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)

iotc ctoi

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

Outline

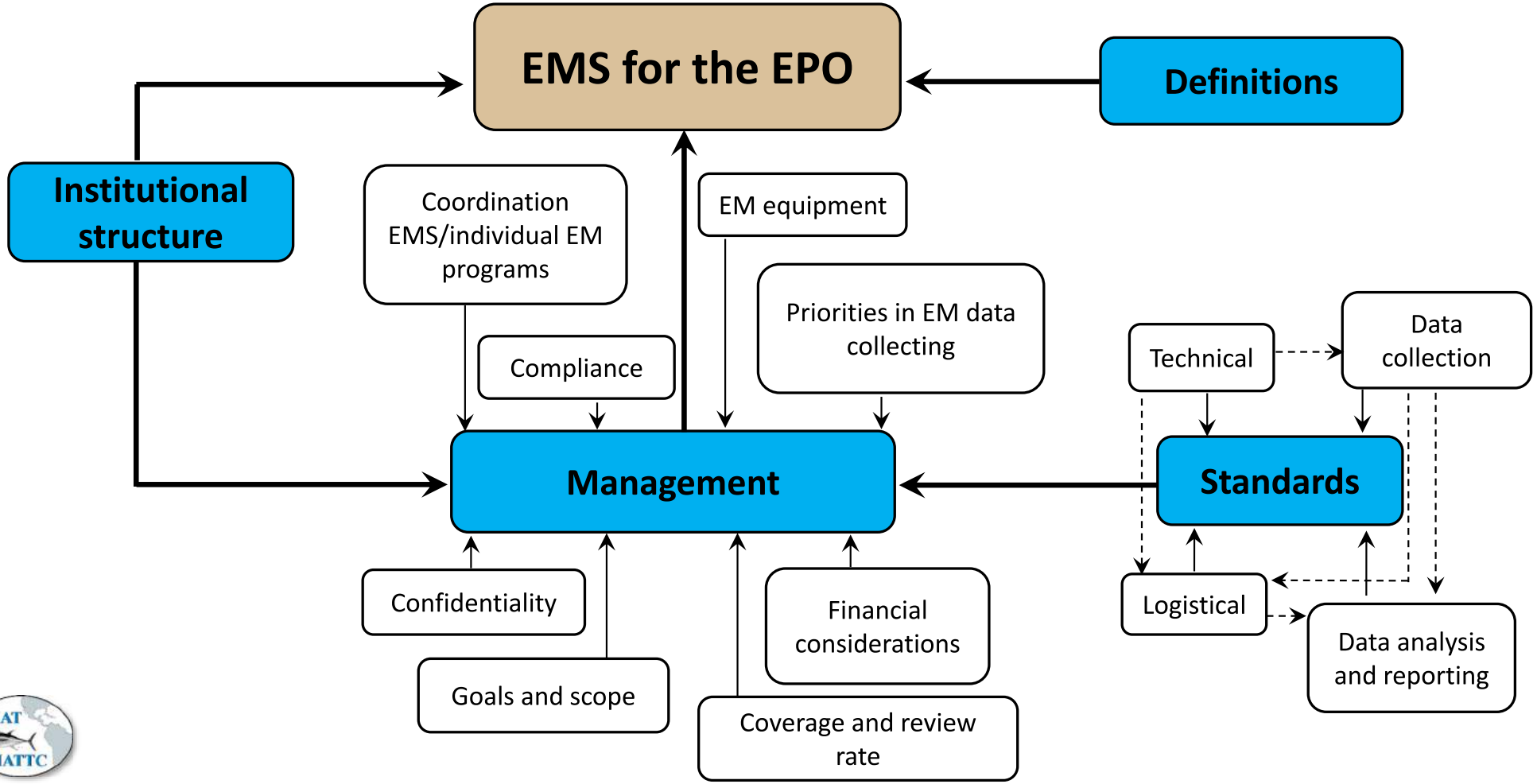
- **Steps taken for the implementation of an EMS for the tuna fisheries in the EPO**.
  - Proposed structure of the EMS.
  - Proposed workplan activities.

- **EM standards on data collection**.
  - Tuna purse-seine vessels in the EPO (Emphasis in small vessels).
  - Tuna longline vessels in the EPO.

