Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

EXPLORING TECHNOLOGIES FOR REMOTE IDENTIFICATION OF FADs

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Background

- Fishers have taken advantage of the aggregative behavior of tunas to fish around FADs.
  - **Very efficient** (e.g., lower proportion of null sets, lower fuel consumption)
  - Relatively **easy to plan and monitor** its location and fish aggregation
- But present **several negative** ecological impacts (e.g. bycatch, juvenile tuna, stranding on sensitive coastal habitats)
- Quantification of these impacts requires efficient collection methods for **high-quality data**.
  - **Tracking individual FADs** throughout their lifetime (FAD ID through the buoy serial number is needed)
  - **Buoys' alphanumeric serial number** has been difficult for observers to collect accurately
  - A system **to automatically and remotely detect and ID FADs** would improve the value and utility of all types of data.
- **Objective**: Evaluate the suitability of an electronic technology to remotely identify FADs in real conditions.

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Background

- Criteria for technology selection, it should:
  - i. **perform efficiently** under any environmental conditions and at a **reasonable distance** (i.e., ideally at a distance where the vessel has detected the FAD or is ready to conduct an activity with it);
  - ii. not be used for **remote/active searching and detection** of buoys (i.e., does not increase vessels' buoy searching abilities);
  - iii. **be affordable** and not incur significant increases in the cost of production;
  - iv. be capable of **transmitting actively** (e.g., continuously) **or passively** (e.g., when called, intermittently);
  - v. be compatible with **external electrical power supply** (e.g., solar panels or the batteries of the buoy);
  - vi. be of **small** size (i.e., does not incur significant changes in current equipment designs);
  - vii. **not interfere with other equipment** of the vessel (i.e., does not create interferences);
  - viii. be **tamperproof** (i.e., made so that it cannot be interfered with or changed) and **not trackable**;
  - ix. be **portable and easy to deploy** (i.e., for the cases in which helicopters/speedboats are used to access the FAD); and
  - x. be able to be **mass produced**.

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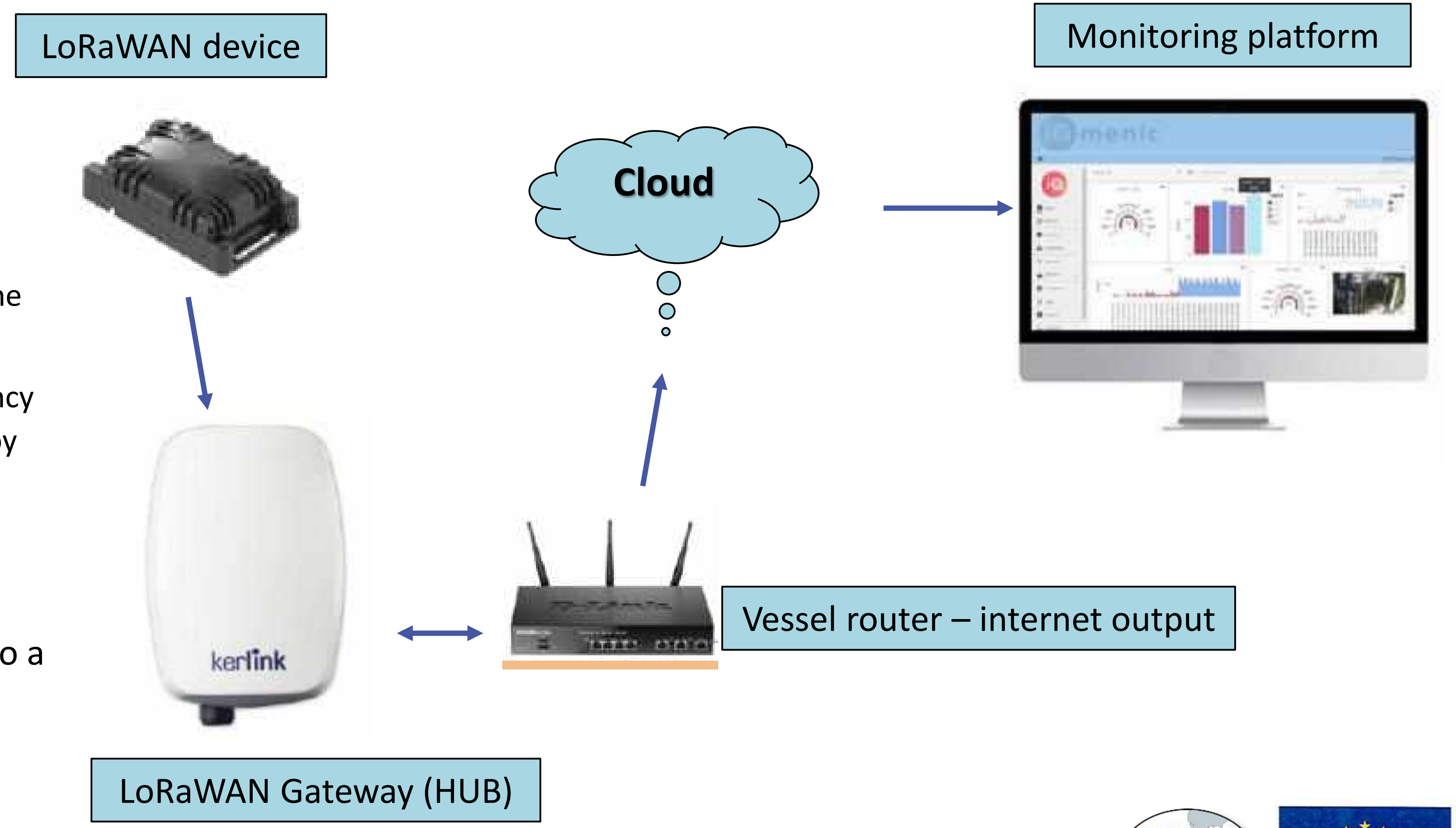
Architecture of the LoRaWAN system

