A PILOT PROJECT OF ELECTRONIC MONITORING SYSTEM (EMS) IN THE KOREAN TUNA LONGLINE FISHERY

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1. SUMMARY OF TRIALS AND PURPOSE

Korea has carried out an EMS pilot project since 2021 by four Korean tuna longline vessels in the Pacific Ocean (Table 1).

The objectives of the project were to:

1) manufacture and operate EM equipment in consideration of Korea's distant water fisheries,
2) identify the availability of human observer data collection considering the characteristics of Korean fishing vessel, and
3) obtain enough video and still image data for the development of an image analysis software program by machine learning method.

2. CAMERAS

2.1 Location of Cameras

Location of cameras were different on each vessel to verify whether the data collected by human observers can be collected by EM, and the following surveys were performed (Table 2):

- **Set information**: Recordings from set start time to set end time. The camera on all four vessels (vessels A-D) were deployed on the stern of the vessel.
- **Biological information**: Recordings from haul start time to haul end time to collect biological information (i.e., identify species, length, weight, processed type, etc.) of catches on deck of the vessel. Two vessels (vessels A and B) had the camera installed in front of the bridge while the other two vessels (vessels C and D) installed the camera on the upper bridge of the vessel.
- **Discards and releases information**: Recordings from haul start time to haul end time to collect information on the species released or discarded by cutting the line. Three vessels (vessels A, B, and C) installed the cameras on the bow of the vessel, while one vessel (vessel D) had the camera on the upper bridge of the vessel.

2.2 Camera types

Most of other CPCs' EMS pilot projects have used dome-type cameras, but Korean EMS pilot project also tested bullet-type and long-body-type cameras to determine the availability of data collection. The specifications of each camera are listed in Table 3. The cameras used in the project meet the specifications set out in EMS-04-01, Technical Standards of an EMS, which is under discussion by IATTC 4th EMSWS.

2.3 Location and number by cameras

The location and the number of cameras were determined based on the data collected by human observers, other CPCs pilot projects and reference materials. The results of the first survey conducted using vessel A were reviewed to enable further refinement to the survey design, and the surveys by vessels B, C, and D were carried out sequentially. The location, type, and number of cameras deployed on each vessel are as follows (Table 4):

- Vessel A: three bullet-type cameras (i.e., each on the stern, bow, and in front of the bridge of the vessel)

- Vessel B: three dome-type cameras (i.e., each on the stern, bow, and in front of the bridge of the vessel)
- Vessel C: three long-body-type cameras and one bullet-type camera (i.e., one bullet-type camera on the stern of the vessel, one long-body-type camera on the upper bridge of the vessel, and two long-body-type cameras on the bow of the vessel)
- Vessel D: two long-body-type cameras, one bullet-type camera, and one dome-type camera (i.e., one bullet-type camera on the stern of the vessel, two long-body-type cameras and one dome-type camera on the upper bridge of the vessel, and no camera on the bow of the vessel)

3. OPERATING SYSTEM

An operating system was installed along with its monitor in the bridge of the vessel. Vessel satellite communication (very small aperture terminal, VSAT) was used to monitor the overall operation including system updates and error checks.

3.1 Storage devices

Korean distant water tuna longline vessels make comparatively lengthy fishing trips which can last up to 20 months so that significantly large amount of storage space is required to record information throughout the trip. However, in this pilot project, a 28 TB HDD was installed, considering the amount of storage space that could cover around 70 sets, i.e., the number of sets a human observer would collect during the three months of scientific survey.

3.2 Display

A touchscreen monitor was installed for easy operation of the system including system checks, error detection, and camera angle adjustments (Figure 1). The main features of the monitor are as follows:

- Buttons: Auto/manual recording, start/end of set and haul, send still image, and adjust camera angle
- Displayed information: remaining storage space, time, latitude, longitude, and video recordings

4. OTHERS

All the vessels with an EM installed had a human observer on board:

- To identify issues on site and potential improvements,
- For a comparative analysis between the data collected by the EM and by the observer,
- For the management of EM equipment, and
- To achieve the observer coverage required.

5. RESULTS

5.1 Set information

The footages recorded by the vessels suggested that most of the set information can be collected with EMS regardless of the camera location and camera type (Table 5 and 6). The start time and end time of set, latitude, longitude, vessel speed, directions, the number of hooks, and the number of baskets were included in the information available for collection. And monitoring the implementation of seabird mitigation measures also seemed practicable subject to installation of additional equipment. However, the EM could not collect non-visual information such as gear length and materials, as was the case with the IATTC report, EMS-04-02.

