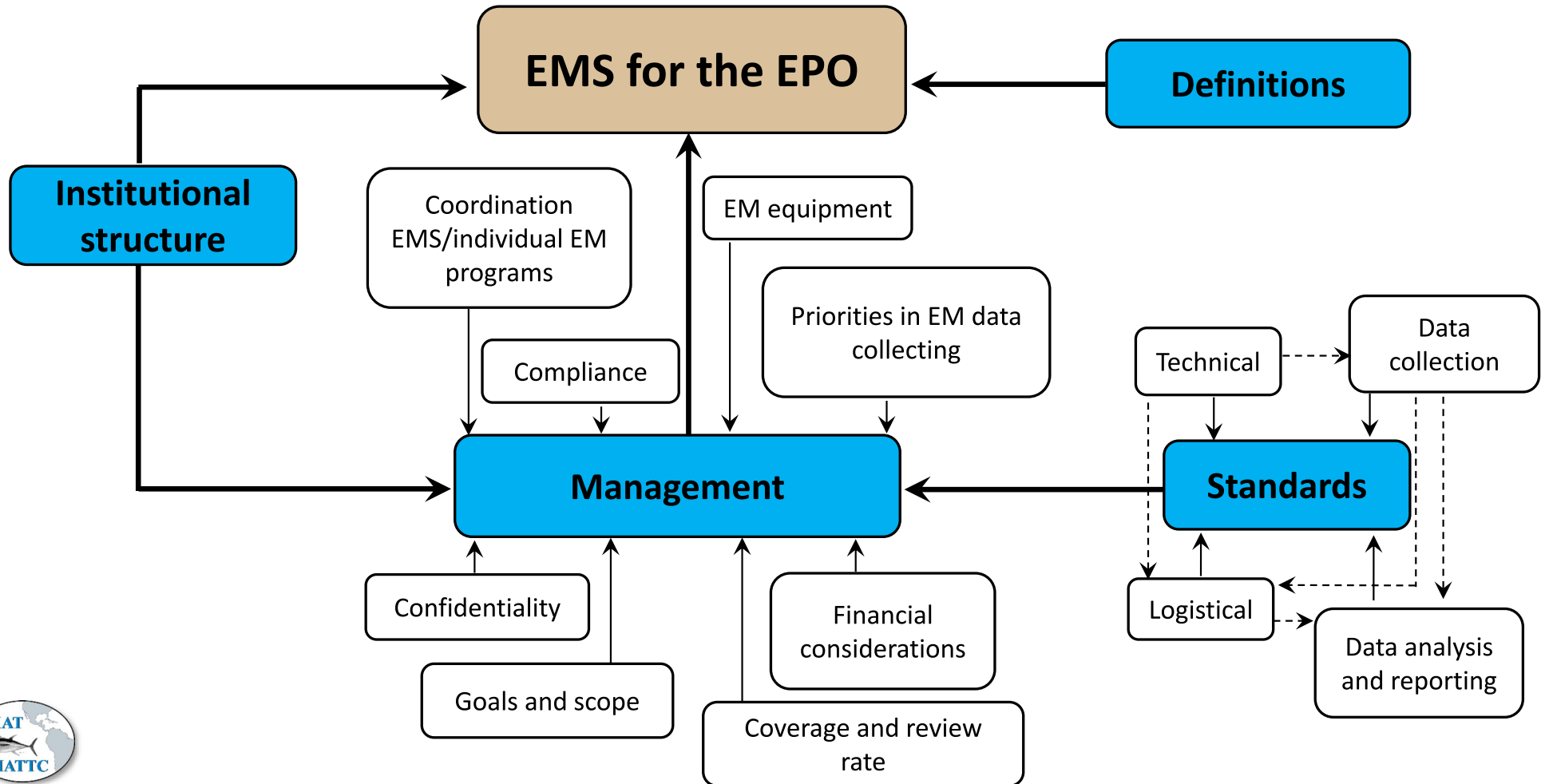


## EMS for the tuna fisheries in the EPO. Background

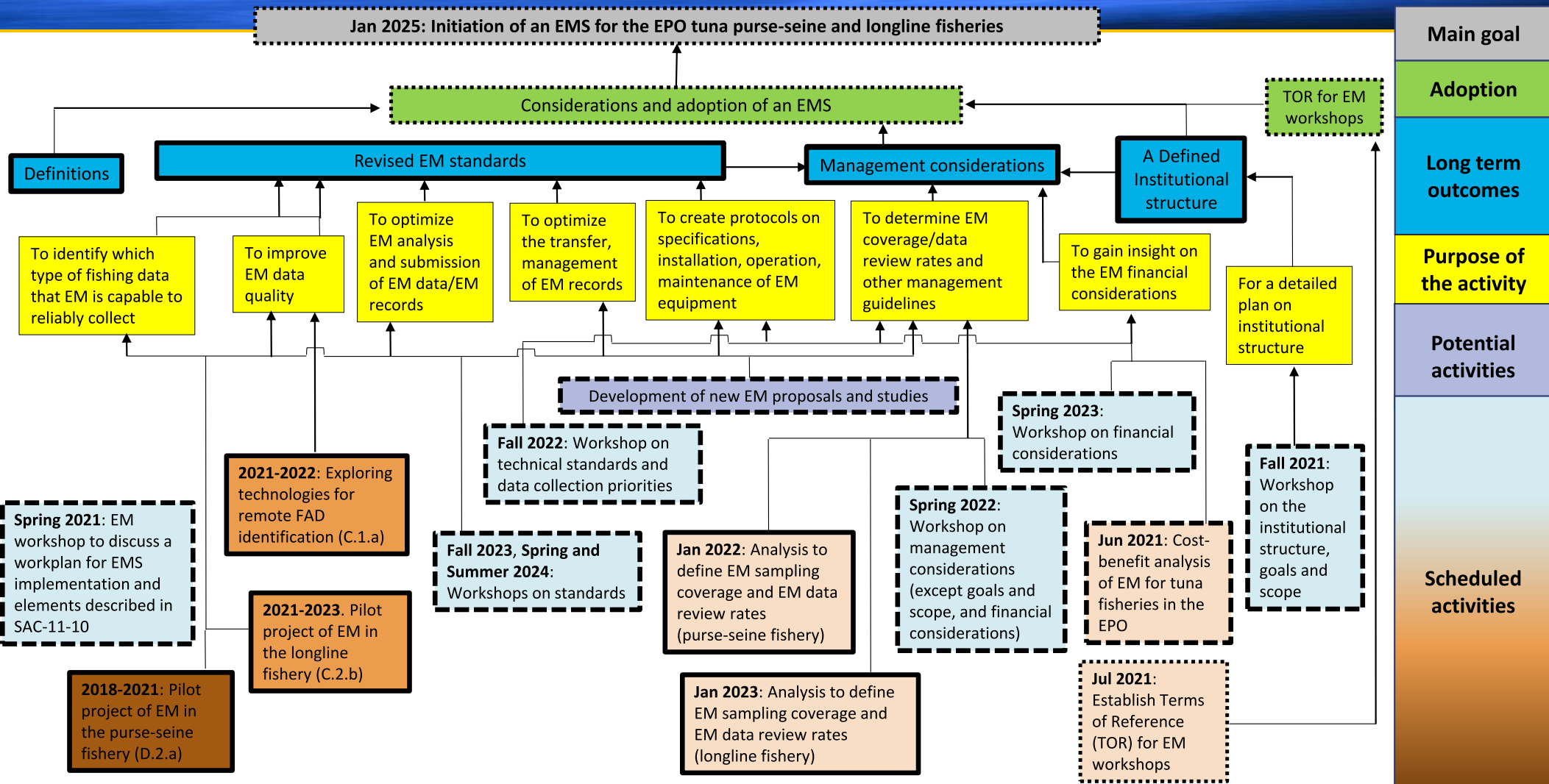
- During SAC-10, and pursuant to **C-19-08**, the IATTC staff was requested to draft minimum standards and data collection and reporting requirements for EMS for the EPO tuna fishery.
- Document **SAC-11-10** was presented by VC in the SAC-11.
- 11<sup>th</sup> Scientific Advisory Committee proposed 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**).