- The **LoRaWAN** technology (Long Radio Digital system)
  - Configurable at different intensities and gains
  - Transmits both actively or passively
  - Very low battery intensive.
- Composed by **2 elements**:
  - Gateway or receptor (**hub**). Connects devices to the cloud or other communication systems
  - **Sensor device** (transmitter). It sends radio frequency signals with sensed information (e.g., the FAD buoy ID) to be picked up by any hub in range.
- In our experiment, the Hub passes the request and resulting information onto the cloud and to a reading computer program or app.
- Experiment in 2 phases:
  - Exploratory
  - Real conditions



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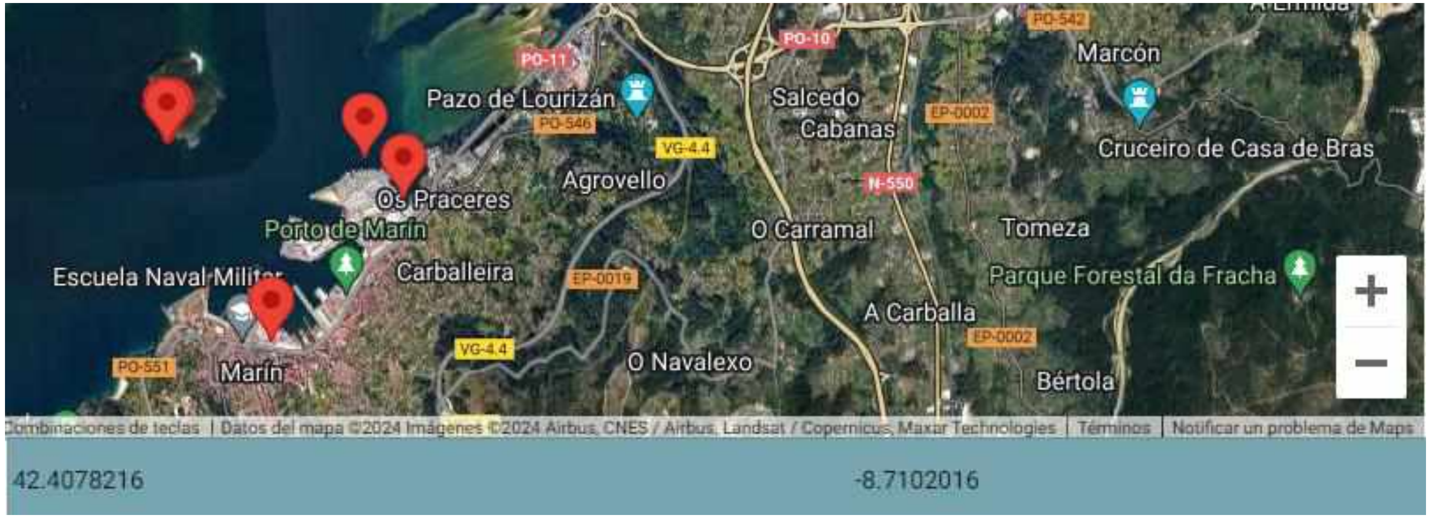
LoRaWAN trials, exploratory: Galicia - Spain

