Global Fishing Watch

GFCM “Nile Delta area cold hydrocarbon seeps" Fisheries Restricted Area

Egypt

April 2021

Executive Summary

There are nine Fisheries Restricted Areas in the General Fisheries Commission for the Mediterranean, with one of the first established in Egyptian waters in 2006, as part of a cluster of three protected areas listed in GFCM Recommendation GFCM/2006/3[1] This Recommendation prohibits fishing activities with towed dredges and bottom trawl nets across all three Fisheries Restricted Areas: "The Lophelia reef off Capo Santa Maria di Leuca" in Italy, "The Eratosthenes Seamount" located in the easternmost Mediterranean Sea between Cyprus and the Nile cone, and "The Nile delta area cold hydrocarbon seeps" in Egyptian waters. The Recommendation text encourages GFCM 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."

The "Nile Delta area cold hydrocarbon seeps" Fishery Restricted Area (the Nile Delta FRA) is situated in the southeast portion of the Eastern Mediterranean Sea, where the depth range is between 200 meters in the south and 1000 meters in the north. It is located in GFCM subarea 26, referred to as the Southern Levant Sea.

Using the best available public and open-source data, this Global Fishing Watch (GFW) report titled: "*GFCM Nile Delta area cold hydrocarbon seeps Fisheries Restricted Area*" provides interested stakeholders with an overview of apparent fishing activity both within the Nile Delta FRA boundaries and up to 10-miles outside of the coordinates. The report aims to help interested stakeholders determine the effectiveness of the Recommendation in protecting vulnerable marine ecosystems (VMEs).

In addition, the report also investigates the possible interactions between neighboring GFCM member state vessels and the GFCM FRA.

For the purposes of this analysis, automatic identification system information was acquired and cross-checked with synthetic aperture radar, optical imagery and expert opinion to assess vessel presence and apparent fishing activity.

This report is the first in a series that presents a preliminary analysis of all three FRAs listed in Recommendation GFCM/2006/3, including the "Nile Delta FRA." The analysis was performed using data gathered from vessels broadcasting AIS signals, using a time frame set from January 2018 to August 2020, which was then compared to synthetic aperture radar (SAR) data and complemented with a sample of optical imagery data and expert testimonial.

[1]Rec. GFCM/30/2006/3 on the establishment of fisheries restrictive areas in order to protect the deep-sea sensitive habitats. Status of_GFCM_FRAs_ (2014); FAO report Vulnerable_marine_ecosystems_Processes; GFCM-Report-2014-SAC-SCME 2014 Montenegro

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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.

This report is the first in a series that presents a preliminary analysis of all three FRAs listed in Recommendation GFCM/2006/3, including the "Nile Delta FRA." The analysis was performed using data gathered from vessels broadcasting AIS signals, using a time frame set from January 2018 to August 2020, which was then compared to synthetic aperture radar (SAR) data and complemented with a sample of optical imagery data and expert testimonial.

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

The GFCM Scientific Advisory Committee endorsed a provisional definition of FRA as "a geographically-defined area in which all or certain fishing activities are temporarily or permanently banned or restricted in order to improve the exploitation and conservation of harvested living aquatic resources or the protection of marine ecosystems." The Convention on Biological Diversity, which has been ratified by all Mediterranean countries, compels States to reduce the biodiversity loss on land and at sea (UNEP-WCMC 2008).

The Nile Delta area cold hydrocarbon seeps area (4 377.5 km2, GSA 26, Egypt), hosts an exceptionally high concentration of cold hydrocarbon seeps supporting unique living communities of presumably chemosynthetic organisms such as polychaetes and bivalves. In 2006, a GFCM Fisheries Restricted Area was established to "protect the deep-sea sensitive habitats, especially the exceptional concentration of cold hydrocarbon seeps which had favored the development of a unique living community," with the geographically defined boundaries set as 31°30.00' N, 33°10.00' E31°30.00' N, 34°00.00' E32°00.00' N, 34°00.00' E32°00.00' N, 33°10.00.'

GFCM FRAs regulate and/or restrict fishing activities in their area of application by establishing total closures or prohibiting the use of some fishing gear. In the case of the Nile Delta FRA, the Recommendation prohibits fishing activities with towed dredges and bottom trawl nets.

In a questionnaire submitted to the Scientific Advisory Committee in 2014, Egypt stated "that the GFCM decision [GFCM/2006/03] has not been incorporated in any specific national regulation and that some fishing activities with bottom trawling do occur in the area." Egypt also reported that some activities of exploration for natural gas and oil occur in the FRA.[2]

A discussion with a representative from the Egyptian authorities during the preparation of this report revealed that the FRA was set up "a very long time ago "which has meant that appropriate steps were not taken thereafter to apply the coordinates into national legislation. Currently, there is no legislation or legal framework in place in Egypt which includes the FRA as a protected area which prohibits trawling.

