



Global Fishing Watch

Eratosthenes Seamount Fisheries Restricted Area

April 2021



Executive summary

This report is the third installment in a series of three analysis reports investigating apparent fishing activity in all the Fisheries Restricted Areas (FRAs) listed in the 2006 General Fisheries Commission for the Mediterranean (GFCM) Recommendation GFCM/2006/3. This recommendation prohibits fishing activities with towed dredges and bottom trawl nets in the following areas:

- The Lophelia reef off Capo Santa Maria di Leuca in international waters, off the coast of Italy.
- The Eratosthenes Seamount” located in the easternmost Mediterranean Sea between Cyprus and the Nile Cone.
- The Nile delta area cold hydrocarbon seeps in Egyptian waters.

In addition, the recommendation text encourages Member States to “protect the areas from the impact of any other activity jeopardizing the conservation of the features that characterize these particular deep-sea habitats.” Using the best available public and open-source data, these Global Fishing Watch reports provide interested stakeholders with an overview of apparent fishing activity both within the boundaries and up to 10 miles outside the coordinates of these three FRAs.

These reports aim to help interested stakeholders determine the effectiveness of the recommendation in protecting vulnerable marine ecosystems (VMEs) and bring greater transparency to the activities taking place in these FRAs. During the analysis of all three FRAs, we gave particular attention to identifying additional activities, including oil and gas drilling or exploration, that overlap with the location of vulnerable marine ecosystems in these areas, in particular cold-water coral mounds.

Eratosthenes Seamount Fisheries Restricted Area

This study overlaid fishing vessel tracks, using automatic identification system (AIS) data plus remote sensing imagery to identify vessels not broadcasting on AIS, to determine the likelihood of fishing activity by demersal trawlers occurring inside the Eratosthenes Seamount FRA.

This multi-data overview of the Eratosthenes Seamount FRA did not identify any bottom trawling in contravention of GFCM Recommendation GFCM/2006/3. Analysis of a 10-mile buffer area around the FRA did identify likely trawling activity and significant activity by vessels linked to hydrocarbon extraction. This whole area, which is rich in cold-water corals, could benefit from additional protection either through an extension of the current GFCM Recommendation or the application of a Specially Protected Areas of Mediterranean Importance (SPAMI) measure.

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GLOBAL FISHING WATCH ANALYSIS: Global Fishing Watch is an international nonprofit organization dedicated to advancing ocean governance through increased transparency of human activity at sea. By creating and publicly sharing map visualizations, data and analysis tools, we aim to enable scientific research and transform the way our ocean is managed. Global Fishing Watch processes a global database of vessel global positioning system positions from AIS data as well as from satellite imagery to highlight apparent fishing activity in the world's oceans.

The analysis was performed using data gathered from vessels broadcasting an AIS signal, using a timeframe set from January 2018 to August 2020, which was then compared to synthetic-aperture radar (SAR) data from March 2019 to October 2020.

DISCLAIMER: Any and all references to “fishing” should be understood in the context of Global Fishing Watch’s fishing detection algorithm, which is a best effort to determine “apparent fishing effort” based on data from the automatic identification system (AIS) collected via satellites and terrestrial receivers. As AIS data varies in completeness, accuracy and quality, it is possible that some fishing effort is not identified and conversely, that some fishing effort identified is not fishing. For these reasons, Global Fishing Watch qualifies all designations of vessel fishing effort, including synonyms of the term “fishing effort,” such as “fishing” or “fishing activity,” as “apparent,” rather than certain. Any/all Global Fishing Watch information about “apparent fishing effort” should be considered an estimate and must be relied upon solely at your own risk. Global Fishing Watch is taking steps to make sure fishing effort designations are as accurate as possible.

1 Background

1.1 GFCM Fisheries Restricted Areas

The Eratosthenes Seamount located in the Eastern Mediterranean, approximately 45 miles south of Cyprus (14,792 km², GSA 25), hosts rare deep-sea benthic associations such as scleractinian corals and sponges. In 2006, a GFCM Fisheries Restricted Area was established in order to protect this vulnerable marine ecosystem. Its geographical boundaries are set from the following coordinates: 33° 00.00' N, 32° 00.00' E, 33° 00.00' N, 33° 00.00' E, 34° 00.00' N, 33° 00.00' E, 34° 00.00' N, 32° 00.00' E.

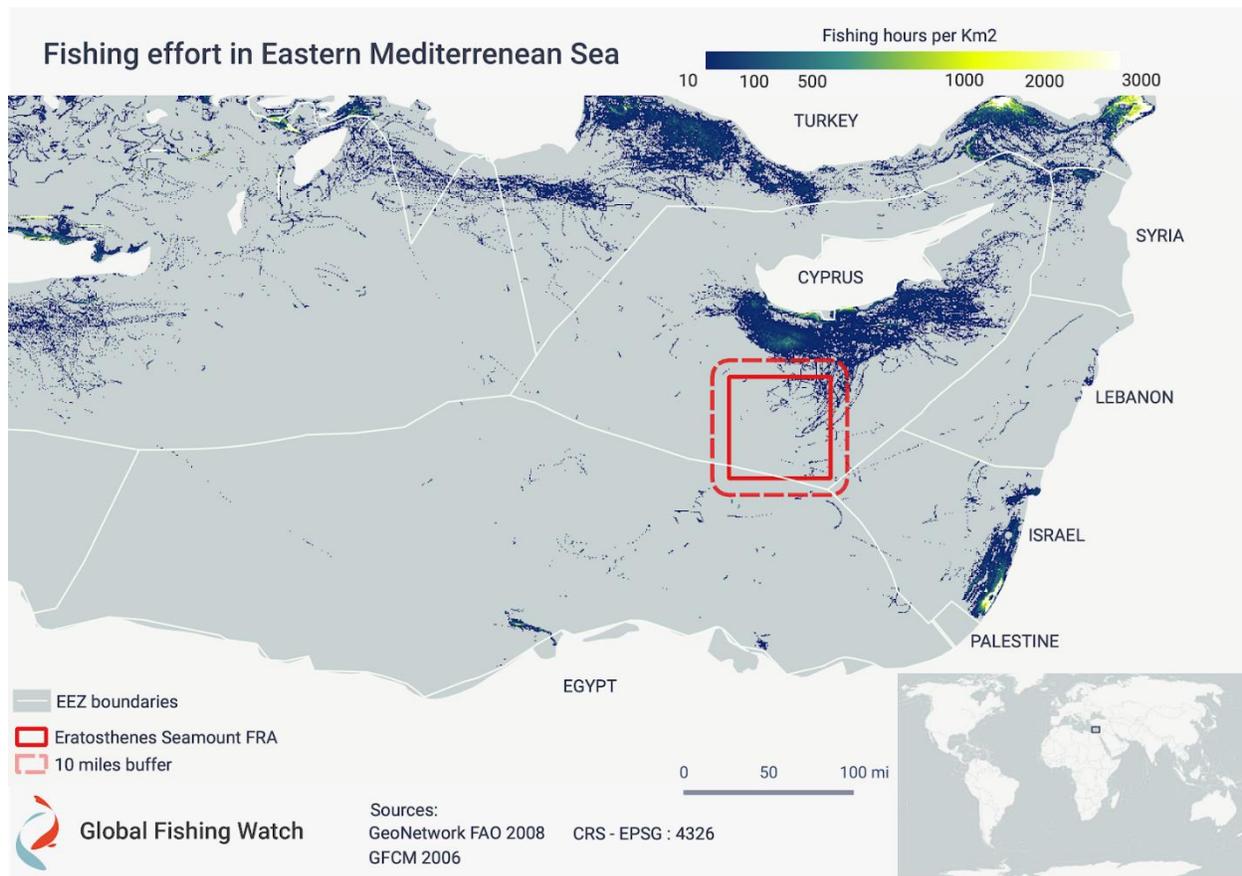


Figure 1. Level of fishing effort from AIS data represented by fishing hours per square kilometer. The red square in the figure corresponds to the borders of the Eratosthenes Seamount FRA while the lighter red dashed box corresponds to a 10-mile buffer area around the FRA.

2 Vessel track analysis: AIS data

In order to estimate fishing vessel activity inside the Eratosthenes Seamount FRA, we analyzed AIS data¹ from vessels active in the FRA. This data was sourced from two AIS providers, SPIRE and ORBCOMM, processed through the Global Fishing Watch platform and applied to the analysis period January 2018 to October 2020.²

AIS data analysis indicated relatively low activity inside the Eratosthenes Seamount FRA with a total of 312 hours of apparent³ fishing effort between January 2018 and October 2020. The 312 hours were conducted by drifting longliners and multi-gear vessels that have contradicting gear types listed in different registries; in this report this second category is called “divergent”⁴ gear classes.