HUB antenna	Range (m)	Date	Sensor Call time	Sensor GPS reading successes	Sensor GPS time
No	800	1/19/2024	16:01	0	
No	800	1/19/2024	16:21	0	
Yes	800	1/19/2024	16:31	1	16:41
Yes	1600	1/19/2024	16:41	1	16:51
Yes	1900	1/19/2024	16:31	1	16:41
Yes	2400	1/19/2024	17:11	0	
Yes	2400	1/19/2024	17:21	1	17:31
Yes	3200	1/19/2024	16:51	0	
Yes	3200	1/19/2024	17:01	0	



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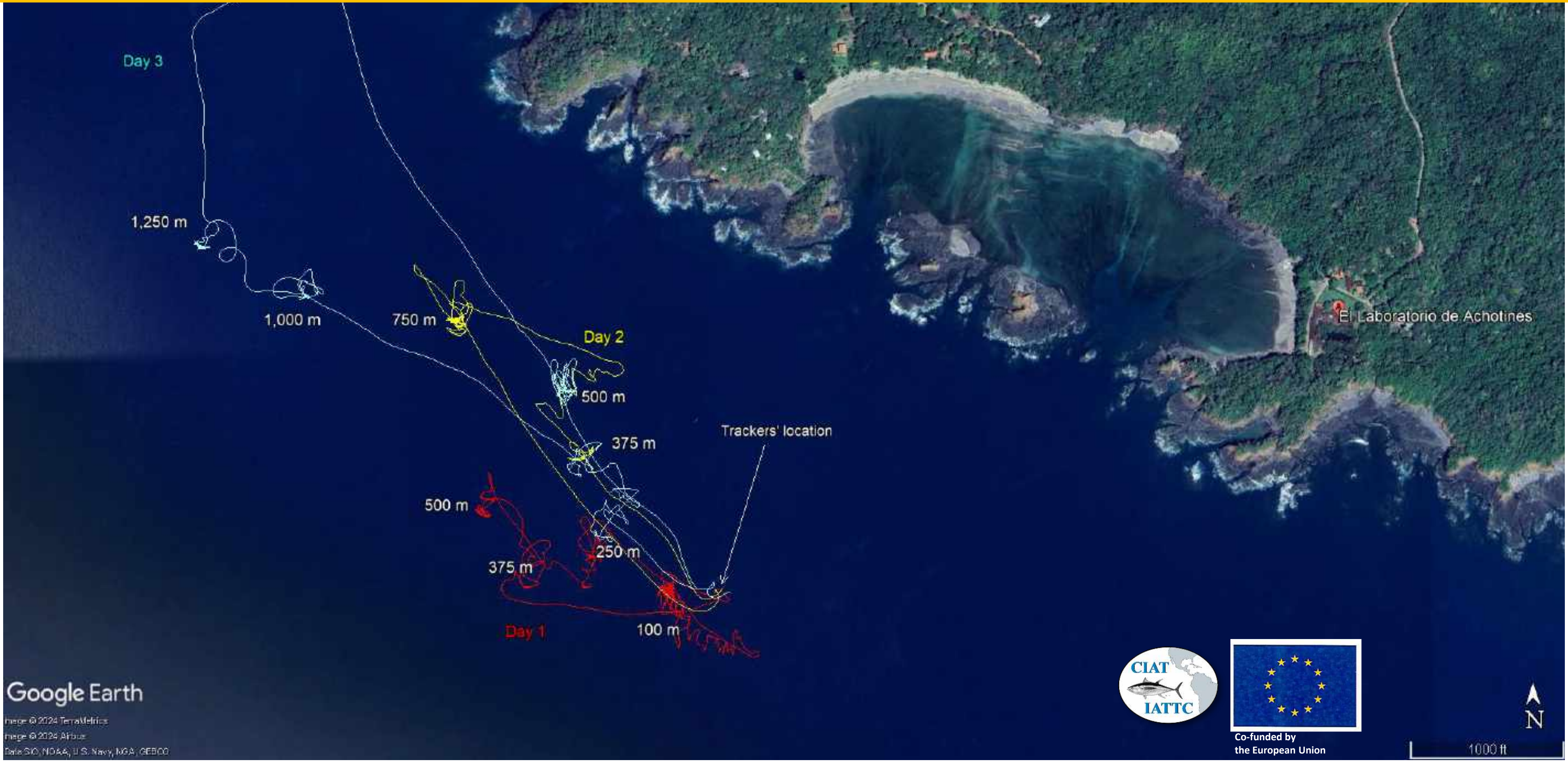
LoRaWAN trials in at-sea conditions: Achotines Lab - Panama