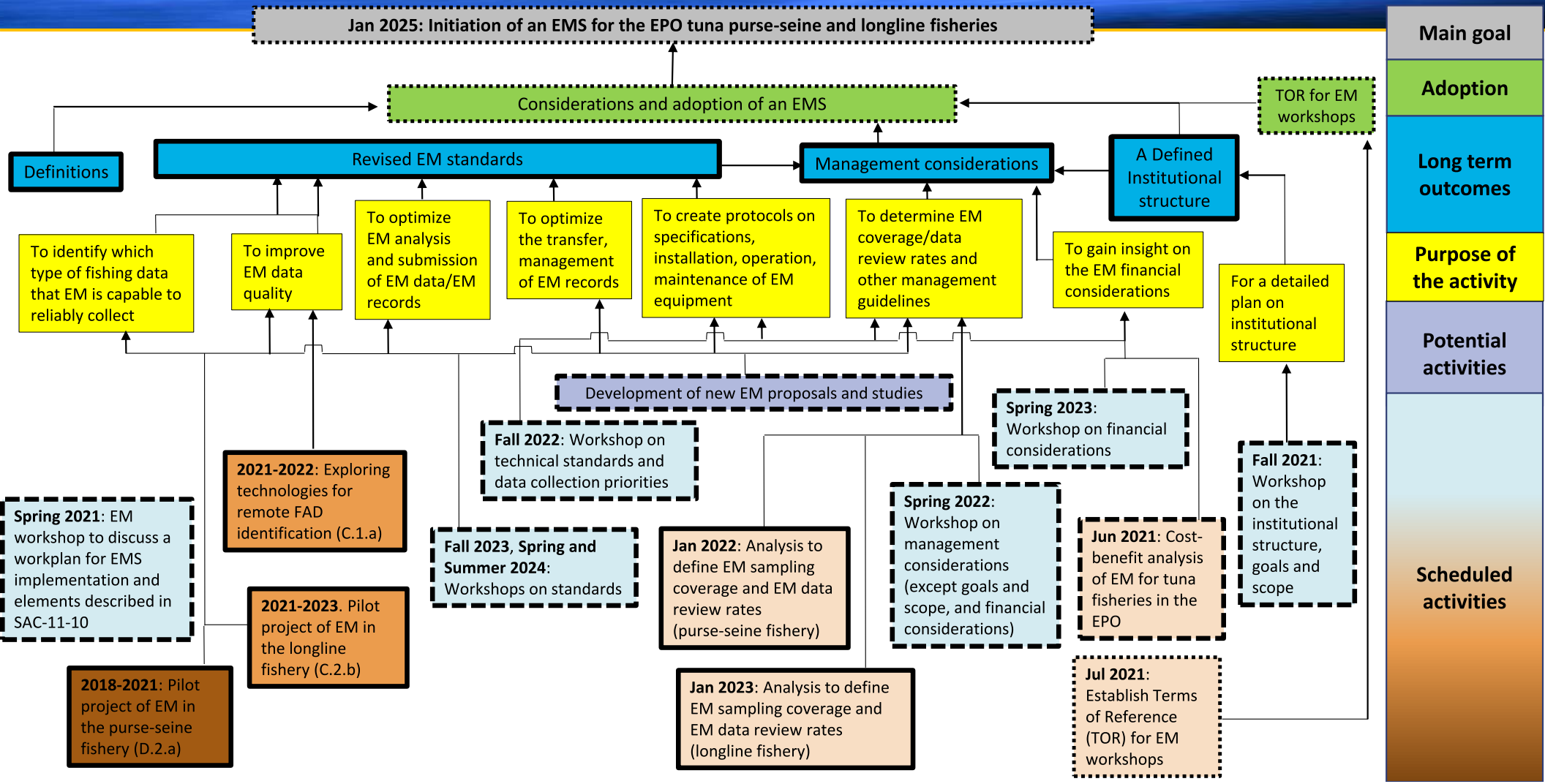
EMS for the tuna fisheries in the EPO. Background

- 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.
- 11th 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 96th meeting.
- 1st 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 98th IATTC Meeting (Res. C-21-03).
    - Adopt the proposed workplan of document EMS-01-02. Adopted during 98th IATTC Meeting.
    - Establish Terms of Reference for the EM workshops. Adopted during 98th 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

Apr 22-23, 2021: EM workshop to discuss a workplan for EMS implementation and elements described in SAC-11-10

98th meeting. Presentation of workplan, the definitions, and to stablish the Terms of Reference for EM workshops

Adopted.
C-21-02
C-21-03

Spring 2022: Workshop on management considerations (except goals and scope, and financial considerations)

99th meeting. Presentation and adoption on the institutional structure, other management considerations, Goals and scope of the EMS (part of Management considerations) established by the Commission

Spring 2023: Workshop on financial considerations

100th meeting. Presentation and adoption of the technical standards, data collection priorities and financial considerations

Spring 2024: Workshops on standards

101st meeting. Presentation and adoption of the revised EMS Standards

Jan 2025: Initiation of an EMS for the EPO tuna purse-seine and longline fisheries

2021 | 2022 | 2023 | 2024

Development of EM proposals and studies

Dec 13-15, 2021: Workshop on the institutional structure, goals and scope

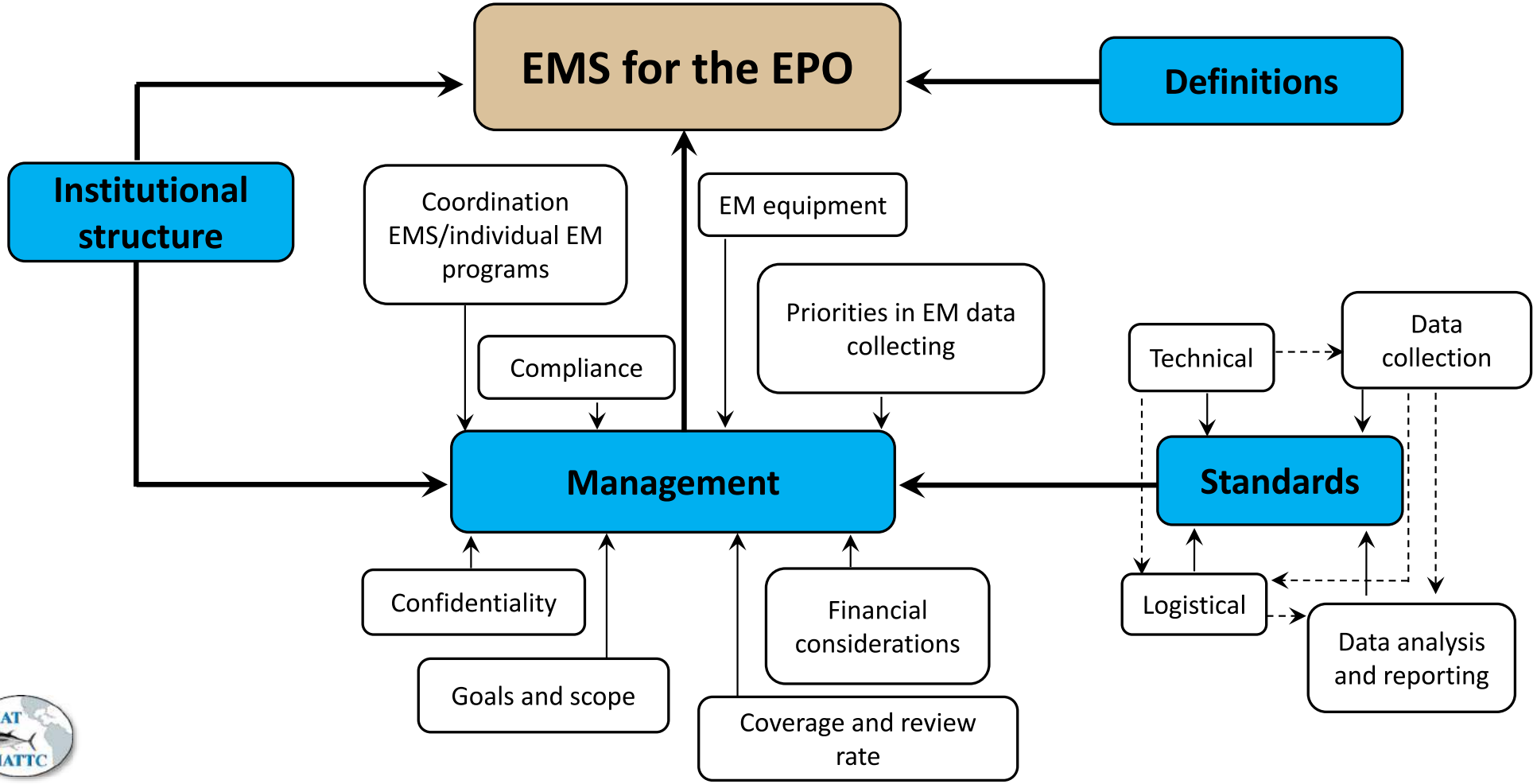
Fall 2022: Workshop on technical standards and data collection priorities