A peak of apparent fishing hours was observed in April and May of 2018 and 2019 and in August 2020. Throughout 2020, there was a lower level of fishing effort overall, which follows a pattern detected as part of a global analysis of the impacts of COVID-19 on fishing activity published in May 2020, entitled “[Global Fisheries during COVID-19](#)”.⁵

2.1 Vessels detected inside the FRA using AIS

Global Fishing Watch observed apparent fishing effort for each flag state, gear class and vessel name detected inside the FRA. Most apparent fishing hours were from longliners flagged to Cyprus and Greece. Two Cypriot vessels had divergent¹⁶ gear classes and a manual analysis of the vessels’ tracks was carried out to determine the most likely gear type used inside the FRA.

Total fishing hours:

- Cyprus: 208 recorded fishing hours across 10 vessels
- Greece: 104 recorded fishing hours across 2 vessels.

¹ A system built to aid navigation and that can be used to track vessels with an AIS transmitter onboard.

² A more detailed AIS analysis methodology can be found in the annex to this report.

³ Any and all references to “fishing” should be understood in the context of Global Fishing Watch’s fishing detection algorithm, which is a best effort to determine “apparent fishing effort” based on AIS data collected via satellites and terrestrial receivers. As AIS data varies in completeness, accuracy and quality, it is possible that some fishing effort is not identified and, conversely, that some fishing effort identified is not fishing. For these reasons, Global Fishing Watch qualifies all designations of vessel fishing effort, including synonyms of the term “fishing effort,” such as “fishing” or “fishing activity,” as “apparent,” rather than certain. Any/all Global Fishing Watch information about “apparent fishing effort” should be considered an estimate and must be relied upon solely at your own risk. Global Fishing Watch is taking steps to make sure fishing effort designations are as accurate as possible.

⁴ The term divergent is used in the context of this report to describe a vessel gear class when the vessel was identified as a longliner in the ICCAT registry but also registered as a trawler in the EU registry.

⁵ <https://globalfishingwatch.org/data-blog/global-fisheries-during-covid-19>

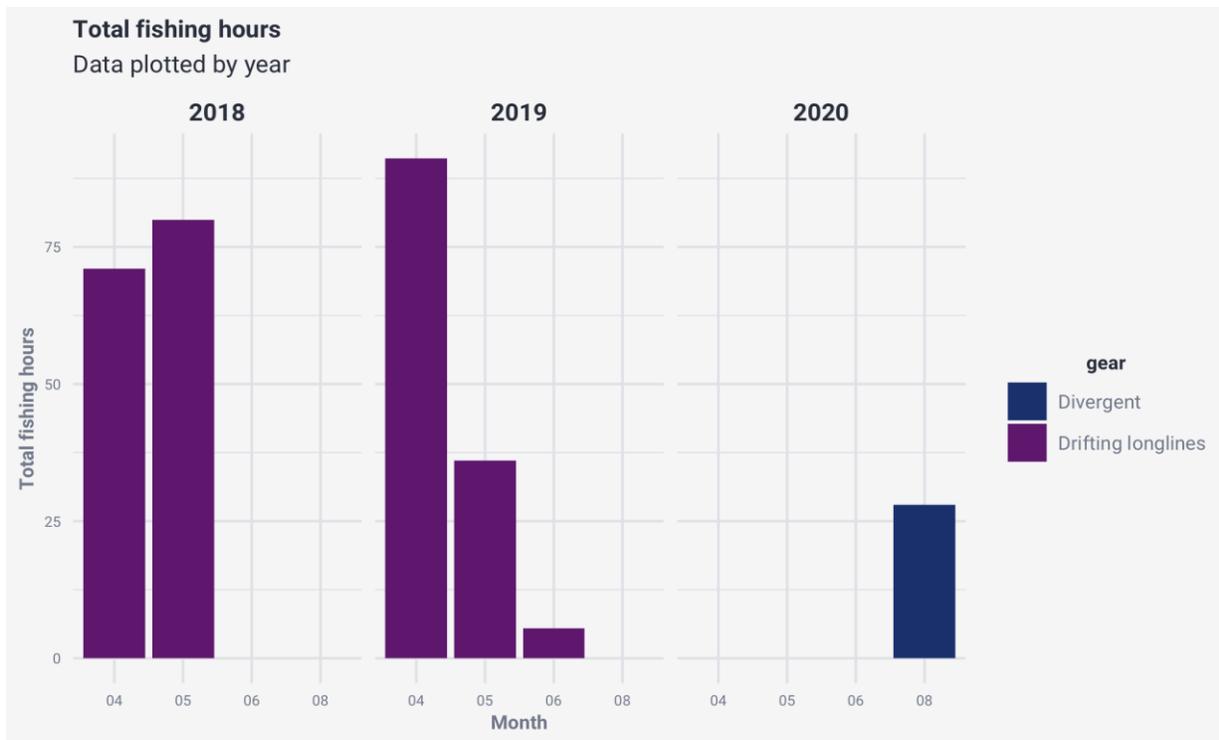


Figure 2. Total hours of fishing effort from AIS data (y axis) plotted by year and month (x axis) in the Eratosthenes FRA. The color represents the gear responsible for the apparent fishing hours.

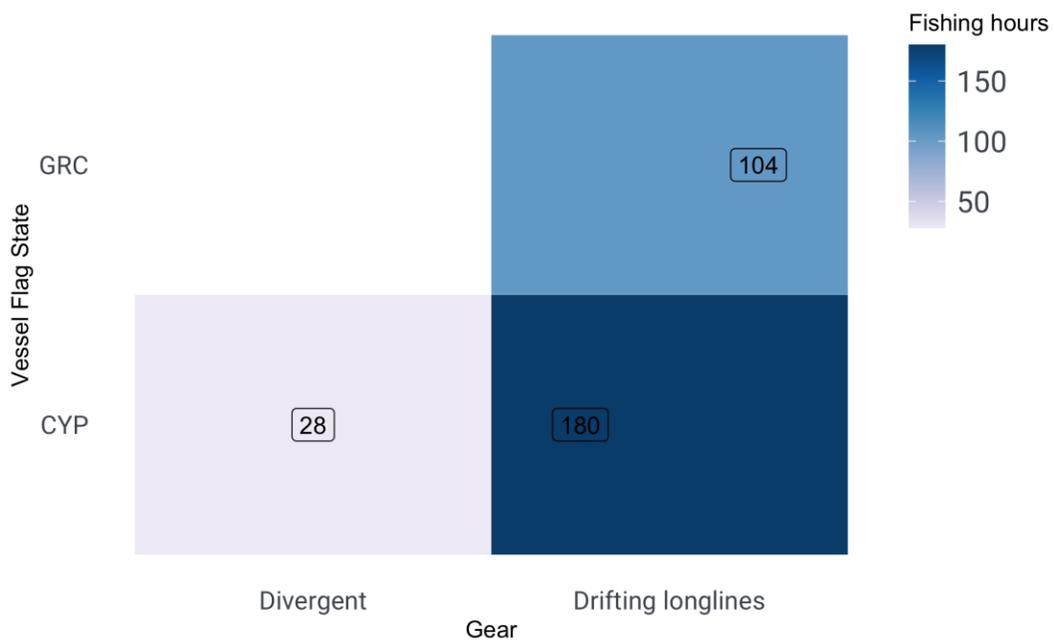


Figure 3. Total hours of fishing effort from AIS data plotted by country (y axis) and gear (x axis) in the Eratosthenes Seamount FRA. White represents a low level of apparent fishing hours while blue represents a high level of apparent fishing hours.

- Twelve vessels were listed in both the [European Union fleet register](#)⁶ and the [International Commission for the Conservation of Atlantic Tunas \(ICCAT\) record of vessels](#)⁷ (Table 1).
- ICCAT registered vessels were licensed to fish for bluefin tuna (*Thunnus thynnus*), albacore tuna (*Thunnus alalunga*) and Mediterranean swordfish (*Xiphias gladius*). All vessels detected were registered with ICCAT as longliners, with two vessels – the GIA SOU KAIKI MOU AI NIKOLA and the MARIA MBOUMBOULINA listed as otter bottom trawlers in the EU registry as well (Table 1).
- The Cypriot vessel GIA SOU KAIKI MOU AI NIKOLA was part of a dispute that occurred in 2018 between Cyprus and Turkey. According to the government of Turkey, the vessel was illegally fishing in Turkish waters⁸ while the government of Cyprus reports the vessel was detained illegally⁹ and disputes these claims.
- The MARIA MBOUMBOULINA vessel flagged to Cyprus and registered as a trawler in the EU registry was found to be steaming¹⁰ through the FRA and no apparent fishing activity was detected. The tracks of the vessel revealed several AIS gaps which are reported below. A historic dispute exists between two states regarding this vessel.⁷

Table 1. Information on all vessels fishing within the Eratosthenes Seamount FRA.