With regards to the types of camera, bullet-type cameras had marginally wider angle compared to that of dome-type camera. A dome-type camera would rule out unnecessary information, which focused on identifying data to be collected due to relatively narrow angle, and save storage space.

5.2 Biological information

Cameras were installed either in front of the bridge or on the upper bridge to collect information on the catches on the deck of the vessel, and collectable information included species identification, processed type, condition of caught fish, fate condition (retained, discarded, and released), regardless of the camera location and type (Table 7 and 8). Biological information such as length and weight would be practicable if image analysis technology is developed, and other information such as tag information, sex, and maturity could also be collected with the crew's support. However, collecting information on sex and maturity wouldn't be possible for unprocessed catches such as albacore and skipjack tuna, and it would also be difficult to collect information on the catches outside the EM recorded angle or if a large portion of an individual is blocked by some crew thus not visible on the EM screen.

There were similar the recorded video results by location of cameras (front and upper side of the bridge). The camera in front of the bridge presented larger and clearer images, but some catches were present outside of the EM recorded range due to the narrower angle. The camera on the upper deck had a relatively wider angle, but the individuals were displayed small on the screen, making it somewhat difficult to identify species from the video. However, we expect these issues to be resolved through improvements in image analytical technologies.

The dome-type camera in front of the bridge had a too narrow range of angles compared to that of the bullet camera in the same location. Although the dome-type camera could be adjusted from side to side, it was practically difficult to manually adjust the camera angle for every catch. The difference between bullet-type camera and long-body-type camera was the presence of a zoom in and out function. Long-body-type camera installed on the bridge could be used to zoom in or out to set the recording range that suits the characteristics of the vessel.

5.3 Information on discards and releases

We tested with different types, numbers, and locations of cameras to collect information on discards and releases, but we were not able to collect information of underwater species (Table 9 and 10). However, species identification may be available if they are brought on board or at least partially expose their taxonomical keys above the water like threshers or oceanic whitetip sharks.

6. FUTURE PLANS

In the upcoming third trial project in 2023, the deployment of the cameras will be changed from the bow and upper bridge in the previous two trials to the upper stern side to increase the probability of collecting information on discards and releases (Figure 2). During the previous trials, all the EM survey were recorded manually by human observers onboard, but an additional camera will be installed on the upper deck to monitor the line hauler speed to test the automatic recording methods.

In addition, starting from the third pilot project, preliminary study will be conducted to develop an image analysis software program.

TABLE 1. Summary of Korea's EMS pilot project period, study area, and fishery type

Period	Area and fishery type
1st project (2021)	- Area: WCPFC - Fishery: Tuna longline (one vessel, Vessel A)
2nd project (2022)	- Area: WCPFC, IATTC - Fishery: Tuna longline (three vessels, Vessel B, C, and D)
3rd project (2023)	- Area: WCPFC - Fishery: Tuna longline (one vessel, TBD)