Fall 2023: Workshops on standards

Summer 2024 (if necessary): Workshops on standards

Ago-Sep 2024: Considerations and adoption of an EMS

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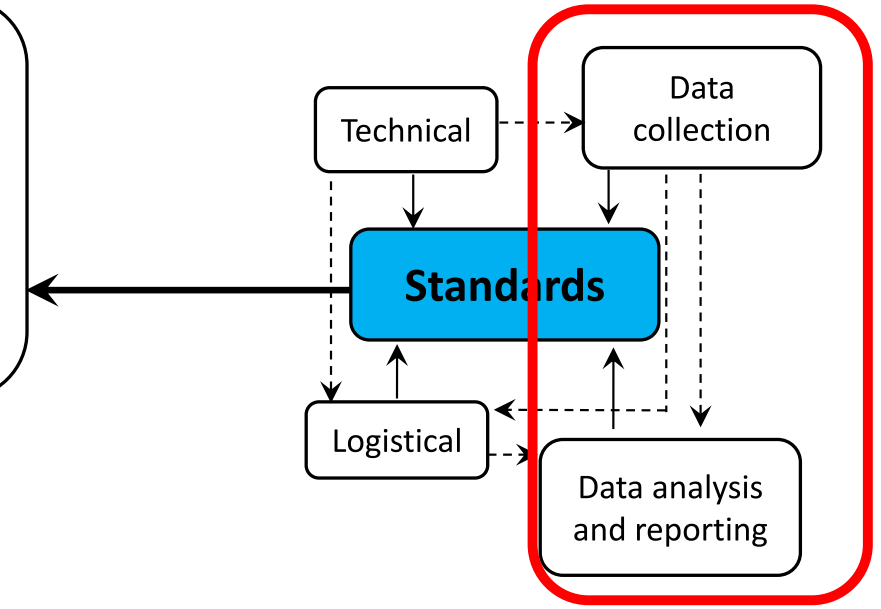
1) Pilot EM Project on small and large purse-seine vessels.
2) Pilot EM Project on Longline vessels.
3) Exploration of technologies for remote identification of FAD buoys.



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

- 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
Total number of active vessels	2	46	6	1	5	9
Number of vessels surveyed	2	38	6	1	3	8
Percentage surveyed	100	82.6	100	100	60	88.9
Percentage among those surveyed	3.5	65.5	10.3	1.7	5.2	13.8

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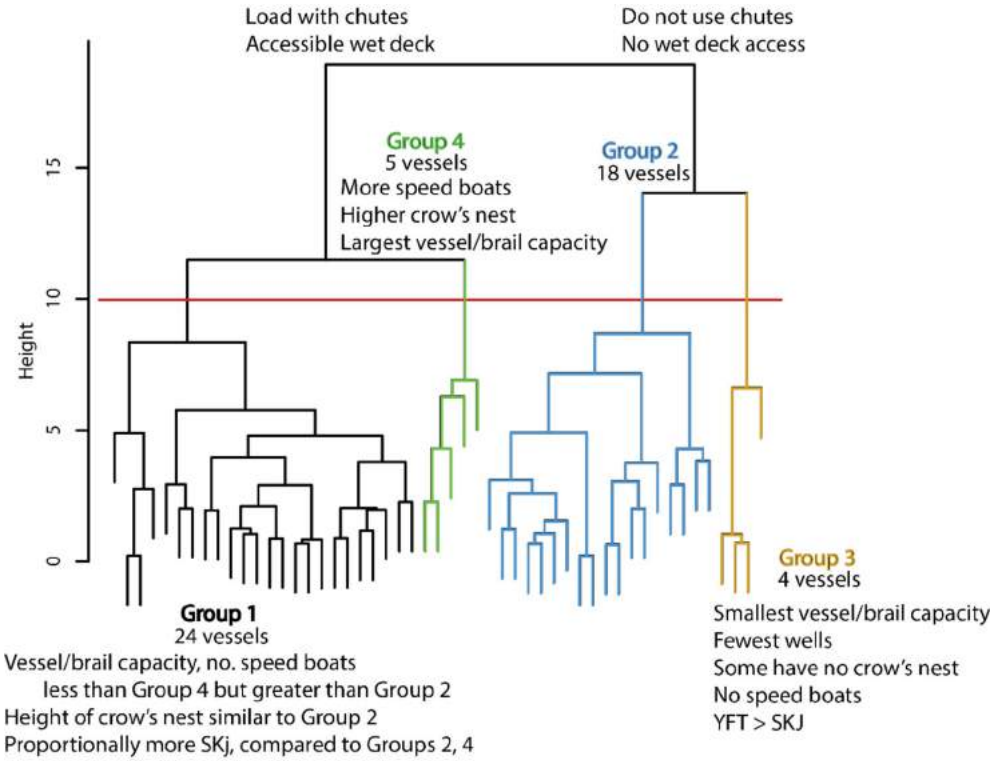
Cluster analysis of Class 1-5 survey data