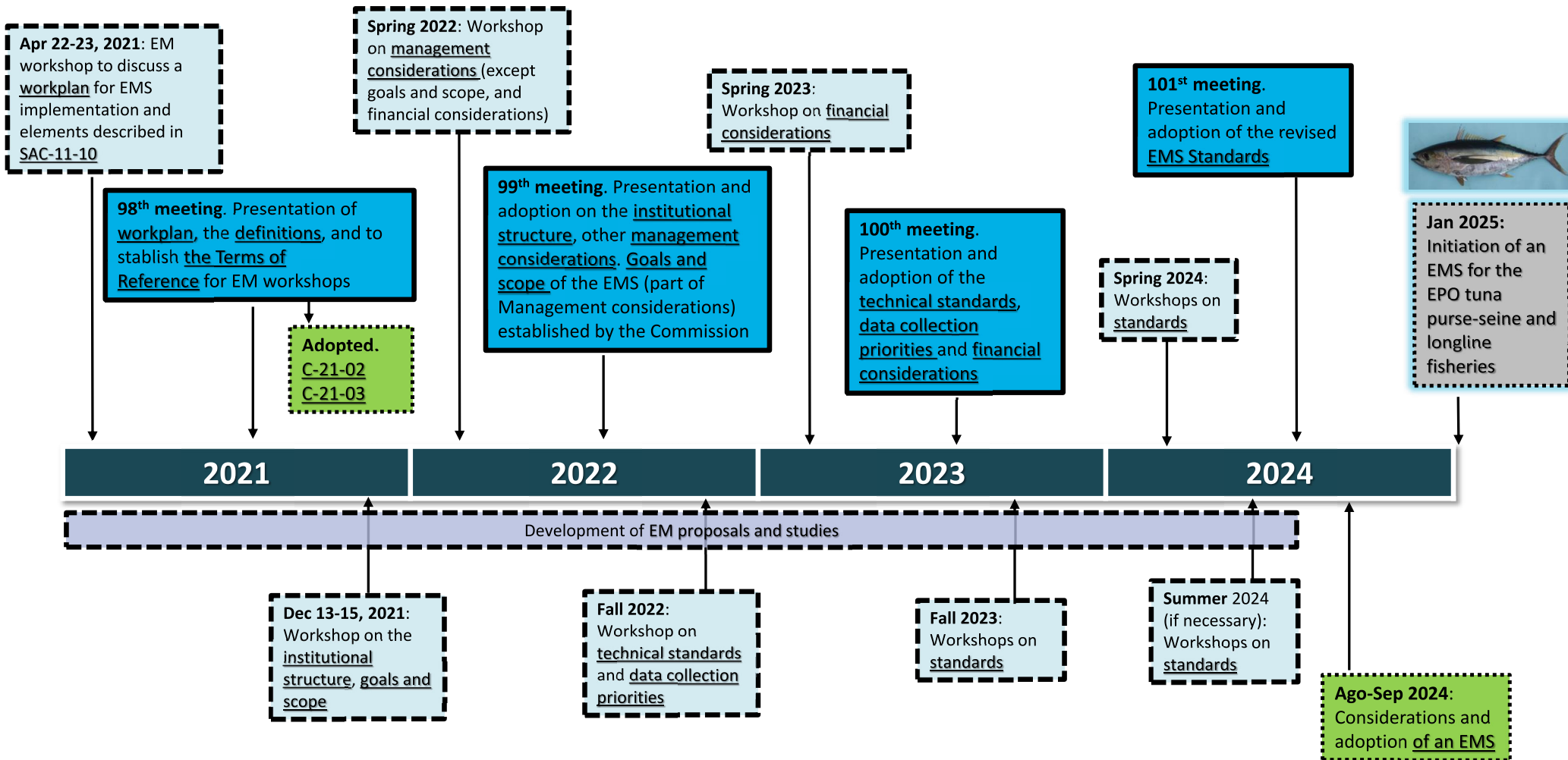
# Proposed structure of the EMS for the tuna fisheries in the EPO