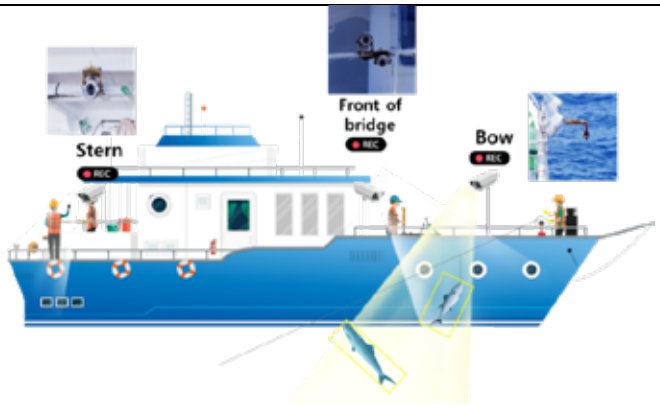
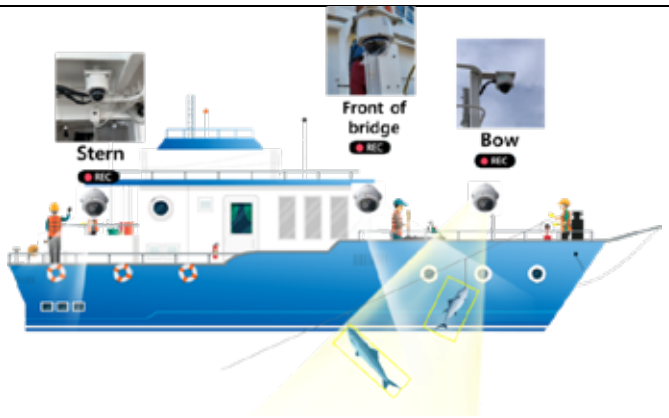
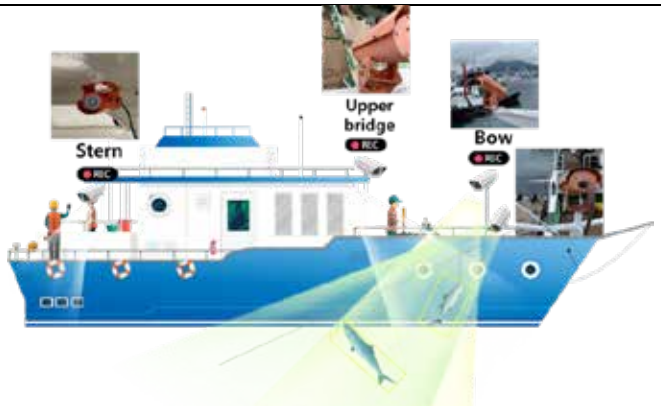
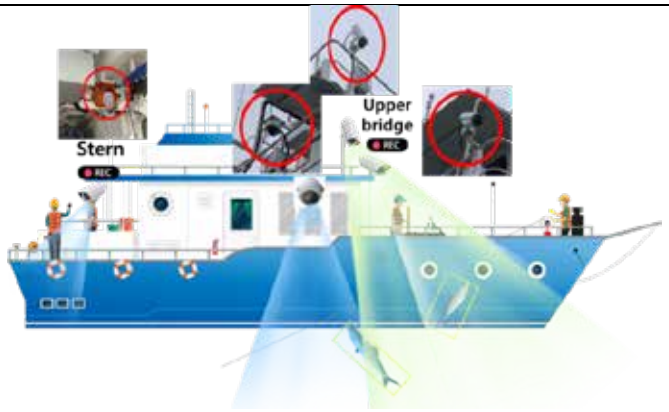
Table 2. Expected information type by deployment of cameras

Information	Location of camera	Vessel	Time of recording	Data
Set information	Stern	A, B, C, D	Set start – Set end	- Set (start/end): latitude, longitude, time, vessel speed, directions - Gear specification: wire trace, shark line, number of blue lights - Effort: number of baskets, number of hooks, hook type - Bait: bait arrangement, bait type - Seabirds mitigation: species identification, implementation of mitigation measures
Biological information	Front of bridge	A, B	Haul start – Haul end	- Individuals brought on deck: species identification, processed type, number of caught, hooked part - Biological information: length, weight, sex - Tag information
	Upper bridge	C, D		
Discards and releases information	Bow	A, B, C	Haul start – Haul end	- Haul (start/end): latitude, longitude, time, vessel speed, direction - Discarded, released: species identification, number of caught, condition
	Upper bridge	D		

TABLE 3. Specifications by camera type

Camera	Bullet-type	Dome-type	Long-body-type
Photo			
Flicker free mode	50, 60Hz	50, 60Hz	50, 60Hz
Dustproof, waterproof	IP67	IP67	IP67
Resolution	1920 x 1080; 2.1 MP	1920 x 1080; 2.1 MP	1920 x 1080; 2.1 MP
Compression	H.265	H.265	H.265
Frame rate (max @ 1920 x1080)	60 (50) fps	30 (25) fps	60 (50) fps
Operating humidity	0 – 90% RH	0 – 90% RH	0 – 90% RH
Operating temperature	-40°C to -60°C	-40°C to -60°C	-45°C to -60°C
Digital zoom	-	16 x	36 x
Additional information	-	- Pan: 360° - Title: -10° ± 190°	Built in wiper