Vessel name	CRS	IMO	IRCS	MMSI	Gear in Neural Net	Gear in EU fleet register	Secondary gear in EU fleet register	ICCAT authorisation	Fishing hours in FRA
NEMESIS	CYP00000 0760	NA	P3AJ3	210975000	LLD	LLD	LLS	Longliner (not specified)	42
GIA SOU KAIKI MOU AI NIKOLA	CYP00000 0781	8691843	P3VR5	210732000	Divergent	OTB	LLD	Longliner (not specified)	28
CHRYSOPIGI TAXIARCHIS	GRC00074 5055	8229949	SY5740	240452000	LLD	LLD	LLS	Multipurpose - hook and lines	83
KAPETAN CHRISTODOULOS	CYP00000 1545	8792180	5BDR4	212447000	LLD	LLD	LLS	Longliner (not specified)	19

⁶ <https://webgate.ec.europa.eu/fleet-europa>

⁷ <https://www.iccat.int/en/VesselsRecord.asp>

⁸ <https://undocs.org/pdf?symbol=en/S/2019/33>

⁹ <https://undocs.org/pdf?symbol=en/a/73/406>

¹⁰ Steaming refers to a vessel that was identified by the Global Fishing Watch algorithm as transiting and not undertaking fishing operations.

KONSTANTINOS ANGELIKI	GRC000037678	8229987	SVA4009	240994000	LLD	LLD	GNS	Multipurpose - hook and lines	21
MOYSHS	CYP000000766	NA	5BLE3	209290000	LLD	LLD	LLS	Longliner (not specified)	22
TA DY0 ADELFA	CYP000000906	8792233	C4MN2	212475000	LLD	LLD	LLS	Longliner (not specified)	22
KOSTANTINO ELEFThERIA	CYP000001411	8792245	5BLJ3	212446000	LLD	LLD	LLS	Longliner (not specified)	23
PANAGIA TON KATHARON	CYP000000761		5BLG3	210924000	LLD	LLD	LLS	Longliner (not specified)	24
ARESTAIANA	CYP000000759		5BLD3	210928000	LLS	LLD	LLS	Longliner (not specified)	20
KATERINA	CYP000000895	NA	5BLF3	209041000	LLD	LLD	GTR	Longliner (not specified)	9
MARIA MBOUMBOULINA	CYP000000232	8740163		209212000	Divergent	OTB	Traps	Longliner	0

Because the EU register lists vessels GIA SOU KAIKI MOU AI NIKOLA and MARIA MBOUMBOULINA as otter bottom trawlers, we analyzed their tracks to investigate whether any bottom trawling was carried out inside the FRA.

The vessel GIA SOU KAIKI MOU AI NIKOLA entered the FRA twice (figure 4) on August 15, 2020. At point 1) the AIS signal was lost for 14 hours over a distance of 23 miles until point 2) where the vessel was still apparently fishing until point 3). Then, the AIS signal was lost again for 8 hours over 54 miles until point 4) where the vessel was apparently fishing until point 5). Here, the signal was lost again until point 6) where the vessel was steaming north towards the coast of Cyprus where the vessel appeared to continue fishing. These tracks do not suggest trawling but instead appear to be a surface gear like purse seine.¹¹

¹¹ Images of the vessel from [a marketing post on the company's social media in June 2020](#)

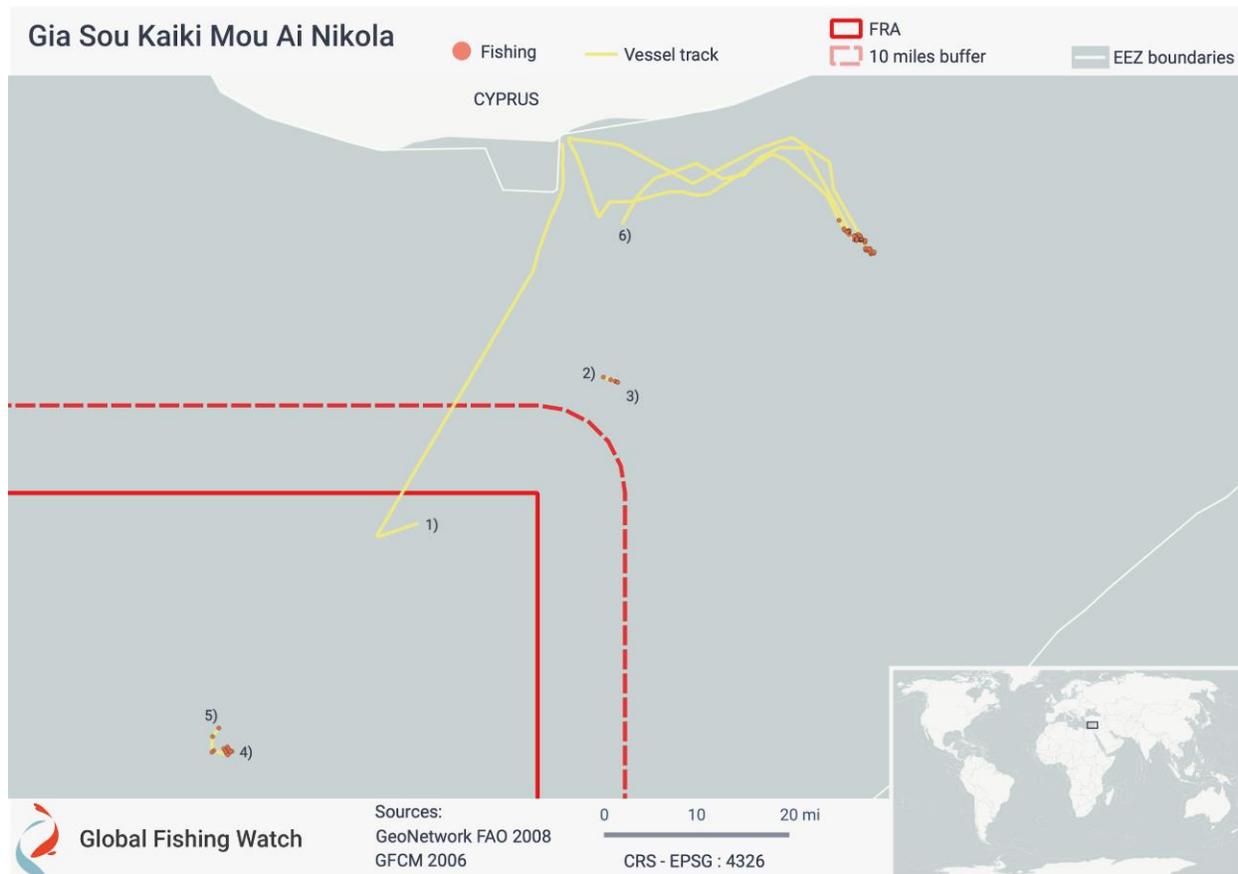


Figure 4. Track of GIA SOU KAIKI MOU AI NIKOLA from August 15 to August 18, 2020.

The vessel MARIA MBOUMBOULINA entered the FRA on August 22, 2018 (figure 5) between point 1) where the vessel was steaming at 8:51 and 2) where the vessel was steaming again on 23 August at 13:19. In the time between points 1) and 2) there was a gap where the AIS signal was not broadcasting for 16 hours over a distance of 85 miles. The vessel AIS signal was lost again for five hours over a distance of 40 miles from point 3) to point 4) where the vessel was apparently steaming back north to Limassol port.

Further research¹² was inconclusive, but suggests the vessel may be a mixed gear vessel that is unlikely to have the capacity to bottom trawl in the depth range found inside the Eratosthenes FRA, which is at least 1,000 meters.

¹² Vessel details:

www.marinetraffic.com/en/ais/details/ships/shipid:121743/mmsi:209212000/imo:8740163/vessel:MARIA_MBOUMBOULINA