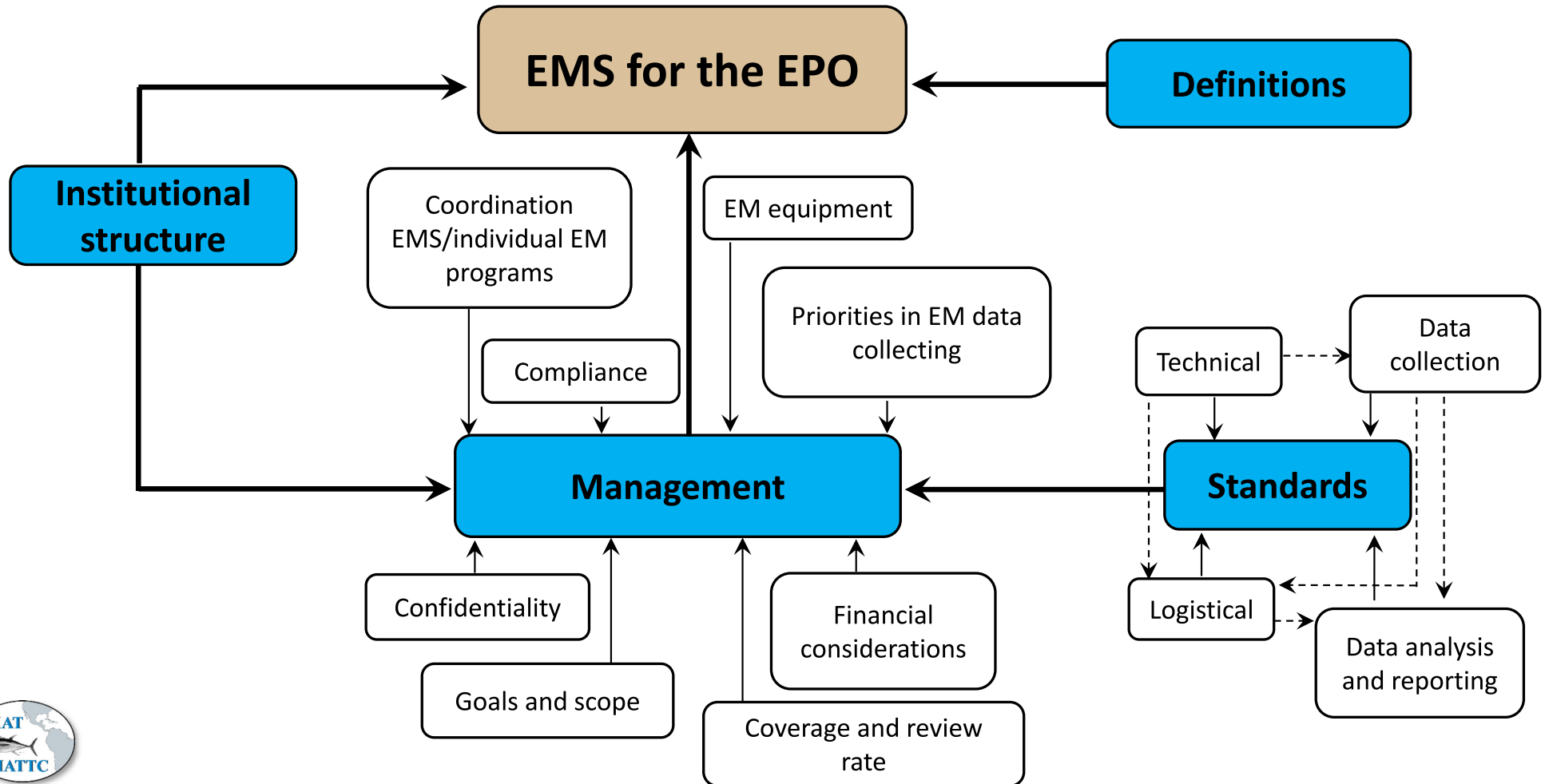
# Adopted workplan for an EMS in the EPO



# Timeline of workshops plan and milestones



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

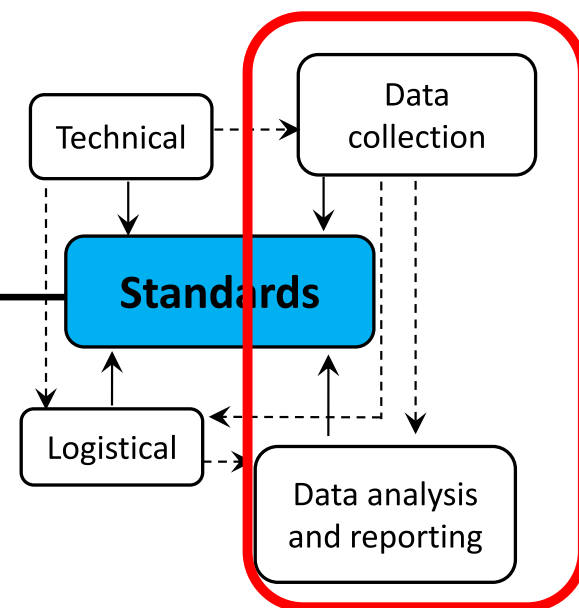


# Pilot EM projects on Data collection and Data analysis and reporting standards



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- 1) Pilot EM Project on small and large purse-seine vessels.
- 2) Pilot EM Project on Longline vessels.
- 3) Exploration of technologies for remote identification of FAD buoys.





# 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.



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# 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	Set type and no. of speed boats	FAD deployment
<ul style="list-style-type: none"> <li>• How are the wells loaded from the main deck?</li> <li>• How are the marketable fish sorted on the main deck?</li> <li>• How are billfish, mantas and large sharks removed from the sack?</li> <li>• Can people work on the wet deck when the wells are being loaded?</li> <li>• What is the brail capacity?</li> </ul>	<ul style="list-style-type: none"> <li>• For what percentage of floating-objects sets does the object remain in the net after encirclement?</li> <li>• What is the number of speed boats used in a typical floating-object set?</li> <li>• What is the number of speed boats used in a typical unassociated set?</li> <li>• How many operable speed boats are onboard?</li> </ul>	<ul style="list-style-type: none"> <li>• By what method are FADs deployed from the vessel?</li> <li>• From where on the vessel are FADs deployed?</li> </ul>
		Vessel infrastructure
		<ul style="list-style-type: none"> <li>• Is the wet deck accessible to people?</li> <li>• What is the height of the crow's nest?</li> <li>• What is the total number of wells in the vessel?</li> </ul>