- 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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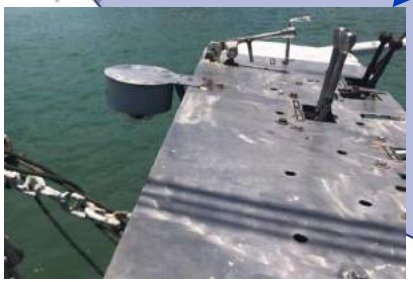
Participating vessel – Class-2

Small vessel

- *4 cameras (Main deck)*

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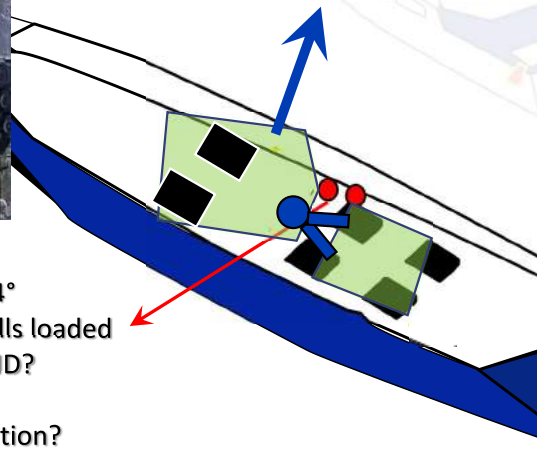
C2 : 180°
- No. speedboats used in the set
- FAD deployment?
- Bycatch fate
- Discards

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



C5-C6 : 104°
- ID of wells loaded
- Species ID?
- 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

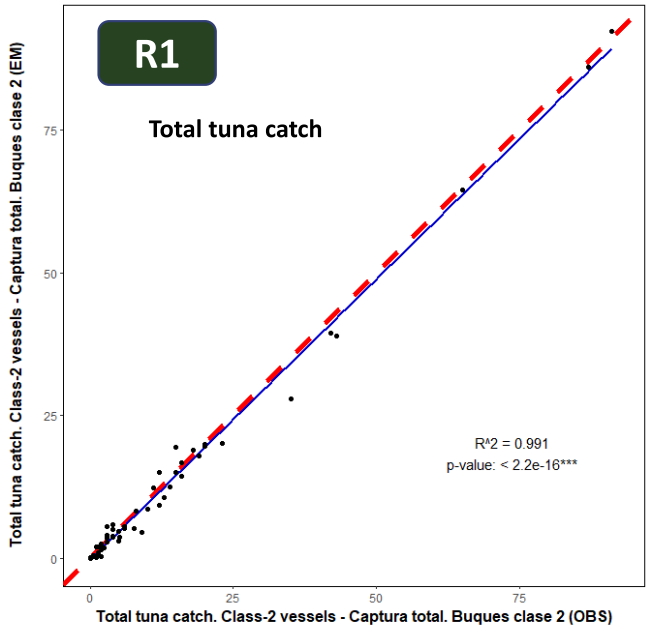
EM data collection current capabilities: Purse-seine