TABLE 4. Camera type and deployment by each vessel

Vessel	Camera type and location	Description
Vessel A		- Camera type: Bullet - No. of camera: three cameras - **Stern**: one bullet-type camera - **Front of bridge**: one bullet-type camera - **Bow**: one bullet-type camera
Vessel B		- Camera type: Dome - No. of camera: three cameras - **Stern**: one dome-type camera - **Front of bridge**: one dome-type camera - **Bow**: one dome-type camera
Vessel C		- Camera type: Long body and bullet - No. of camera: four cameras - **Stern**: one bullet-type camera - **Upper bridge**: one long-body-type camera - **Bow**: two long-body-type cameras
Vessel D		- Camera type: long-body, bullet and dome-type - No. of camera: four cameras - **Stern**: one bullet-type camera - **Upper bridge**: two long-body-type cameras and one dome-type camera - **Bow**: No camera

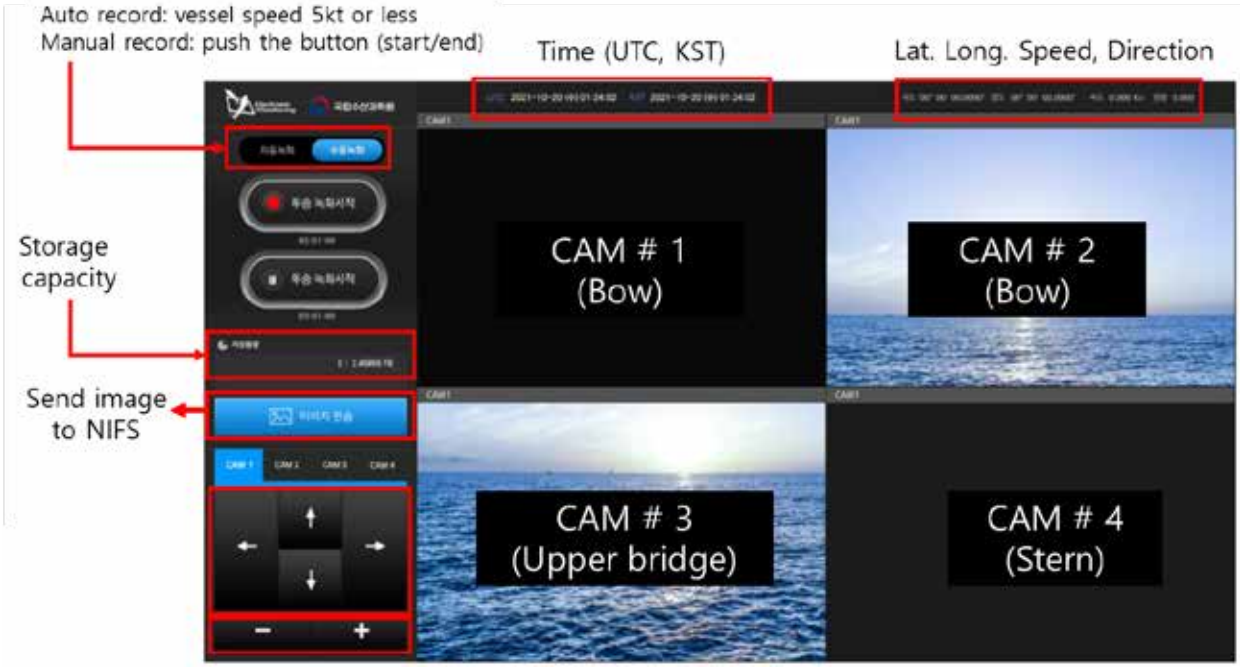


FIGURE 1. A screenshot of the operating system installed on the vessels.