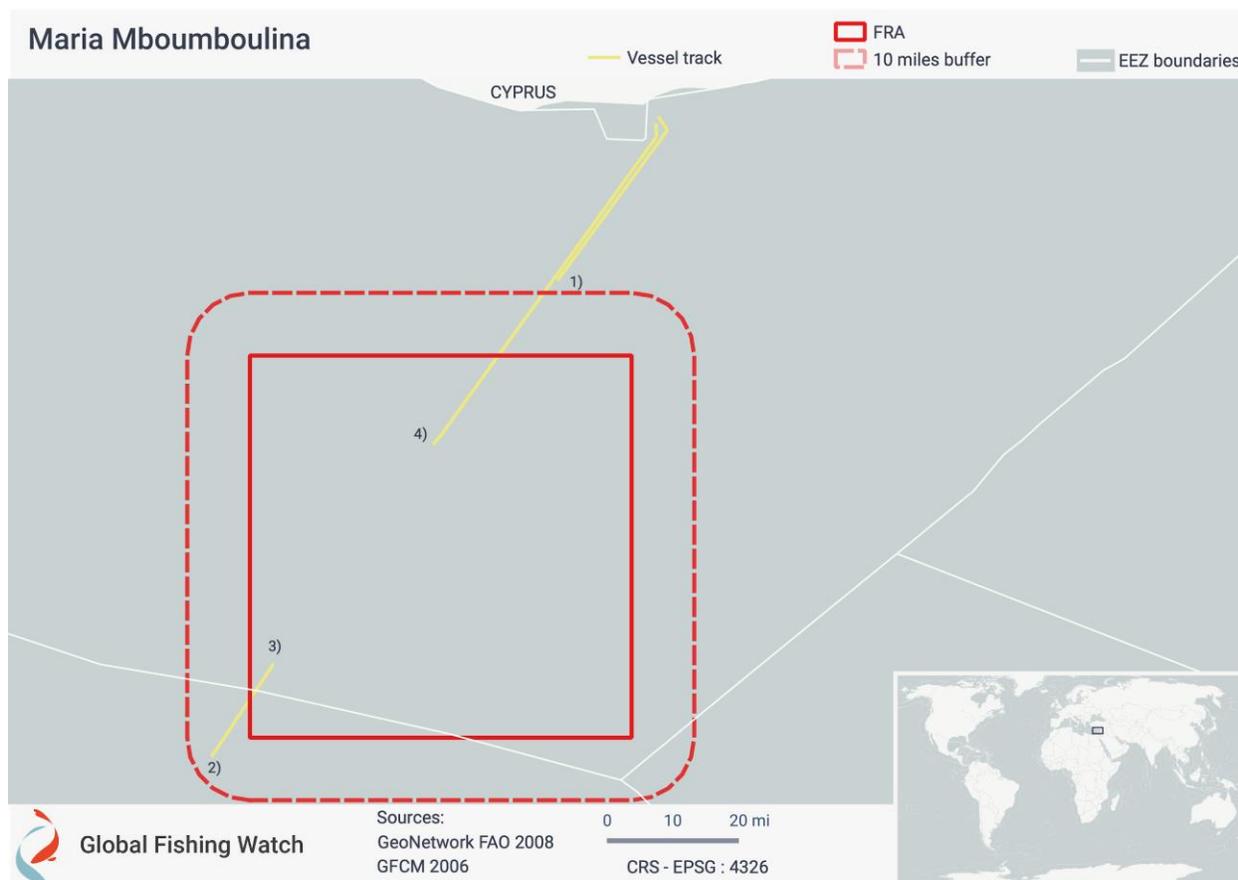


Figure 5. Track of MARIA MBOUMBOULINA from August 22 to August 24, 2018.

Gaps in AIS transmission are instances in which the vessel has temporarily stopped transmitting AIS. Information related to gaps in AIS data as presented in this report should be verified with additional monitoring tools and vessel logs. Transmission gaps may be due to intentional disabling of AIS; however, other reasons including low satellite coverage or high-density areas can limit AIS data. In addition, AIS data tends to be sparser and more limited for vessels equipped with inferior-quality devices.¹³ It is difficult for Global Fishing Watch to draw conclusions on whether the AIS gaps were intentional or due to poor reception or faults with the transmission system.

¹³ Taconet, M., D. Kroodsma and J.A. Fernandes, J.A. *Global Atlas of AIS-based fishing activity – Challenges and opportunities*. (2019). Rome, Italy: FAO.

2.2 AIS: Vessels detected within a 10-mile buffer zone

To better understand the level of fishing activity outside of the FRA boundaries, the AIS analysis was extended to within a 10-mile buffer around the FRA. This was reviewed using the same time period (January 2018 – October 2020).

Most of the activity detected by Global Fishing Watch in the 10-mile buffer zone was conducted by drifting longliners, with a total of 123 apparent fishing hours detected. In addition, two vessels flagged to Cyprus with divergent gear (Figure 7) also appeared to be fishing inside the 10-mile buffer zone but to a much lesser extent compared to the longliners: these two Cypriot vessels appeared to fish for only 10 hours (Figure 6).

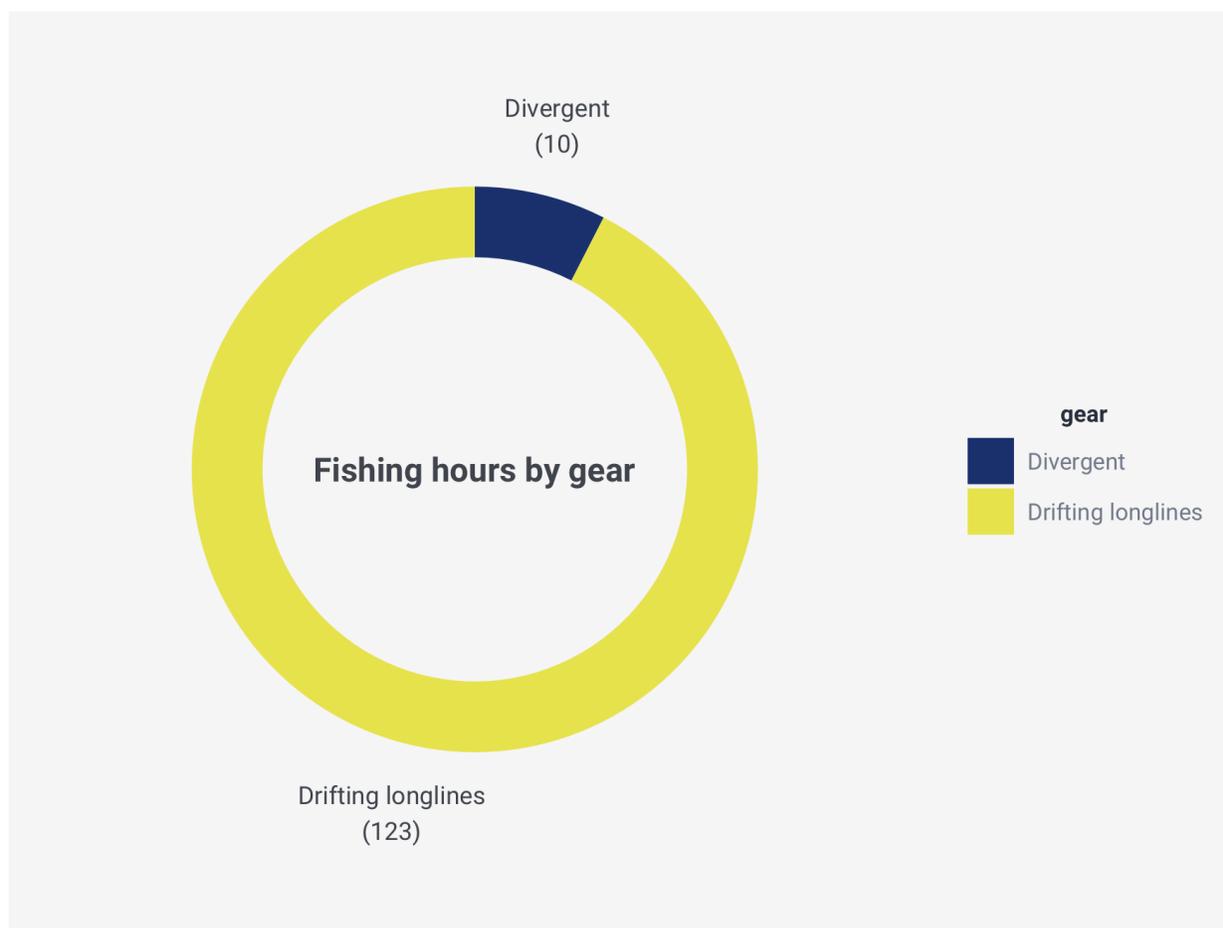


Figure 6. Total fishing hours distributed across gear types for vessels that were fishing within 10 miles of the Eratosthenes FRA between 2018 and 2020.