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

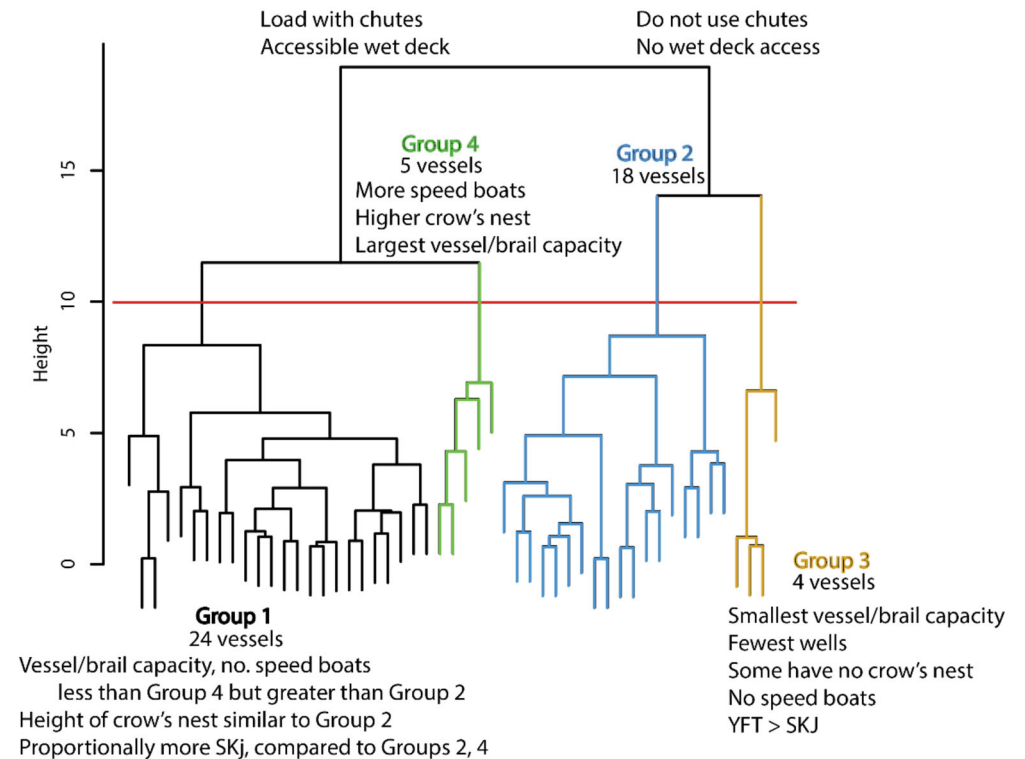
	COL	ECU	MEX	PAN	PER	USA
<b>Total number of active vessels</b>	2	46	6	1	5	9
<b>Number of vessels surveyed</b>	2	38	6	1	3	8
<b>Percentage surveyed</b>	100	82.6	100	100	60	88.9
<b>Percentage among those surveyed</b>	3.5	65.5	10.3	1.7	5.2	13.8



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# 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

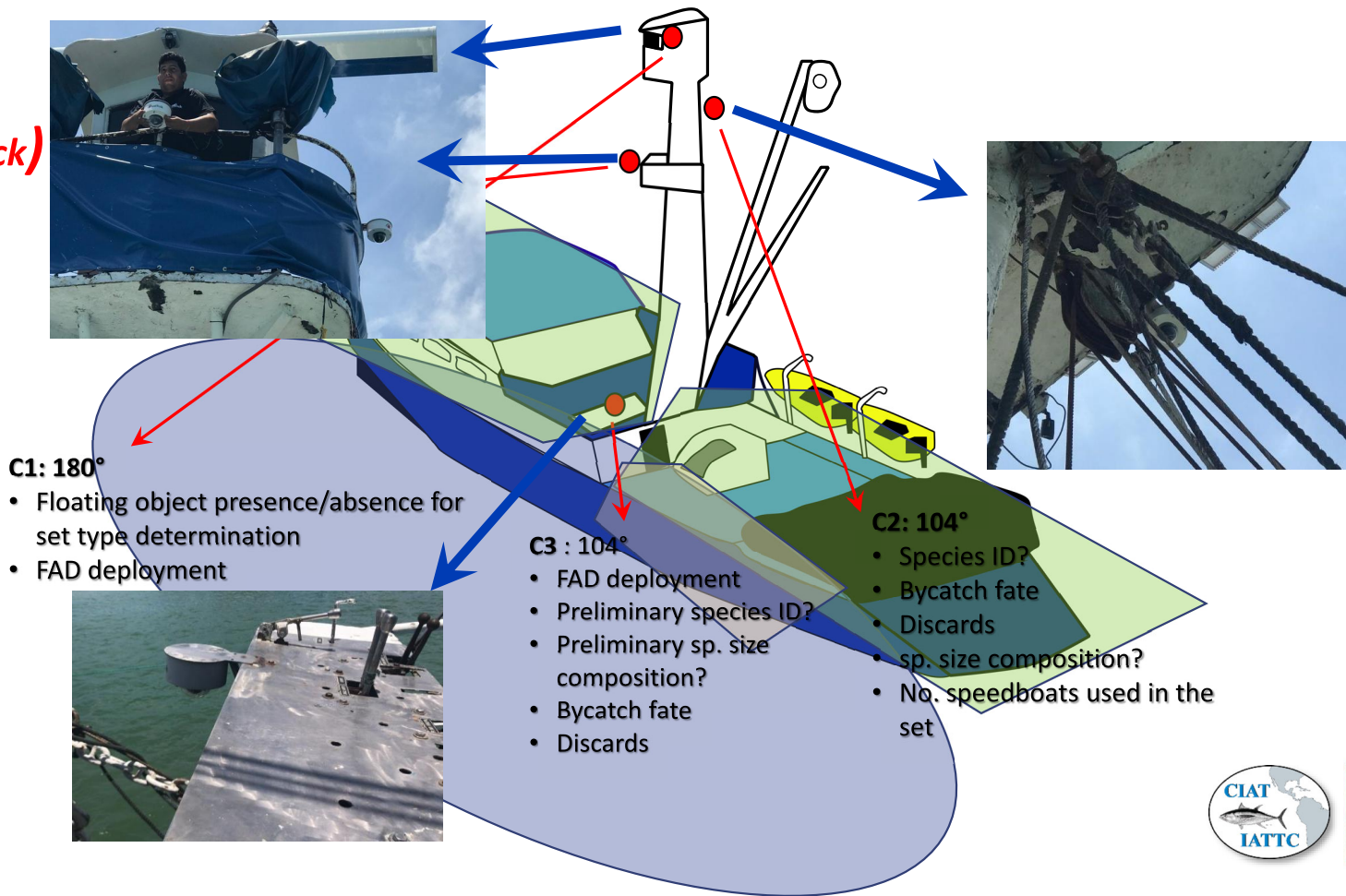


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# Participating vessel – Class-2

## Small vessel

- 4 cameras (Main deck)



# Participating vessel – Class-5

## Bernardita B.

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



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- 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