This issue is not exclusive to Egypt, as the poor enforcement of GFCM FRAs remains widespread. The European Commission adopts fisheries conservation and management measures that are binding to all European Union (EU) Member States; however, many Member States are yet to transpose the legislations related to GFCM FRAs into their own national law.

"It is up to each member of the GFCM to enforce the regulations that affect its waters and to control the activities of its fishing vessels. Lack of effective management across marine protected area (MPA) was identified as a major flaw in the Mediterranean and was linked to insufficient financial resources. However, compliance in the Mediterranean FRAs is being enhanced by the creation of the GFCM's Compliance Committee and the increasingly regulated

[2] Status_of_GFCM_FRAs_ (2014); FAO report Vulnerable_marine_ecosystems_Processes; GFCM-Report-2014-SAC-SCME 2014 Montenegro.

use of remote vessel monitoring systems (VMS) which is becoming mandatory in most Mediterranean countries through GFCM regulations" (Rodríguez-Rodríguez et al., 2016).

2 Findings

Despite fleets in the northern part of the Mediterranean having mandated AIS for almost 100 percent of vessels larger than 15 m, AIS is not commonly used in southern and eastern areas of the Mediterranean and, where AIS is fitted, it is often of insufficient quality. AIS reception is also unreliable in these southern and eastern areas due to a lack of terrestrial receptors that effectively capture AIS use.

The GFW analysis used a combination of satellite imagery through SAR, in addition to AIS data to provide a better understanding of fishing activity in this area,[3] coupled with optical imagery to areas of high activity.

Although the findings from the AIS analysis suggests the presence of a low level of apparent fishing activity within the FRA - focused eastward of the boundaries nearing the coast of Palestinian and Israeli waters (Figure 1), the combined SAR and optical imagery analysis suggests that there is a high level of apparent fishing activity within the coordinates of the area and the 10mile buffer zone used in this analysis to understand activity beyond the FRA boundary.

According to the GFCM, small-scale fishing vessels in the Mediterranean are defined as below 12 m in length overall. Detection using a Global Fishing Watch algorithm on satellite images from ESA Sentinel-1 SAR satellites, provides a reliable detection of vessels as small as 18 m, this suggests there are a large number of potential industrial and semi-industrial fishing vessels and/or maritime security vessels within the FRA not broadcasting via AIS.

Processing 18 months of ESA Sentinel-1 SAR imagery, Global Fishing Watch detected 478 such likely vessels[4] inside the FRA, with at least 250 vessels detected in just one month in 2019.

There are legitimate reasons a vessel may not broadcast on AIS: vessels may not be required to do so under International Maritime Organization[5] (IMO) regulations due to their size or, like Egypt and Israel, the flag State does not require it on fishing vessels less than 300 GT. SAR detections do not confirm fishing activity but do provide an indicator of apparent fishing activity.

[3] Taconet, M., Kroodsma, D., & Fernandes, J.A. 2019. Global Atlas of AIS-based fishing activity - Challenges and opportunities. Rome, FAO. (also available at www.fao.org/3/ca7012en/ca7012en.pdf).

[4] GFW applies an algorithm to detect objects in the ocean identified by SAR that appear to be vessels. The algorithm is a best estimate identification and therefore the objects are categorized as likely vessels. See Methods for further detail

[5] The IMO ship identification number scheme was introduced in 1987 through adoption of resolution A.600(15), as a measure aimed at enhancing "maritime safety, and pollution prevention and to facilitate the prevention of maritime fraud". It aimed at assigning a permanent number to each ship for identification purposes

An additional layer of optical imagery from ESA Sentinel-2 satellites was also added to this analysis, resulting in identification of vessels exhibiting behavior consistent with trawling activities. However, without the associated AIS data or further information, it is impossible to confirm these findings without further investigation by the flag or coastal State.

AIS FINDINGS: January 2018 - October 2020

- AIS analysis detected no explicit activity by towed dredges or bottom trawl nets that are prohibited by Recommendation GFCM/2006/3;
- AIS data analysis indicated a relatively small amount of activity by two longliners (hook and lines) registered to ICCAT inside the Nile Delta FRA, with a total of 38 hours of apparent fishing effort.

REMOTE SENSING FINDINGS: March 2019 - September 2020

- GFW Sentinel-1 SAR analysis detected 478 likely vessels not broadcasting on AIS objects inside the FRA, with two areas of concentrated detections in the North West and South East of the FRA. There appears to be a large discrepancy between the number of vessels detected by SAR and the number reporting positions using AIS;
- In the North West of the FRA detections were identified following the depth contour in an area known for deep water shrimp. Furthermore, an additional layer of optical imagery from Sentinel-2 was also reviewed suggesting that some of the SAR detections are likely to be fishing vessels with behavior that appears to be consistent with trawling, although GFW is unable to confirm this from remote sensing alone;

In the South East of the FRA there was a concentration of likely vessel detections that mostly occurred during one month in 2019 and are unlikely to be fishing related. The detections using satellite images from Sentinel-1, which provides a reliability of detections of vessels as small as 18 meters, suggests that there are a large number of potential industrial and semi-industrial fishing vessels and/or maritime security vessels operating in the area within the FRA that are not broadcasting via AIS.