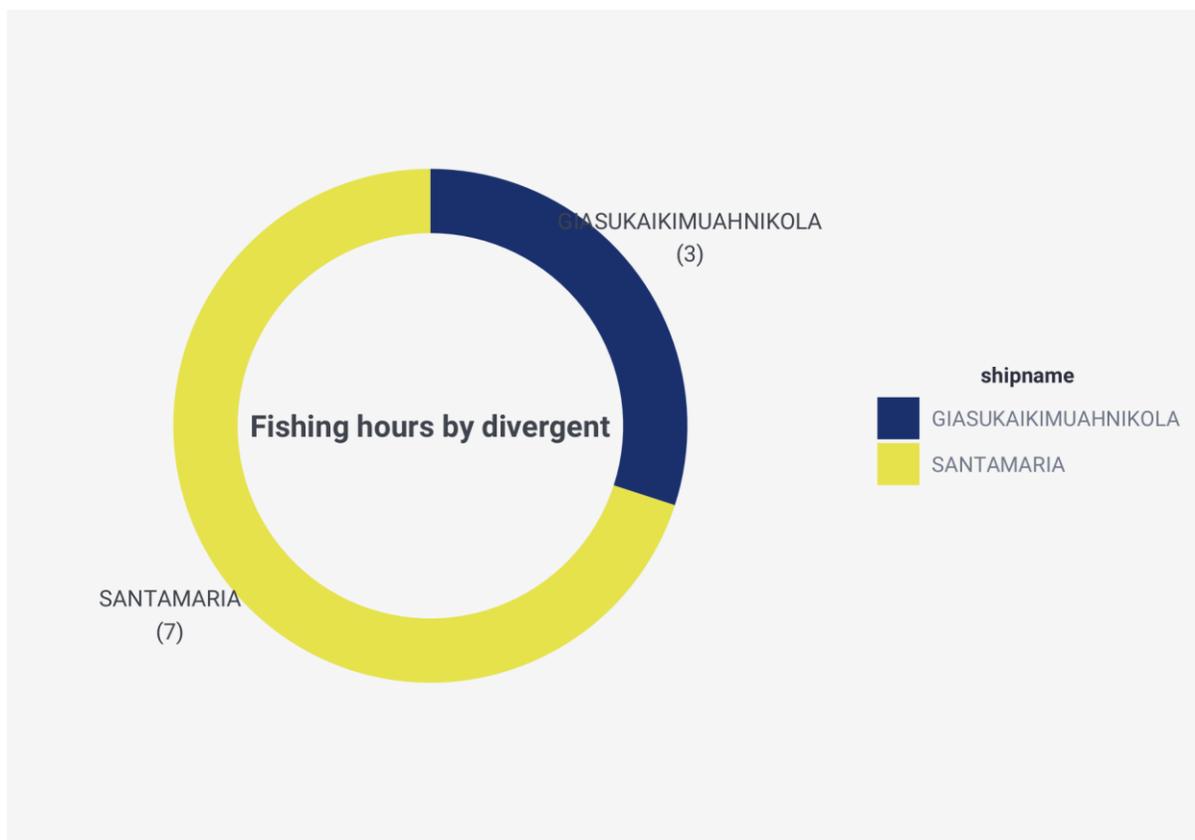


Figure 7. Total apparent fishing hours using unknown gear across two vessels within 10 miles of the Eratosthenes Seamount FRA between 2018 and 2020.

The GIA SOU KAIKI MOU AI NIKOLA – registered as both a trawler and a longliner – appeared to conduct three hours of fishing activity in the applied buffer. It was also detected inside the FRA.

The SANTA MARIA,¹⁴ flagged to Cyprus, is registered as a trawler as primary gear and a longliner as secondary gear according to the EU Registry. Its ICCAT registry lists it as a longliner. On August 22, 2020, the SANTA MARIA started fishing at point 1) for approximately 22 hours until point 2), where the AIS signal was lost for approximately four hours over a distance of 14 miles until 3), where the vessel conducted apparent fishing activity until point 4), moving northward away from the FRA.

¹⁴ Vessel ID - MMSI: 209232000, CFR: CYP000000786, IMO: 7634745

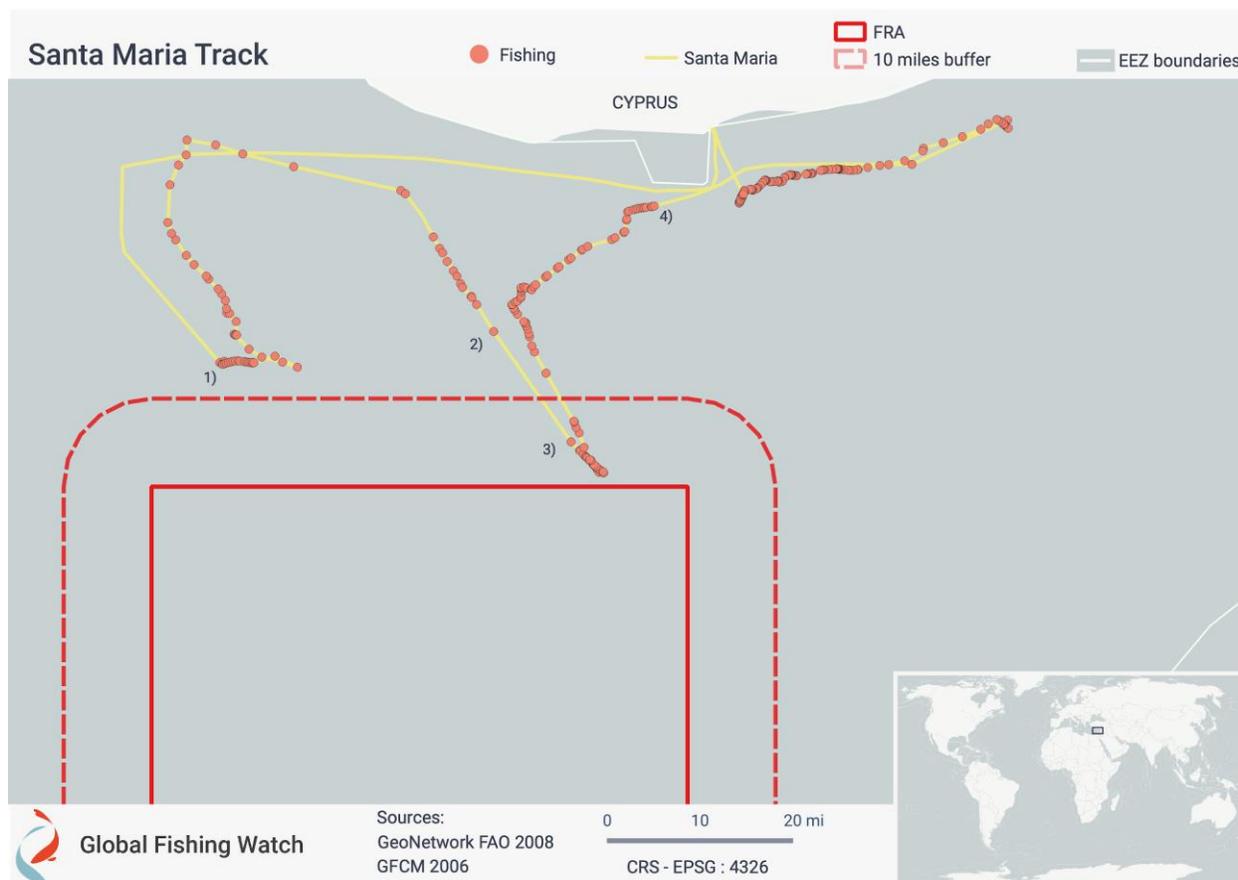


Figure 8. Track of SANTA MARIA from August 22 to August 26, 2020. The red line represents the Eratosthenes Seamount FRA.

The SANTA MARIA was fishing within the 10-mile buffer zone during two other trips: one on 11 July 2020 and one between July 13 and July 15, 2020.

The SANTA MARIA was found to be fishing and steaming at the same time and at a similar position to the GIA SOU KAIKI MOU AI NIKOLA (Figure 9). Although the gear type used cannot be confirmed, it remains unlikely that these mixed gear vessels have the capacity to bottom trawl deeper than 250m.