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LoRaWAN trials in at-sea conditions: Achotines Lab - Panama





Range (m)	HUB antenna	Sensor 1 Calls	Sensor 1 status reading successes	Sensor 1 GPS reading successes	Sensor 2 Calls	Sensor 2 status reading successes	Sensor 2 GPS reading successes
100	No	10	10	10	10	10	5
250	No	8	8	6	8	8	5
375	No	8	8	8	8	8	4
500	No	10	8	3	10	7	5
500	Yes	10	10	7	10	10	6
750	No	9	1	1	10	3	0
750	Yes	14	7	1	14	11	5
1000	Yes	7	1	0	7	1	1
1250	Yes	8	0	0	8	0	0

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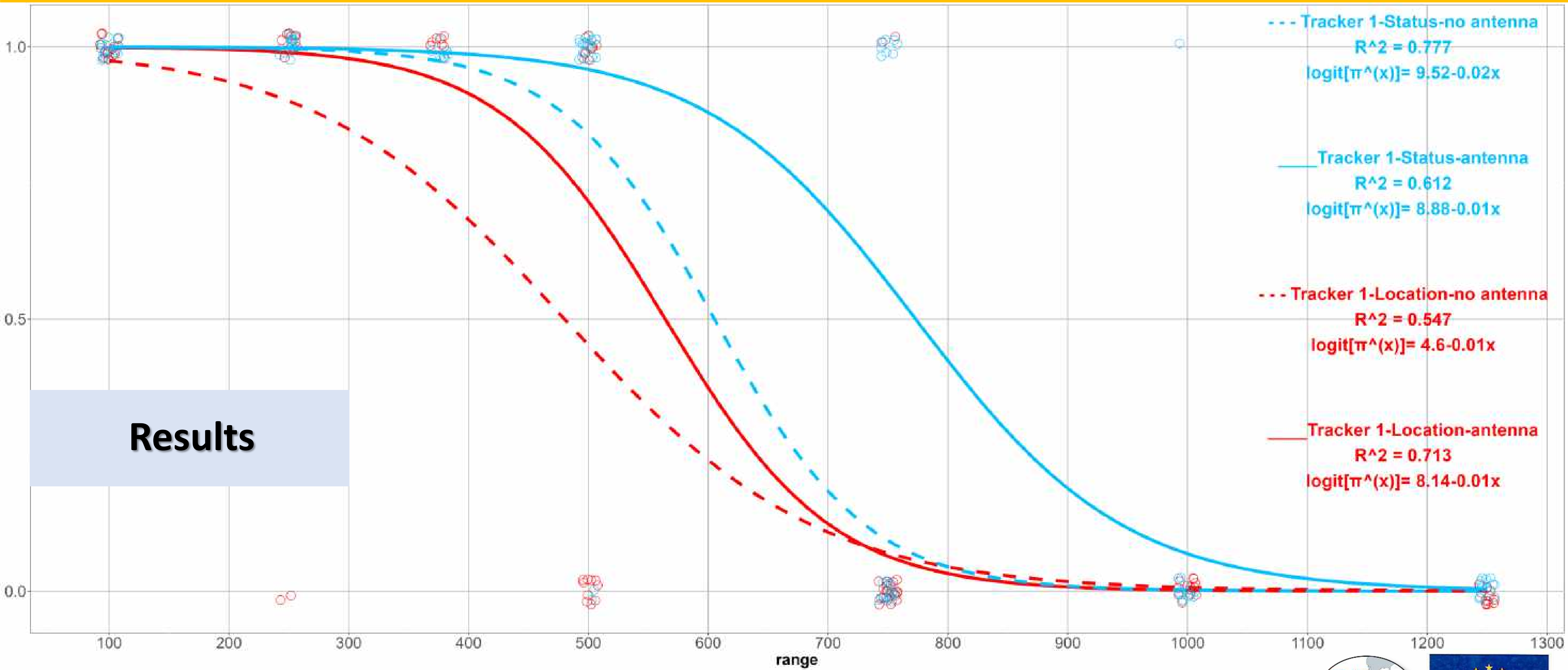
LoRaWAN trials in at-sea conditions: Achotines Lab - Panama