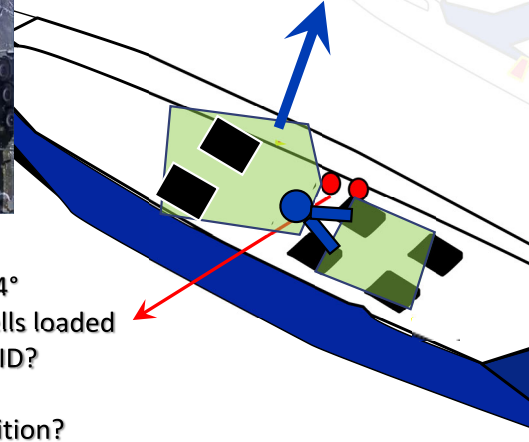
- C2: 180°**
- No. speedboats used in the set
  - FAD deployment?
  - Bycatch fate
  - Discards



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



- 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



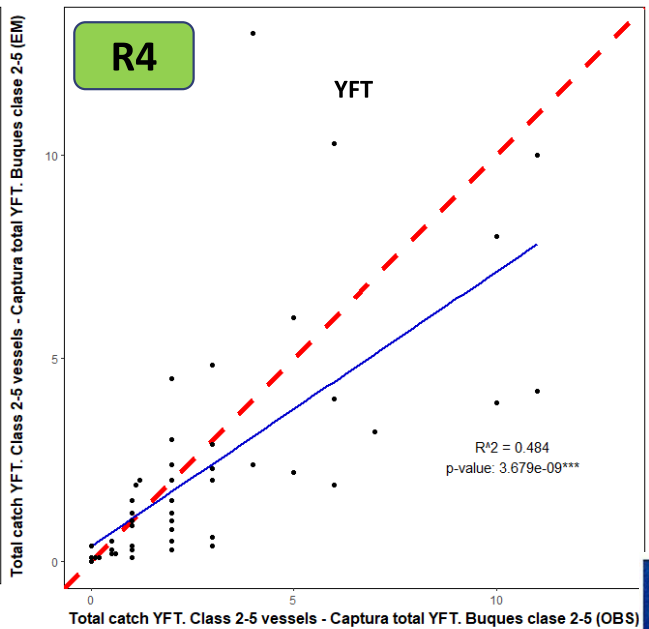
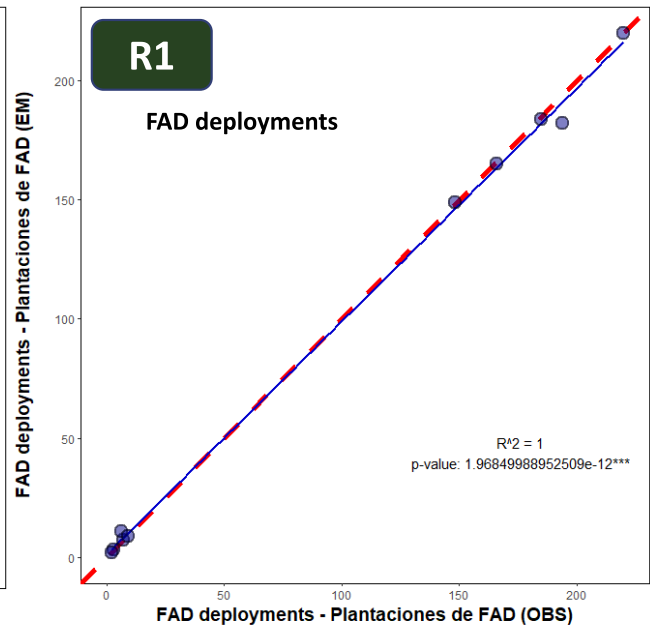
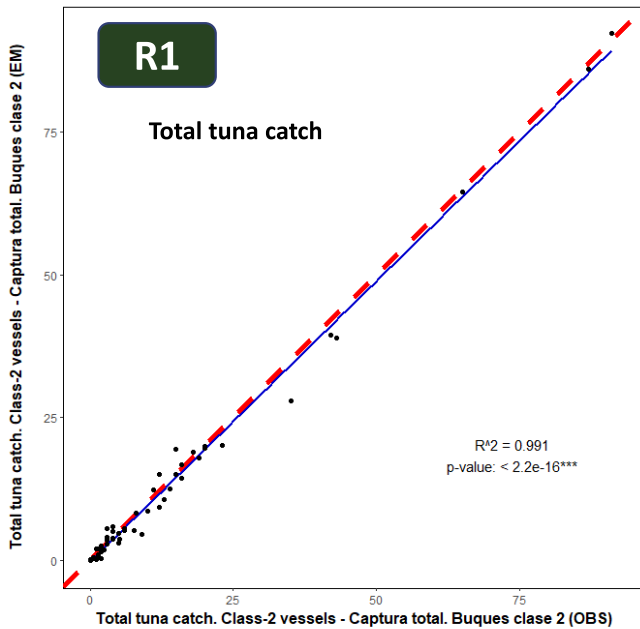
For example:  
Total catch, FAD  
deployments,  
Bycatch of large-sized  
individuals.