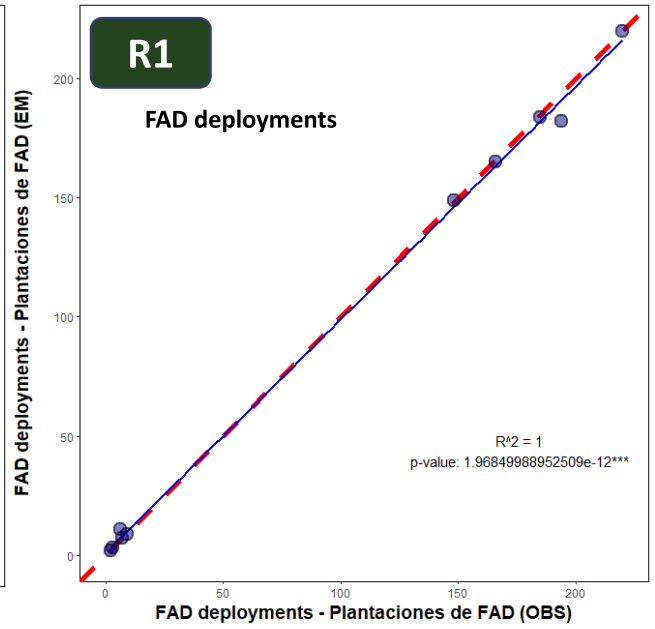
R1	Ready - Listo
R2	
R3	
R4	

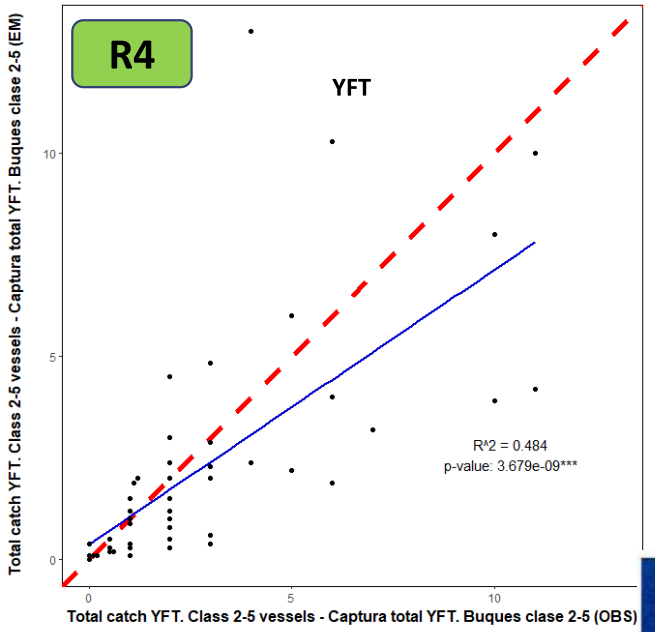
For example:
Total catch, FAD deployments,
Bycatch of large-sized individuals.

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.

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Preliminary results - Shark comparison

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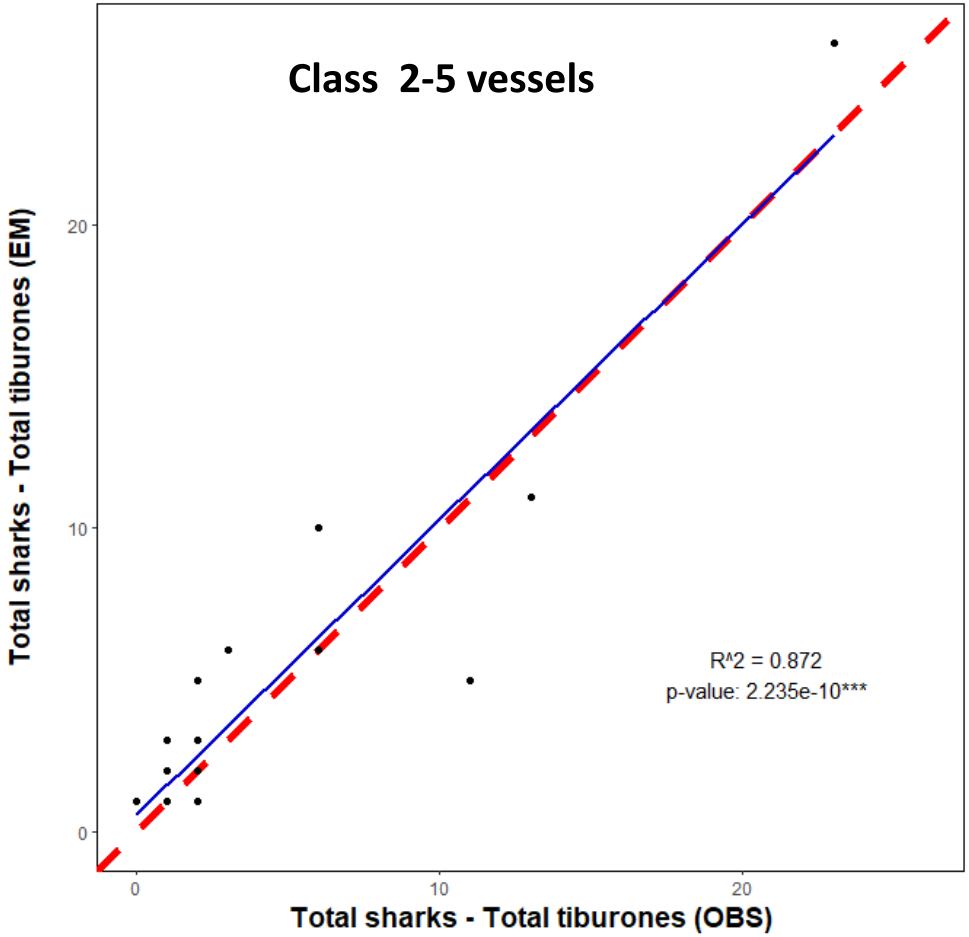
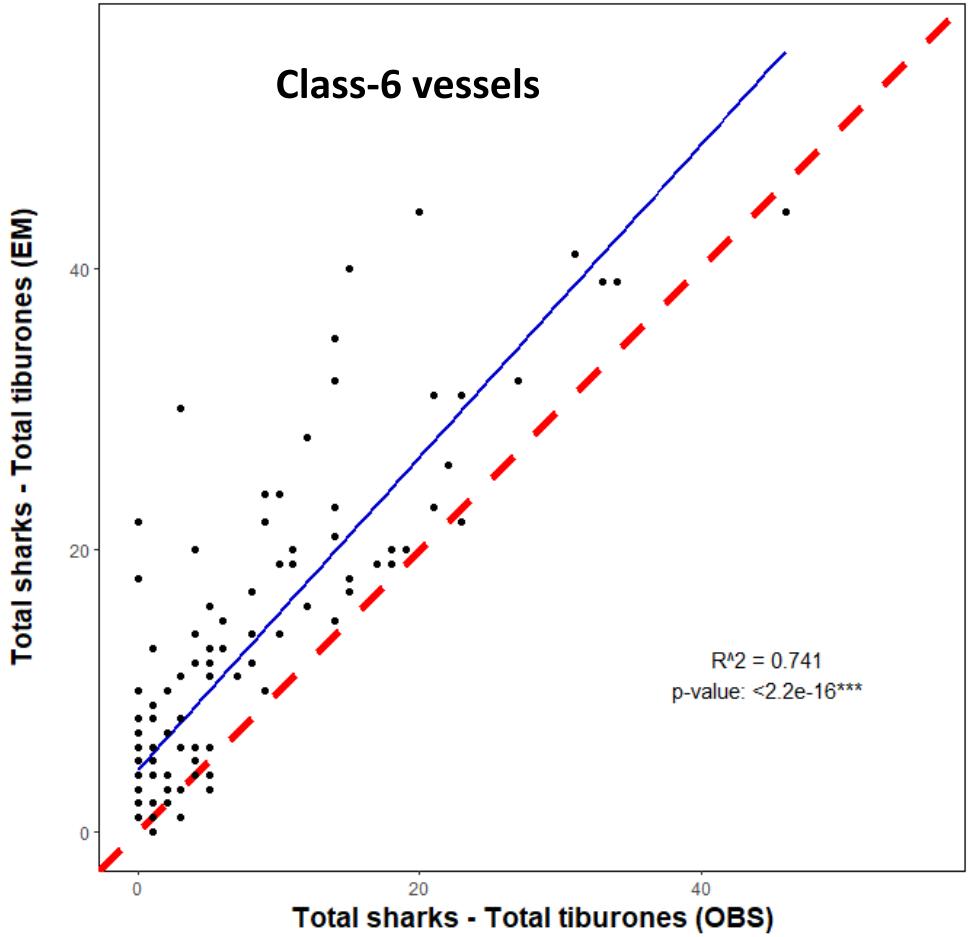
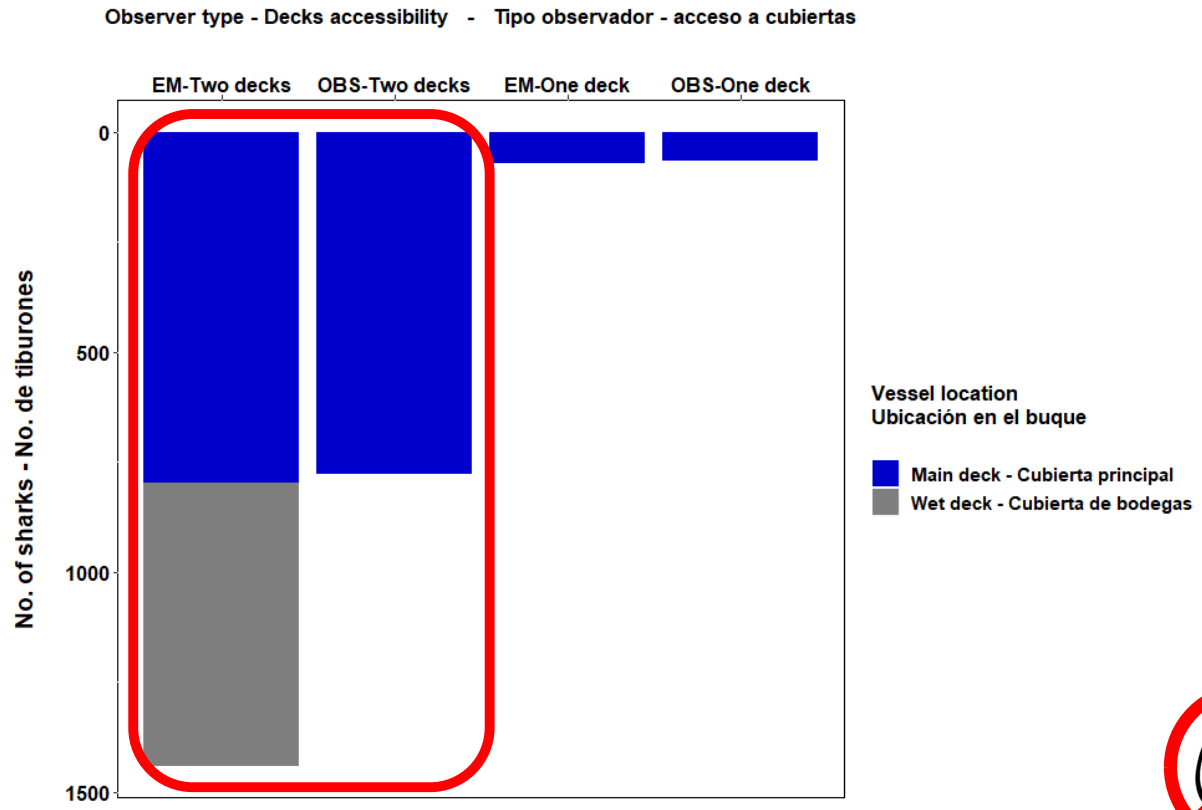