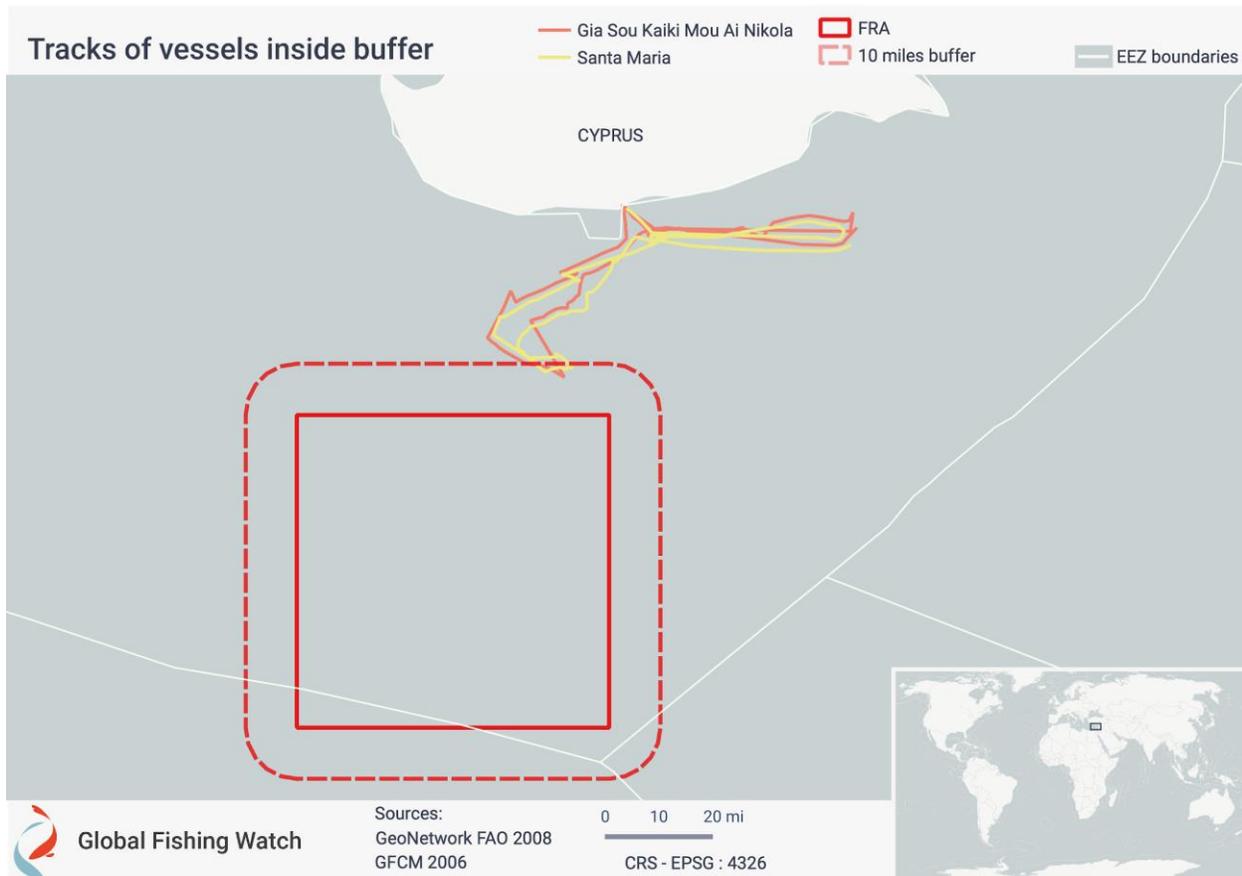


Figure 9. Track of SANTA MARIA and GIA SOU KAIKI MOU AI NIKOLA from July 13 to July 15, 2020. The red line represents the Eratosthenes Seamount FRA.

3 Remote sensing: Synthetic aperture radar imagery

To gain a better understanding of the potential fishing activity taking place inside the Eratosthenes Seamount FRA, we used remote sensing imagery to detect vessels that were operating within the area but not transmitting on AIS. Sentinel-1 synthetic aperture radar (SAR) imagery from the European Space Agency Copernicus program was reviewed for the Eratosthenes FRA between March 2019 and September 2020. SAR is a type of radar that provides two-dimensional images of a landscape. When the images are taken over the ocean it is possible to automatically detect the presence of vessels over at least 18 miles against the surrounding sea.

Global Fishing Watch processes Sentinel-1 data globally, running a vessel detection algorithm and matching detections with AIS data to identify vessels that are present but not broadcasting AIS signals. These vessels are referred to as “dark fleets” – vessels that do not publicly broadcast their location or appear in public monitoring systems.

In the Mediterranean the Sentinel-1 satellite captures images of the ocean approximately every 2-3 days. Global Fishing Watch SAR analysis confirmed 55 likely vessel detections within the FRA between March 2019 and September 2020 (Figure 10). The detections were scattered across the FRA with no discernable hotspots of activity. Two areas outside the FRA in the northwest and south show concentrations of detections that are likely to be related to offshore sites linked to hydrocarbon extraction.

The SAR analysis suggests an average of just over one potential vessel likely not broadcasting on AIS detected inside the FRA for each satellite pass when an image of the area was taken. This suggests a relatively consistent presence of a very small number of vessels not broadcasting on AIS inside the FRA (figure 11).

The number of detections of likely vessels¹⁵ not broadcasting on AIS per month appeared to be fewer in 2020 than 2019. There were no obvious seasonal peaks in detections across both years (figure 12).

It is not possible to confirm the type of vessels being detected by Sentinel-1 SAR inside the FRA with no matched AIS signal and available information. The low level of activity by “dark” vessels is consistent with the AIS analysis, which did not show trawling activity and does not suggest there is a risk that unreported bottom trawling is occurring inside the FRA.

¹⁵ The term “likely vessel detection” is used to describe pixels classified in the radar images that corresponded to possible vessel detections. See the section on SAR analysis in the annex for more information.

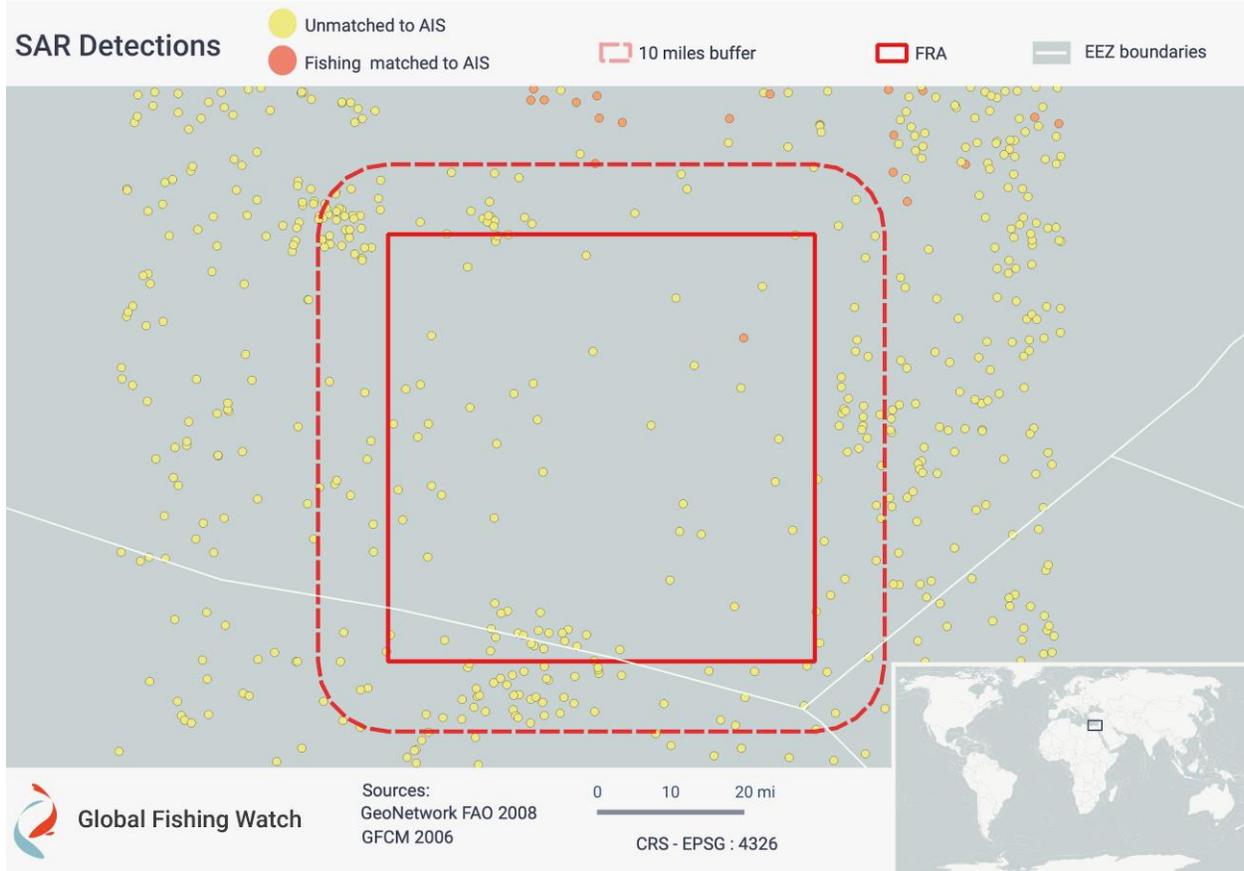


Figure 10. SAR detections unmatched to AIS data (yellow dots) and matched to AIS of fishing vessels (orange dots). The solid red line shows the borders of the Eratosthenes Seamount FRA and the lighter red dashed line represents the 10-mile buffer around the FRA.