P1
P2
NP

Possible - Posible  
Not possible - No posible



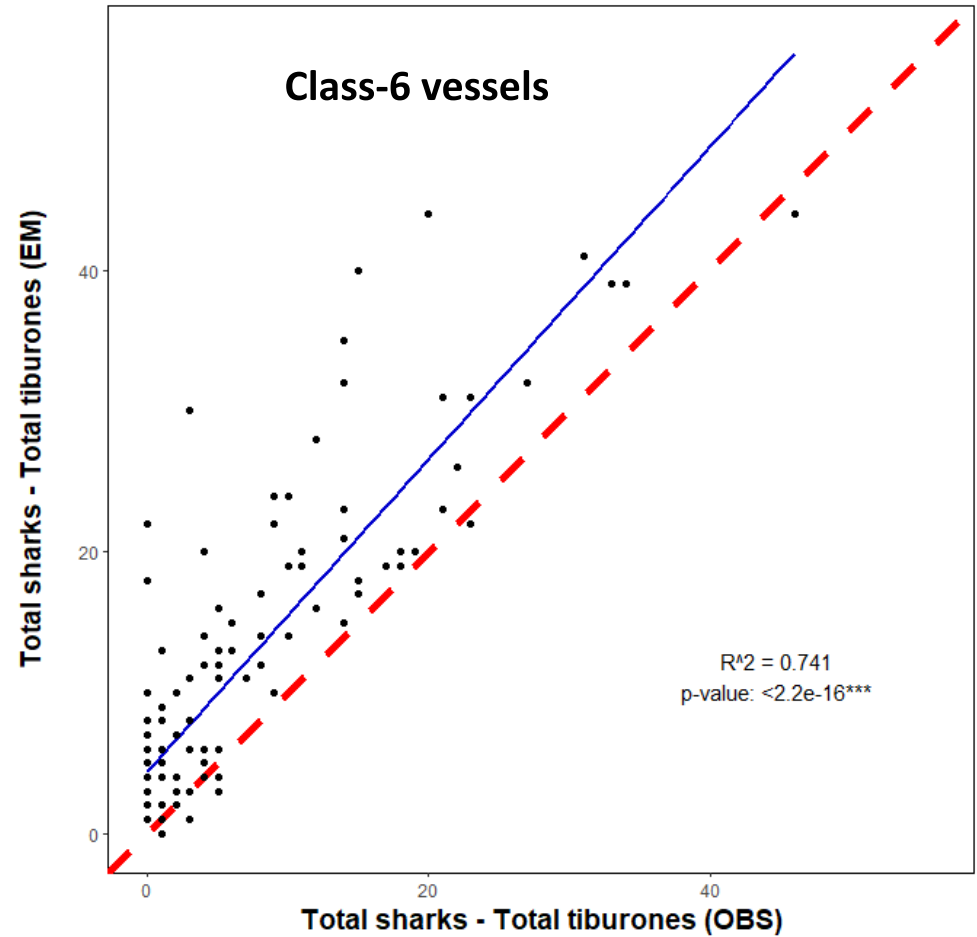
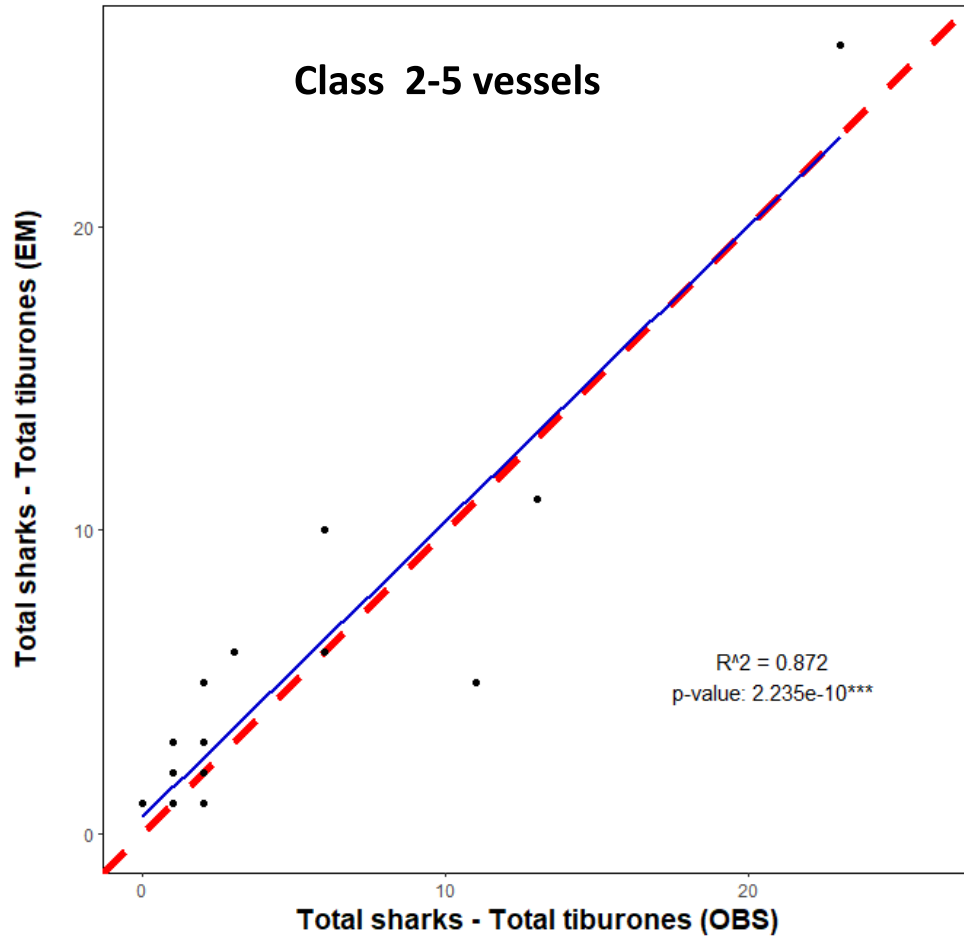
For example:  
FAD ID, size  
composition.