Sensor 1

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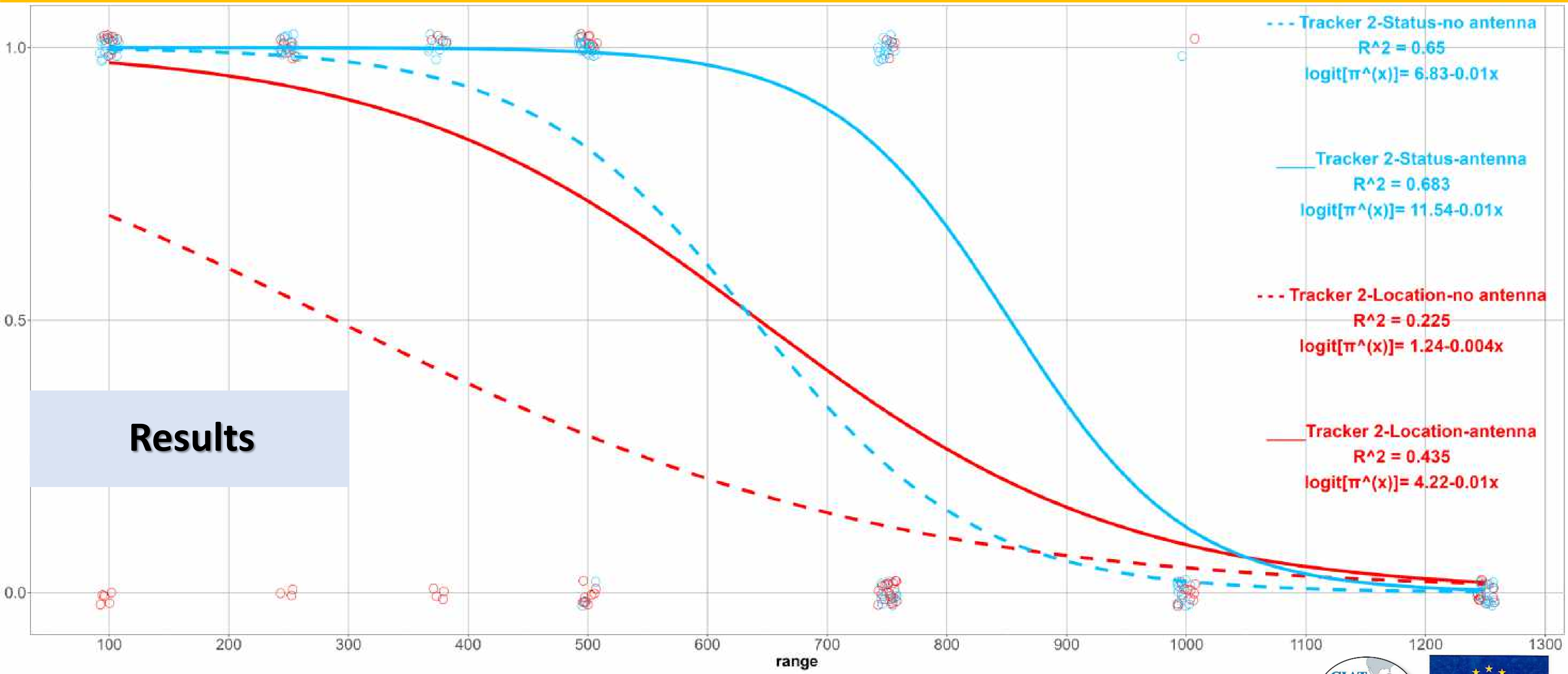
LoRaWAN trials in at-sea conditions: Achotines Lab - Panama