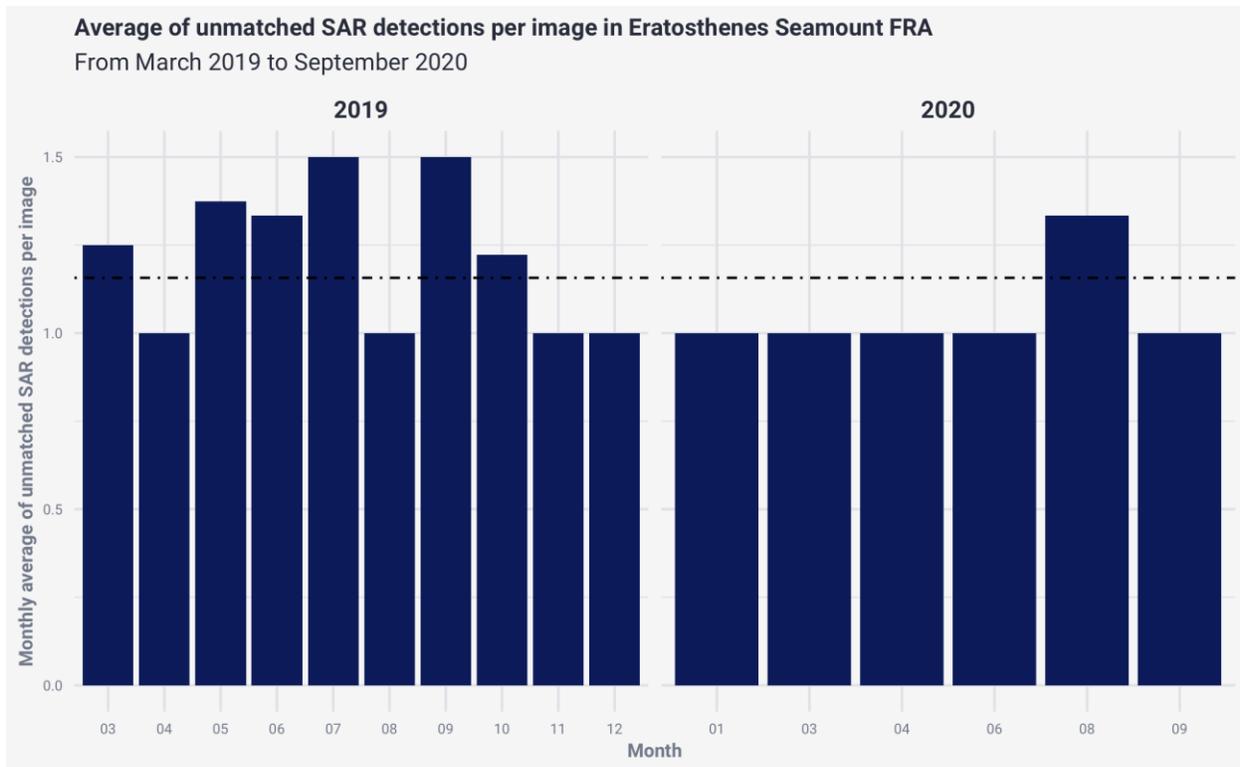


Figure 11. Average monthly SAR detections per image that are unmatched to any AIS records in the Eratosthenes Seamount FRA. The black dashed line represents the average of detections per image from March 2019 to September 2020.

4 Hydrocarbon extraction in the Eastern Mediterranean

The analysis of the Sentinel-1 SAR detections identified two areas of interest that are not related to fishing activity as non-fishing vessels appeared to be grouped in two locations: in the northwestern corner and at the southern border of the FRA (figure 13).

These groups of possible non-fishing vessels appeared to be near what Global Fishing Watch classified as stationary objects, as they were not moving across multiple satellite images. After reviewing optical images¹⁶ from ESA Sentinel-2, these stationary objects and the non-fishing vessel detections around them appear to correspond to drilling or exploration sites. More specifically, the one situated in the southern border of the FRA seems to correspond to the location of Zohr gas field¹⁷ and the one in the northwest corner to the Calypso gas field.¹⁸

¹⁶ The images were recorded between 1-15 August, 2019 from ESA Sentinel-2 satellites.

¹⁷ <https://www.offshore-technology.com/projects/zohr-gas-field>

¹⁸ <https://www.dw.com/en/eastmed-gas-paving-the-way-for-a-new-geopolitical-era/a-49330250>

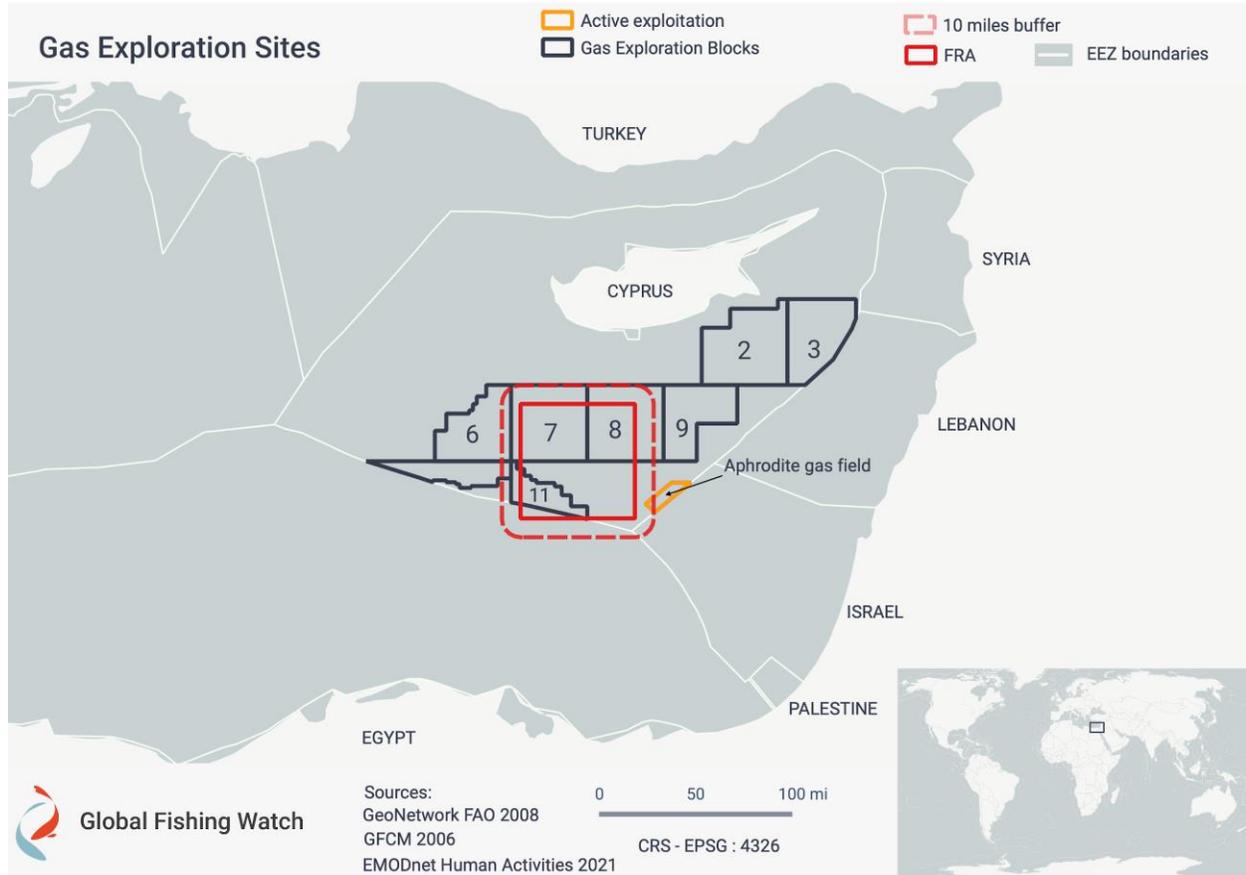


Figure 12. Gas exploration blocks with active licenses (black) around the Eratosthenes Seamount FRA (red square) and 10-mile buffer (dashed red line). The active Aphrodite gas field is marked in orange.