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

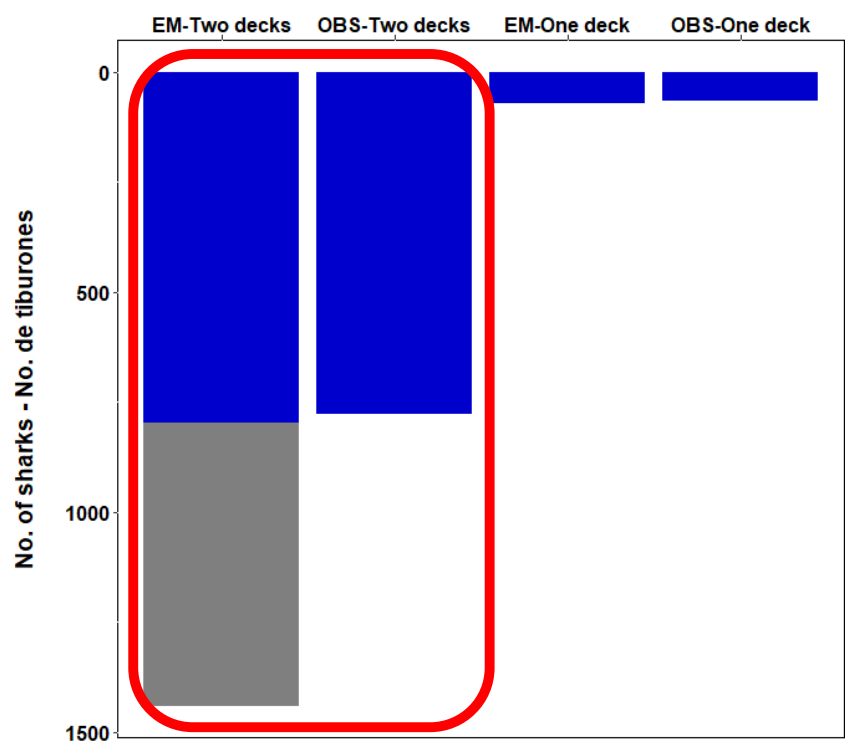


# Preliminary results - Shark comparison



# 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

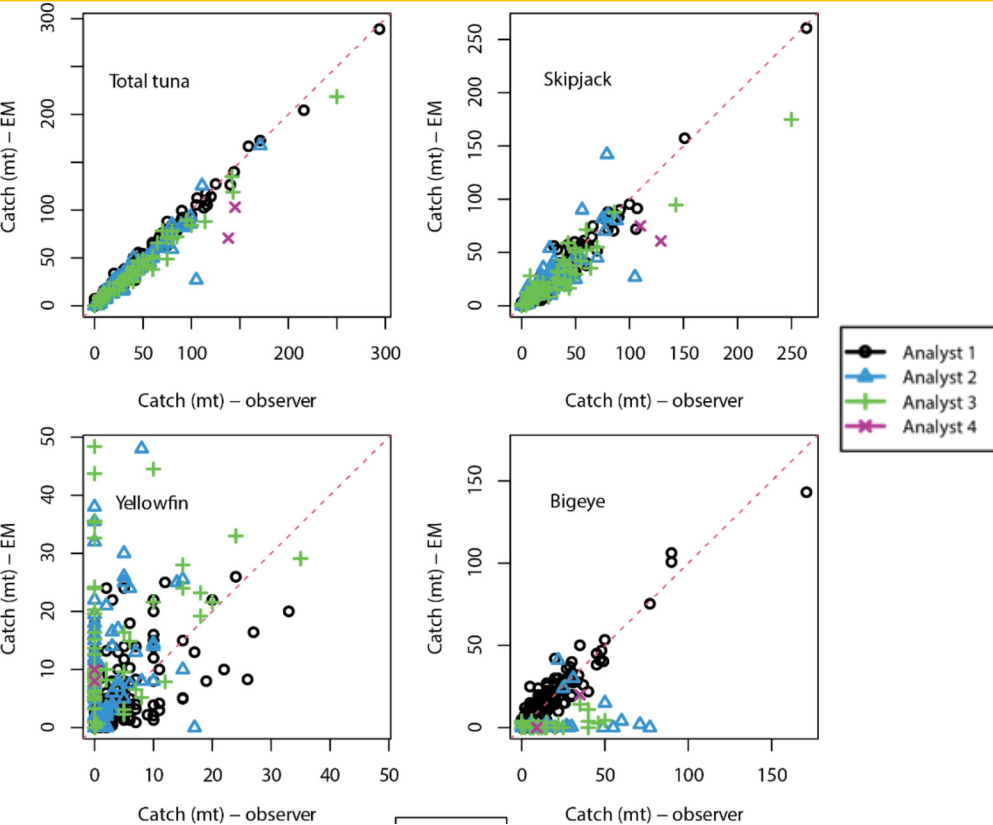




# EM analyst comparison



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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.

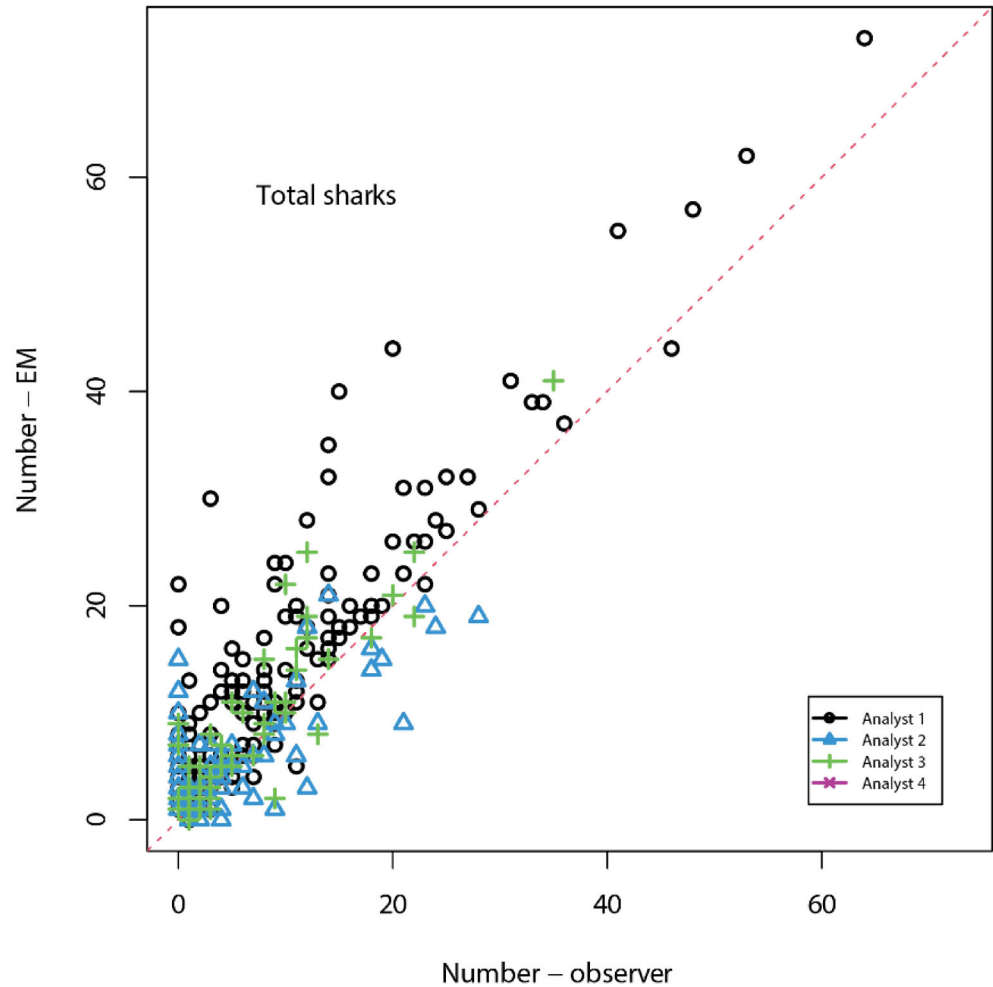
```
tmp.gamobj<-gam(em_BETTotalCT~(-1)+reviewer.fac+obs_BETTotalCT:reviewer.fac,data=frm)
Results (first 3 rows are intercepts; next 3 are slopes)
Total tuna
                Estimate Std. Error t value Pr(>|t|)
reviewer.2      0.31284   0.67636   0.463 0.64393
reviewer.3      0.37896   1.06334   0.356 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



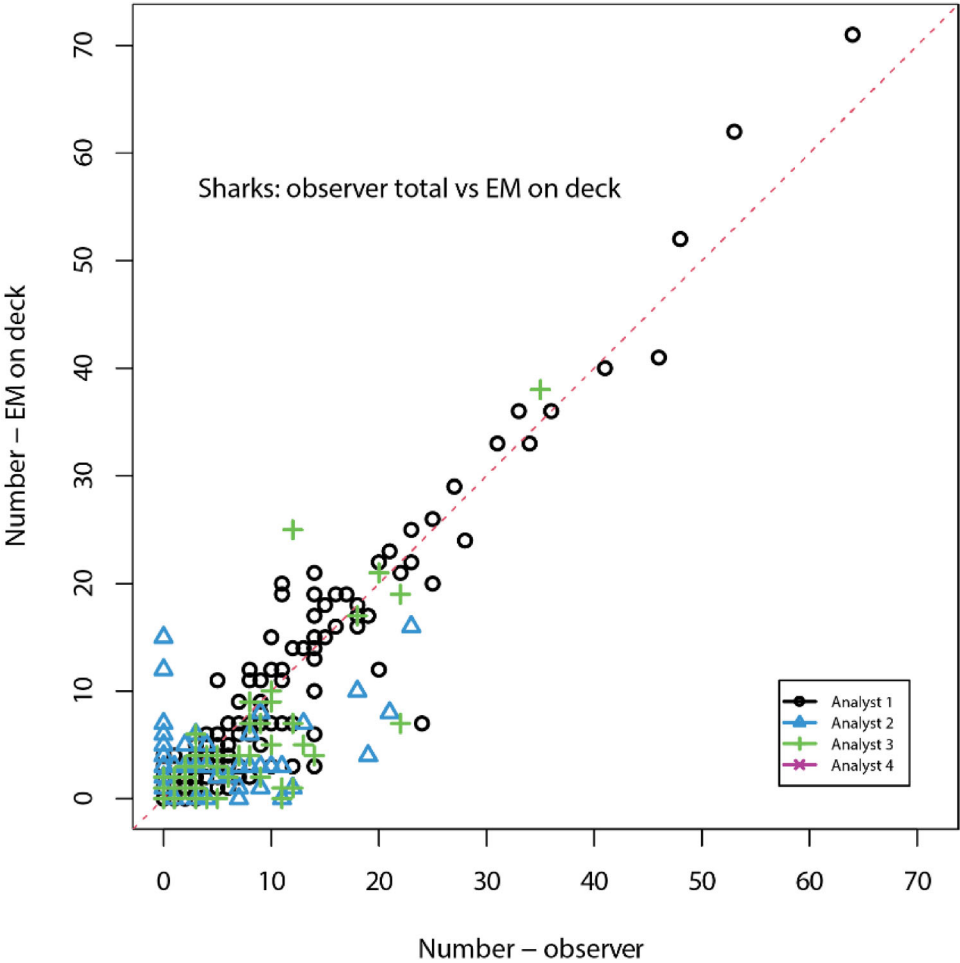
```