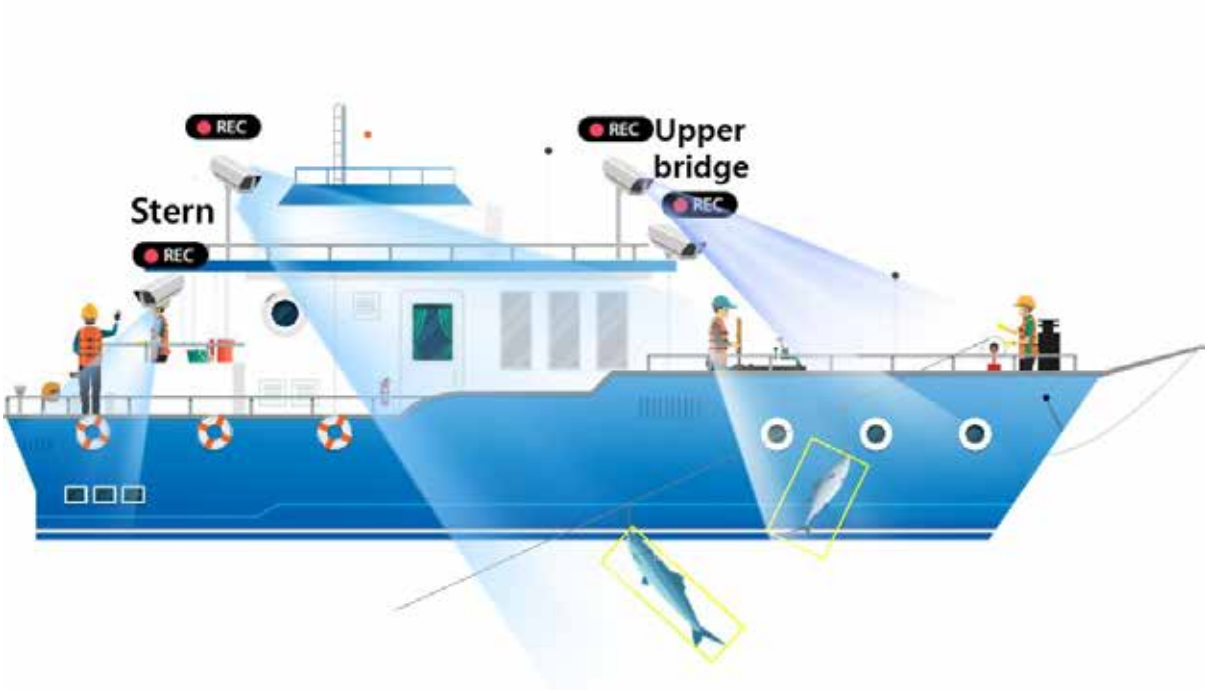


FIGURE 2. Location of camera deployment for the 3rd pilot survey in 2023.

TABLE 5. Set information by vessel

Vessel A One bullet-type camera, Stern	**Vessel B** One dome-type camera, Stern
	
Vessel C One bullet-type camera, Stern	**Vessel D** One bullet-type camera, Stern
	

TABLE 6. Summary of set information collected by EMS

Information	Available	Unavailable
Set information	- Set start/end: time and latitude, longitude, vessel speed, directions - Bait information - Number of hooks, number of baskets, number of blue lights, number of buoys - (If additional equipment installed) Monitoring of implementation of seabird mitigation measures	- Length and material of main line and branch line - Use of wire trace - Automatic bait thrower speed

TABLE 7. Biological information by vessel

Vessel A one bullet-type camera, Front of bridge	**Vessel B** One dome-type camera, Front of bridge
	
Vessel C One long-body-type camera, Upper bridge	**Vessel D** One long-body-type camera, Upper bridge
	

TABLE 8. Summary of biological information collected by EMS

Information	Available	Unavailable
Information on the catch brought on deck	- Species identification - Processing method - Health when caught - Retained, discarded, or released - (If analysis method developed) biological information e.g., length, weight, sex, and maturity - (Under crew's assistance) tag information, maturity	- Sex and maturity for unprocessed catch - Catch present outside the range of camera angle or blocked by crew thus not visible on screen

TABLE 9. Discards and releases information by vessel

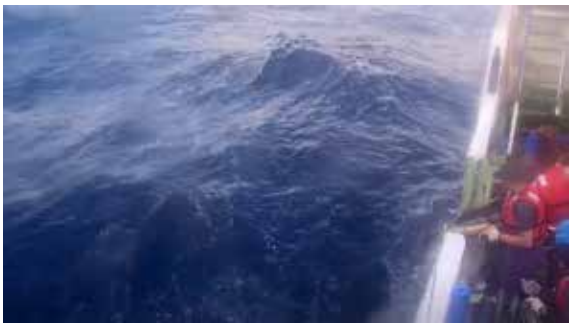
Vessel A One bullet-type camera, Bow	**Vessel B** One dome-type camera, Bow
	
Vessel C Two long-body-type cameras, Bow	**Vessel D** One long-body & one dome-type cameras, Upper bridge
<Long-body-type, Bow inside>	**<Dome-type >**
	
<Long-body-type, Bow outside>	**<Long-body-type>**
	

TABLE 10. Summary of discards and releases information collected by EMS

Information	Available	Unavailable
Discards and releases information	- Species identification of catch brought on deck - Species identification of individual partially exposing taxonomical keys above the surface	- Information of underwater species discarded or released