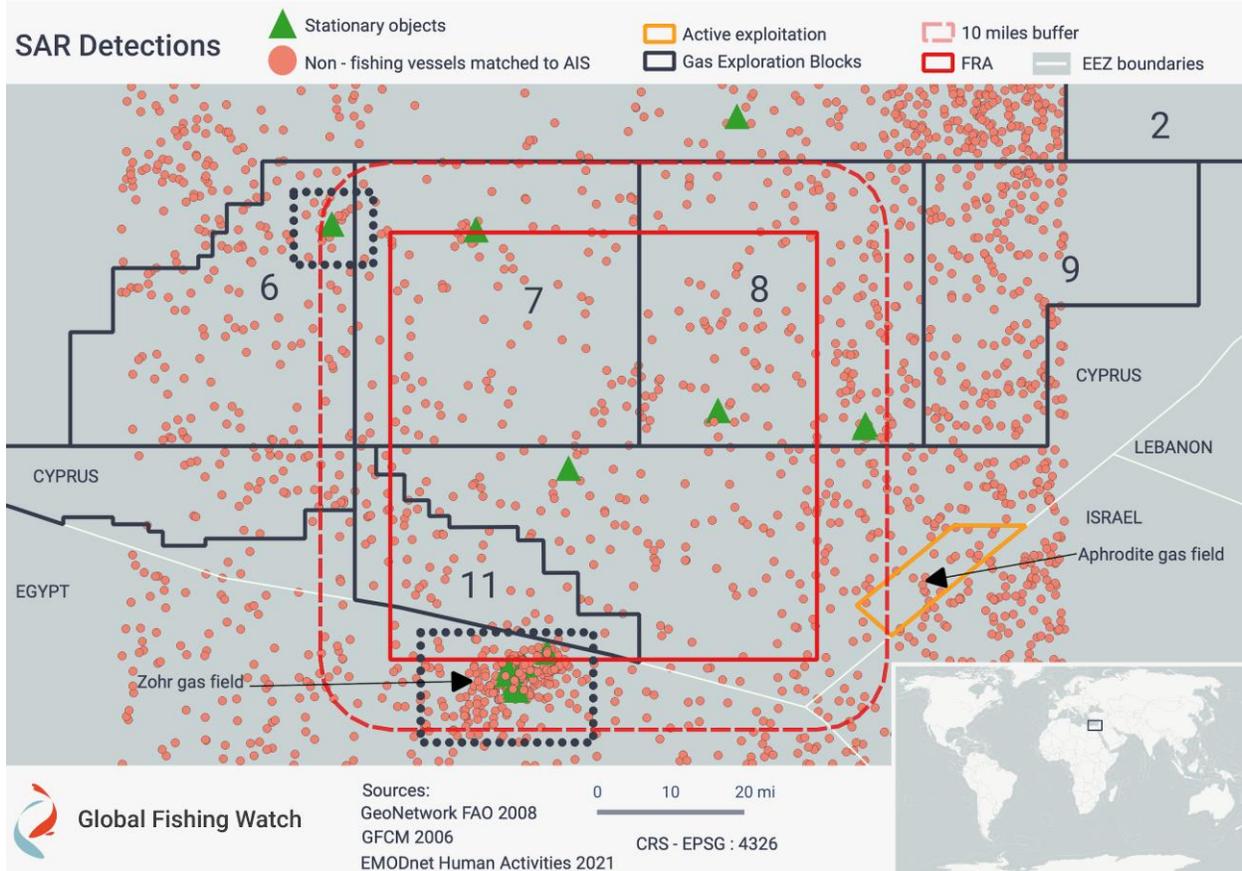


Figure 13. SAR detections matched to AIS data of non-fishing vessels (orange dots) and stationary objects (yellow dots) within the Eratosthenes Seamount FRA (red square) and 10-mile buffer (dashed red line). The delimitation of blocks for gas exploration that have active licenses is shown in black, with the active Aphrodite gas field in orange.

5 Key findings

AIS findings January 2018 – October 2020

- AIS data analysis indicated a total of 312 hours of apparent longliner fishing effort between January 2018 and October 2020 inside the Eratosthenes Seamount FRA.
- Longliners flagged to Cyprus and Greece account for the vast majority of fishing effort: 284 fishing hours.
- The AIS data analysis did not reveal any likely trawling activity inside the FRA.
- Gaps in AIS data as presented in this report should be verified with additional monitoring tools and vessel logs.

- Ten apparent fishing hours from three trawlers were recorded outside of the FRA coordinates and within the applied 10-mile buffer.

Remote sensing findings March 2019 – September 2020

- From the information available it is not possible to confirm the type of vessels detected by Sentinel-1 SAR inside the FRA with no matched AIS signal. The low level of activity by “dark” vessels is consistent with the AIS analysis, which did not show a high level of fishing activity and does not suggest there is a risk that unreported bottom trawling is occurring inside the FRA.
- AIS and remote sensing analysis identified activity inside the Eratosthenes Seamount FRA that is likely related to non-fishing activities, including possible hydrocarbon extraction.

6 Conclusions

Based on the AIS data analyzed between January 2018 and October 2020, no trawling activity or trawlers were detected inside the FRA and most of the fishing activity detected is attributable to ICCAT vessels licensed to fish for pelagic species. However, three trawlers participating in trawling activity were detected in a 10-mile buffer area outside the FRA coordinates that we applied for research purposes. This may suggest the need to extend the boundaries of the FRA in order to protect vulnerable marine ecosystems from trawling.

The SAR analysis revealed the presence of non-fishing vessels seemingly grouped in the northwestern corner and southern border of the FRA, near detections that Global Fishing Watch classified as stationary objects. These areas appear to correspond to natural gas drilling sites, including the Zohr gas field and the Calypso gas field, which are located in the 10-mile buffer.

The UN Convention on the Law of the Sea provides that every state, island and coastal state is entitled to special rights over the exploration and use of marine resources in its exclusive economic zone (EEZ). However, the Mediterranean basin, especially the Eastern Mediterranean, is insufficiently protected from the potential environmental risk associated with expanding and increasing hydrocarbon exploration by state and non-state actors. The Eratosthenes Seamount is recognized as a priority area for inclusion in the list of Specially Protected Areas of Mediterranean Importance (SPAMI) under the Barcelona Convention. Seamounts are particularly vulnerable to anthropogenic stressors, including hydrocarbon exploration, as they harbor varied marine species and ecosystems.

7 Recommendations to GFCM Member States

Recommendations to GFCM Contracting Parties and Cooperating non-Contracting Parties:

1. Increasing the transparency and consistency of fishing vessel information – including in the EU, ICCAT and GFCM fleet registers – would further support implementation of Recommendation GFCM/2006/03.
2. The GFCM should mandate vessel management system (VMS)/AIS reporting requirements to monitor vessels authorized to conduct fishing activities within and around FRAs.
3. All vessels 15m and above must be included in the GFCM fleet register.
4. All GFCM Contracting Parties and Cooperating non-Contracting Parties should publicly share vessel registries, including the unique vessel identification number and gear type, and submit this information to the GFCM.
5. In line with what is currently required by the EU, the GFCM should require that fishing vessels above 15 meters length overall (LOA) be equipped with and continually transmit positions via AIS.

Annex: Analysis methodologies

AIS analysis-based methods

AIS broadcasts a ship's position so that other ships are aware of its location, in order to avoid collision. The International Maritime Organization (IMO) started to mandate the use of AIS on vessels larger than 300 gross metric tons that travel internationally under the 2002 International Convention for the Safety of Life at Sea.

The key factors that affect the completeness and accuracy of footprints derived from AIS analysis are its use and reception. AIS must be installed and broadcast in order to be detected. AIS reception is a measure of how likely it is for a vessel's AIS message to be received correctly by the existing network of satellites and terrestrial antennae placed along the world's coastlines. In regions of the world with high maritime traffic, AIS signals can interfere with each other, which reduces reliable satellite reception.

A recent study¹⁹ by the UN Food and Agriculture Organization (FAO) and Global Fishing Watch found that in Mediterranean waters, almost all EU vessels over 15 meters use AIS. However, AIS captures mostly trawlers and purse seiners and often fails to capture other gears that are commonly used by smaller vessels in the Mediterranean, such as gillnets or longliners. In fact, around 50 percent of the Mediterranean fleet is made of vessels that are less than 12 meters in length. Fishing activity in the southeastern Mediterranean Sea is poorly represented in AIS data compared to the northern part of the Mediterranean, and even many vessels larger than 15 meters do not broadcast. This is especially true for North African countries, including Egypt, which have an extremely low AIS use for all flagged vessels. The lack of AIS use in these countries is typically due to both poor transmitters and a lack of terrestrial receptors that capture AIS use.

Besides the direct use of ICCAT and EU registries, the fishing vessels analyzed in this report were also chosen based on the Global Fishing Watch database of fishing vessels. The fishing database is defined in Kroodsma et al. (2018)²⁰ and includes fishing vessels based on registry database information or as defined by a convolutional neural network. The fishing vessel identity information most commonly transmitted in AIS, such as name and IMO number, was used in this analysis, while vessel flag was identified from a combination of registry and AIS transmission records.

SAR analysis-based methods

To investigate the presence of vessels not using AIS in the Eratosthenes Seamount FRA, SAR data was reviewed. Images were obtained from the European Space Agency (ESA) Sentinel-1

¹⁹ <http://www.fao.org/documents/card/en/c/ca7012en/>.

²⁰ Kroodsma, D.A. et al. Tracking the global footprint of fisheries. *Science* 359 (2018): 904–908.

mission. Sentinel-1 is primarily a land satellite, but the portion of sea that includes the Eratosthenes Seamount FRA is captured every 2-3 days.

SAR sends pulses of radio waves and records the echo of each pulse, creating radar imagery of the landscape. Objects across a landscape, for example vessels across the sea, can be differentiated because they return signals that have different strengths. In fact, different roughness and electrical properties of the surface or objects on the surface will influence the strength of the returned pulse while creating the radar imagery.

A Global Fishing Watch algorithm, which is a variation of an algorithm described in Park et al. 2020,²¹ was used to classify pixels of the radar images that corresponded to possible vessel detections. The algorithm also identifies stationary objects: when the same object is detected repeatedly in the exact same location then it will be classified as a stationary object. This included isolating pixels that returned signals that were significantly stronger than the background ocean.

Secondary analysis of ESA Sentinel-2 optical data was carried out over areas and temporal periods with high abundance of vessel detections inside the FRA. The optical images were selected for low cloud cover and calm sea conditions and vessels found inside the FRA were detected manually in a GIS program.

²¹ Park, J., J. Lee, K. Seto, T. Hochberg, B.A. Wong, N.A. Miller, K. Takasaki, et al. Illuminating dark fishing fleets in North Korea. *Science Advances* 6, no. 30 (2020): eabb1197.