Preliminary results - Shark sightings by vessel location



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EM analyst comparison

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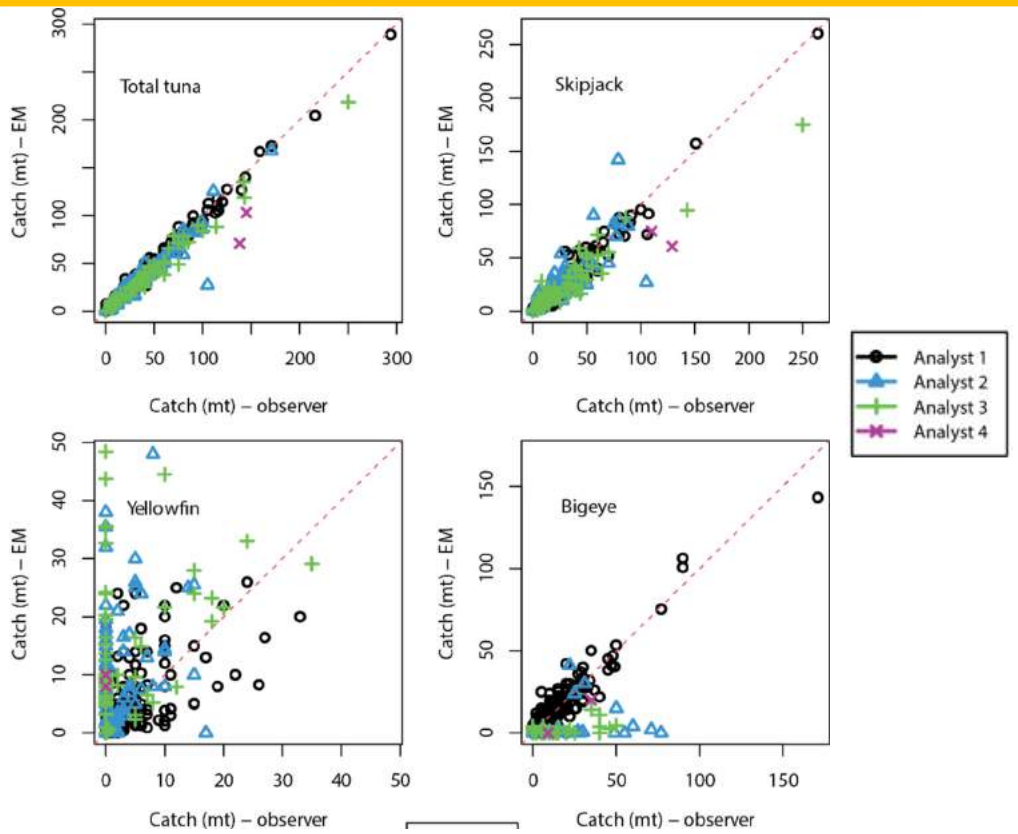