Results

Sensor 2

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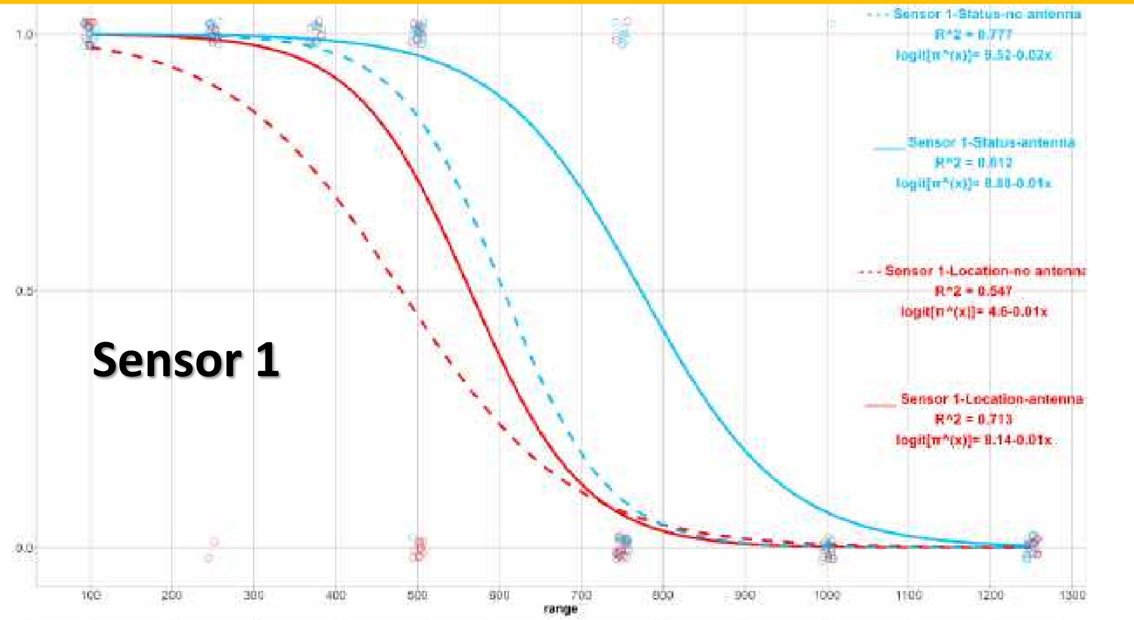
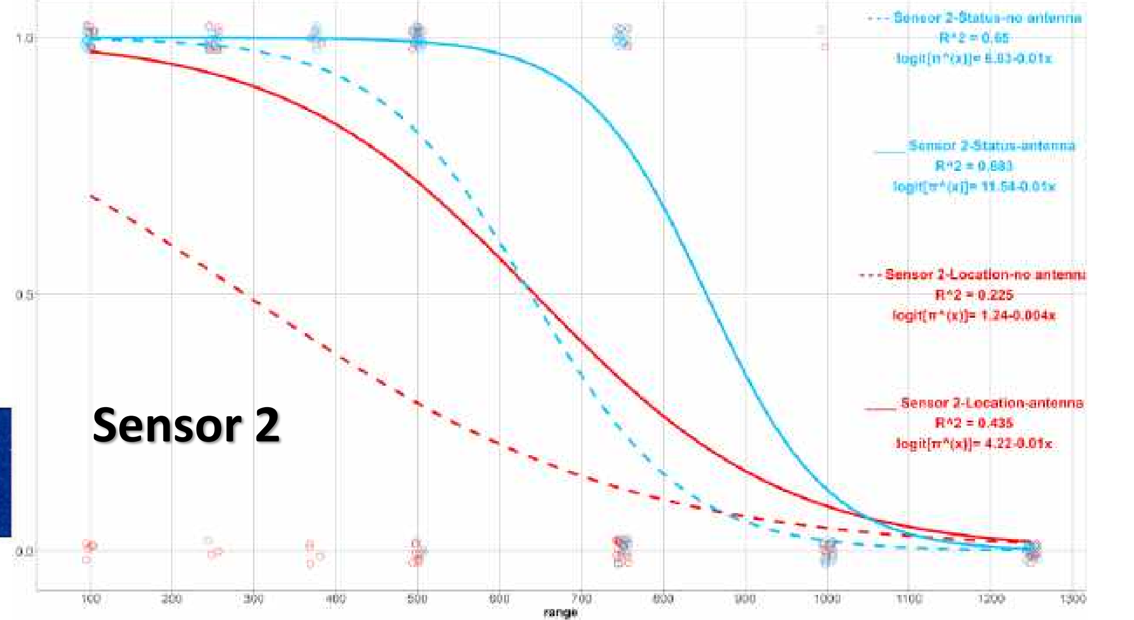
LoRaWAN trials in at-sea conditions: Achotines Lab - Panama