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).



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# Pilot EM Project on longline vessels

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



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# Pilot EM Project on longline vessels

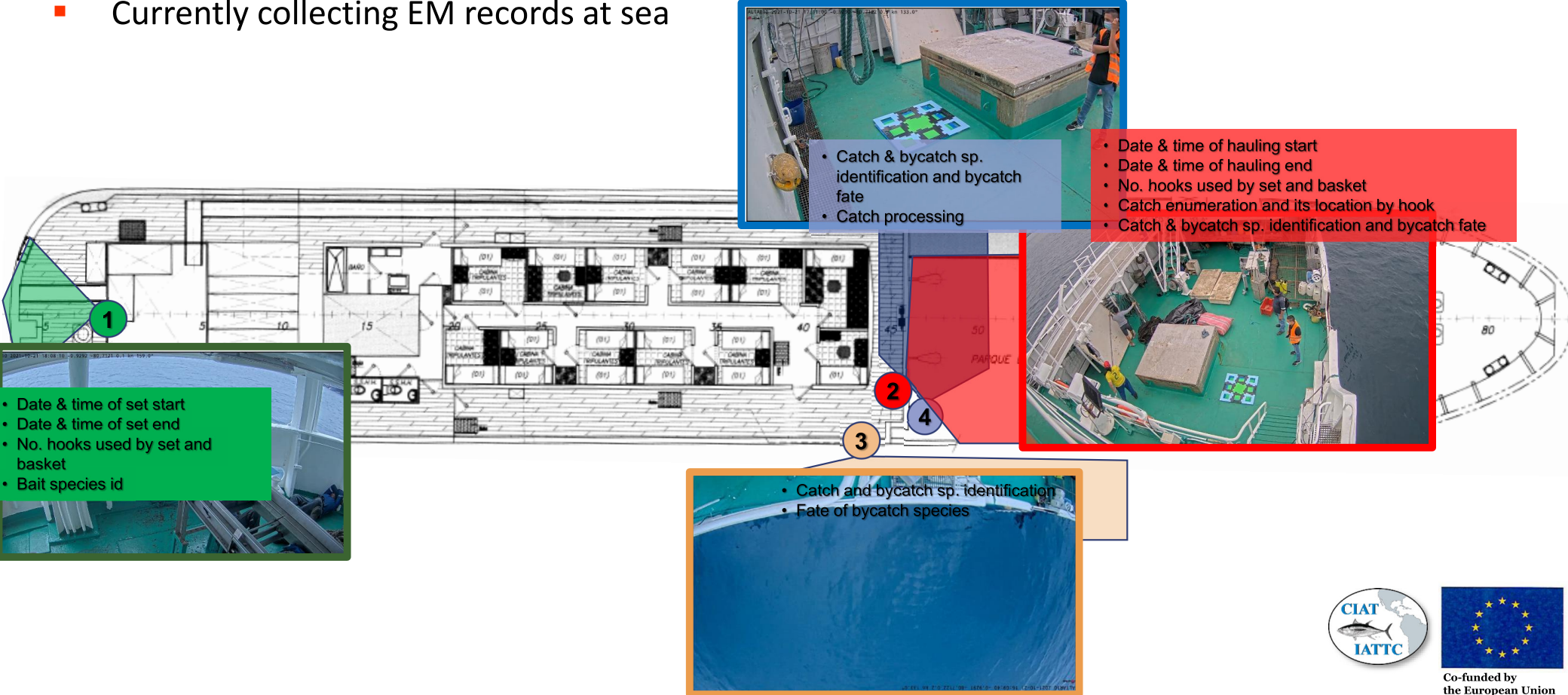
- February 2021 to May 2023
- Four-camera EM system installed



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# Pilot EM Project on longline vessels

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



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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.



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# 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.





# 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)

[www.IATTC.org](http://www.IATTC.org)



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