1. Observer and EM data similar for total tuna catch, and for catch of SKJ.
2. Relationship degrades for YFT. Although slope for Analyst 1 is close to 1.0, SE is large.
3. Poor relationship for BET, except for one EM analyst, despite the fact that the model fit to the data is acceptable.

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	***

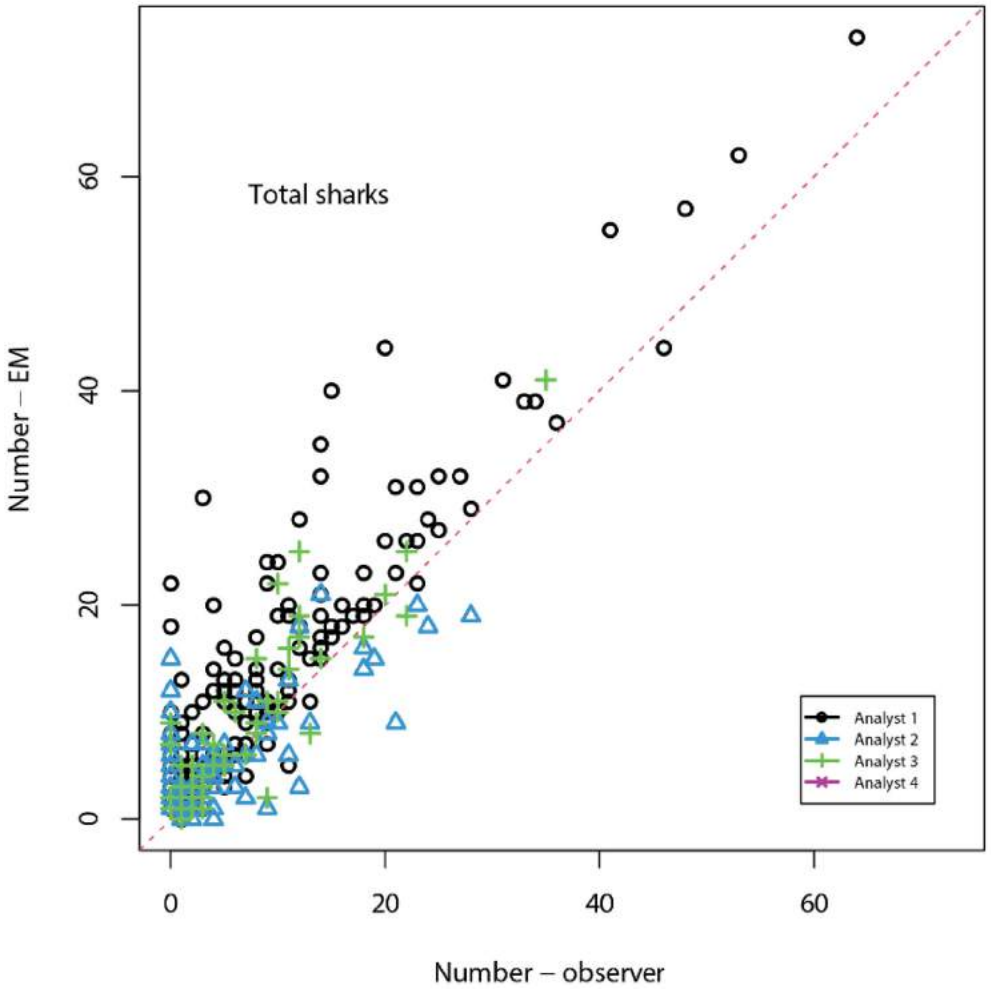
R-sq.(adj) = 0.274 Deviance explained = 51.9%
GCV = 55.723 Scale est. = 54.96 n = 438

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).