Sensor	Antenna	Reading	#Df	Log-Lik	Df	Chisq	Pr(>Chisq)
1	Yes	Location	2	-9.93			
	No		2	-17.88	0	15.89	< 2.2e-16 ***
2	Yes	Location	2	-20.35			
	No		2	-28.41	0	16.12	< 2.2e-16 ***
1	Yes	Status	2	-13.43			
	No		2	-8.47	0	9.91	< 2.2e-16 ***
2	Yes	Status	2	-10.3			
	No		2	-13.47	0	6.35	< 2.2e-16 ***
1	Yes	Status	2	-13.43			
		Location	2	-9.93	0	6.99	< 2.2e-16 ***
1	No	Status	2	-8.47			
		Location	2	-17.88	0	18.81	< 2.2e-16 ***
2	Yes	Status	2	-10.3			
		Location	2	-20.35	0	20.11	< 2.2e-16 ***
2	No	Status	2	-13.47			
		Location	2	-28.41	0	29.88	< 2.2e-16 ***





- The antenna significantly improves detection rates (150-300m)
- 75% - Location 100-350m (450-500 with antenna)
- 50% - Location 300-480 m (575-650 m with antenna)

- 75% - Status 500-550m (675-750m with antenna)
- 50% - Status 600-650m (775-850m with antenna)

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Conclusions

- Significant information from evaluating the LoRaWAN technology at-sea:
  - Effectiveness for transmitting information (location) between the sensor and the hub within a specific range: **450-500 m (HUB with antenna), and 100-350 m (HUB without antenna)**.
  - Potential communication between satellite buoys to nearby vessels/devices
  - Could enables data recording on various electronic devices (e.g., EM equipment, other technologies available at vessel bridge, helicopters(?))
  - Cost-effective, safe, and feasible to be seamlessly integrated with EM or other vessel electronic systems.

- Consider the LoRaWAN technology for the development of sensors transmitting the FAD buoys' serial number to receivers located at distances no greater than 500 m.

- Consider exploring the LoRaWAN technology for applications with other fishing activities that require remote and automatic data collection (e.g., electronic scales for weight estimates).

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Preguntas – Questions?

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