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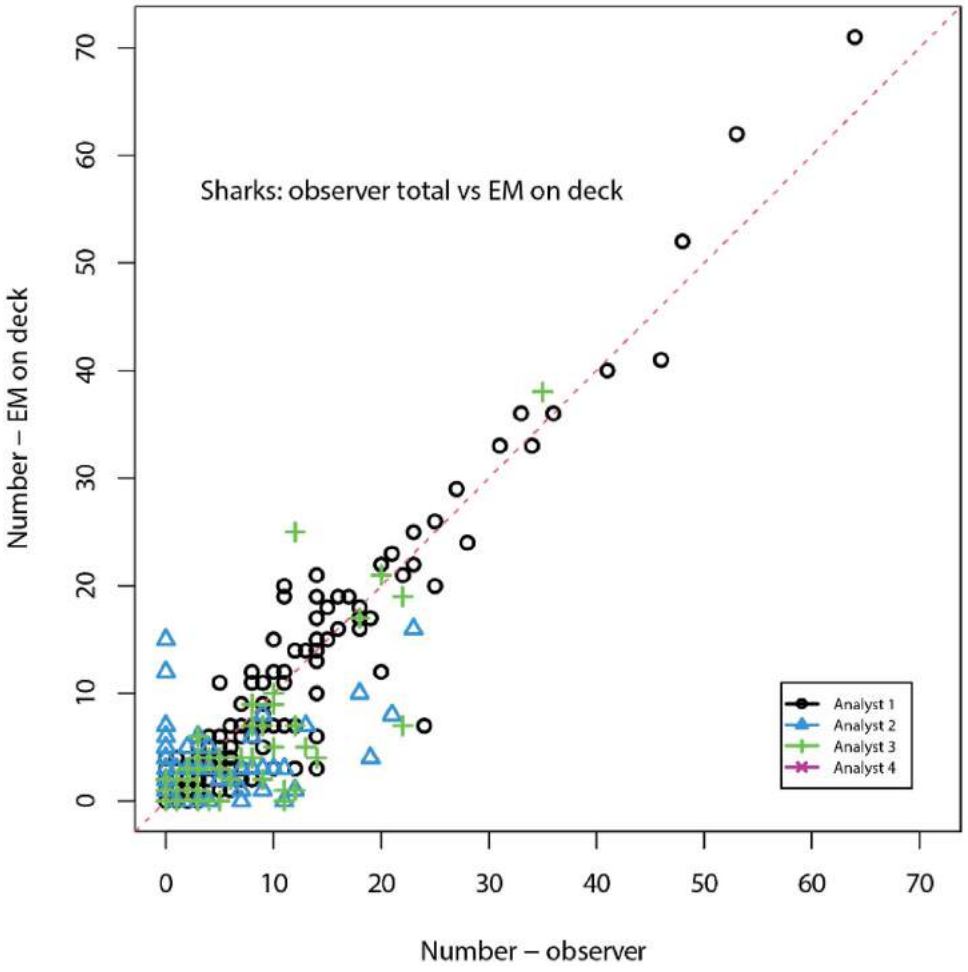
EM analyst comparison

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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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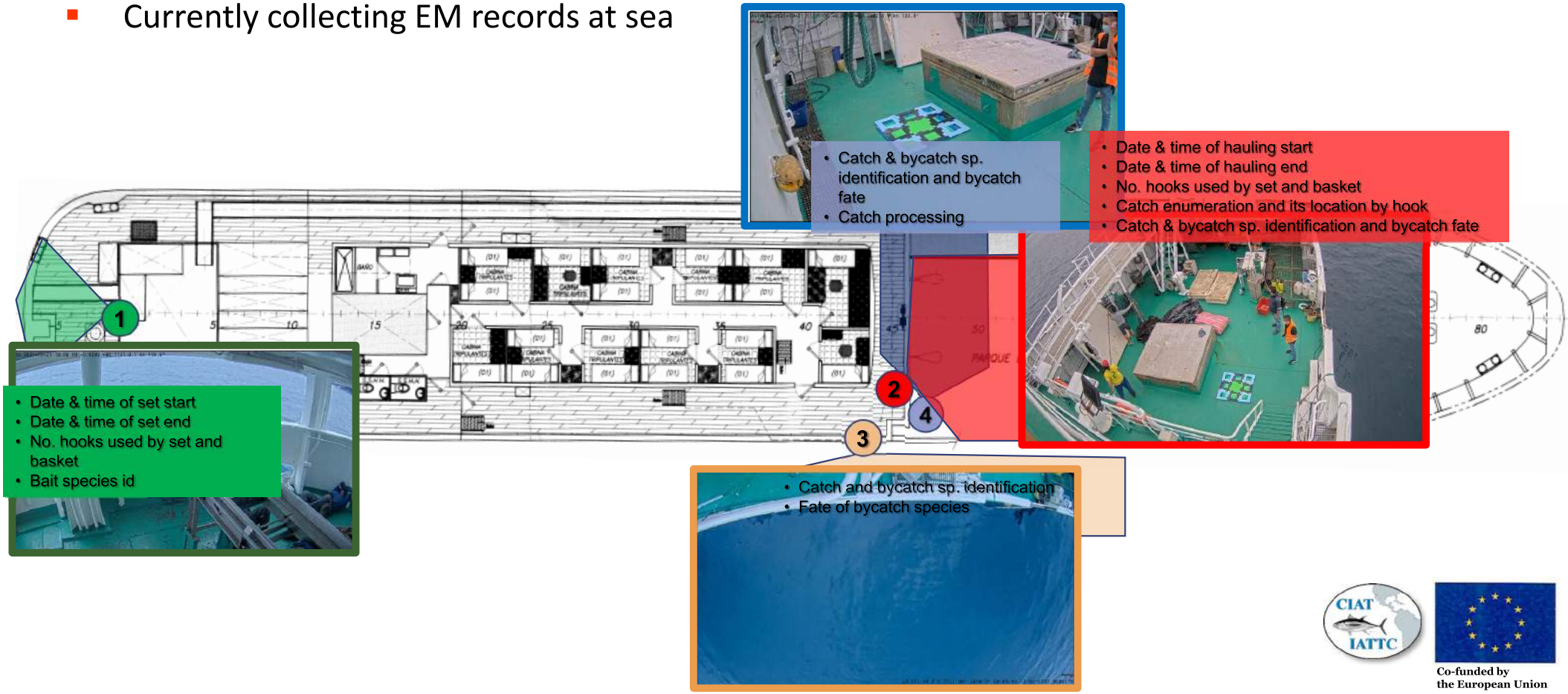
Pilot EM Project on longline vessels

- 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.

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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

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

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

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

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