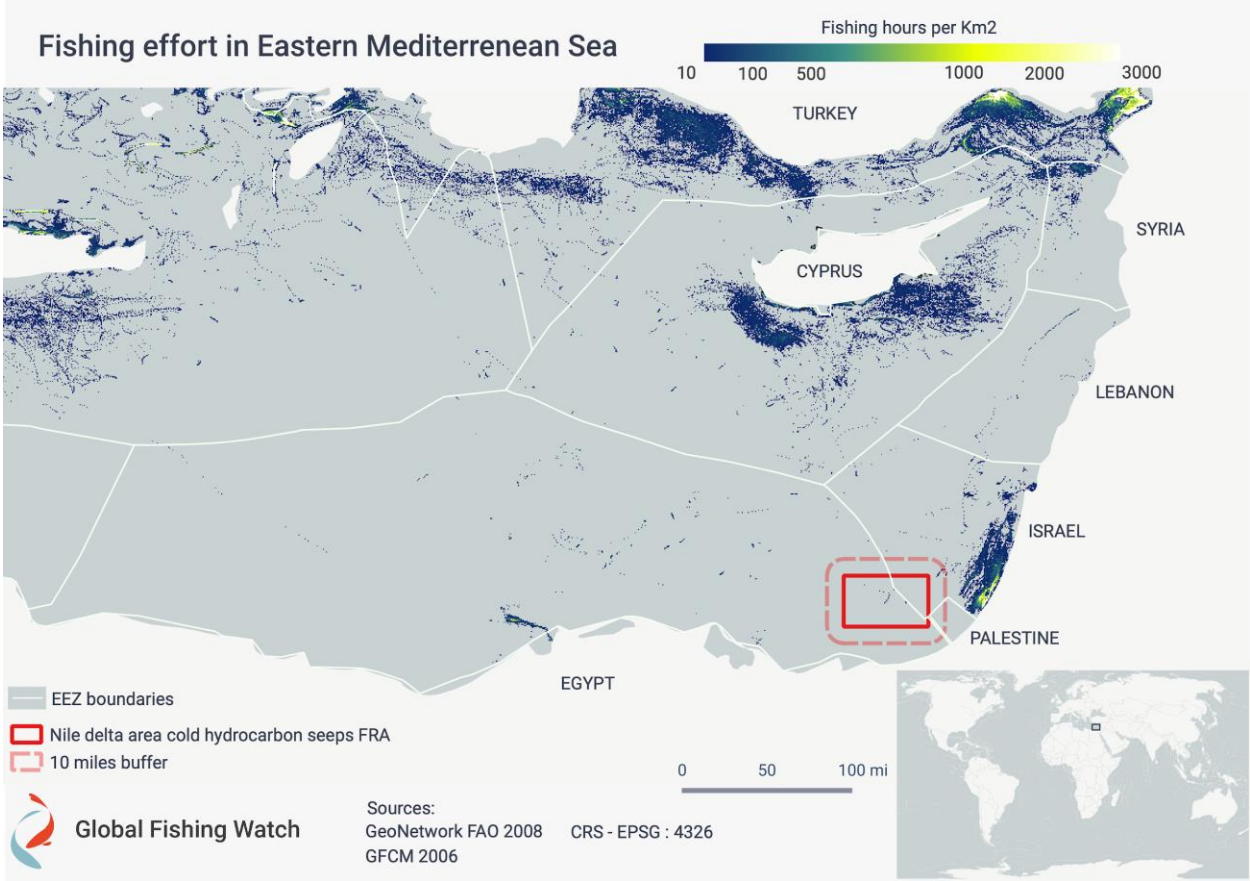

Figure 1. Level of fishing effort from AIS data represented by fishing hours per square kilometer. The red square in the figure corresponds to the borders of the Nile Delta FRA whereas the lighter red dashed box corresponds to a 10-mile buffer around the FRA.

3 Vessel track analysis: AIS data

To estimate fishing vessel activity inside the Nile Delta FRA, GFW first looked at the AIS data — a system built to aid navigation and that can be used to track vessels which operate AIS. The AIS data was sourced from SPIRE and ORBCOMM, processed through the GFW platform and applied to the analysis period, Jan. 2018 to Oct.2020. A more detailed AIS analysis methodology can be found in the annex to this report.

3.1 Vessels detected inside the FRA using AIS

AIS data analysis indicated a relatively small amount of activity by fishing vessels inside the Nile Delta FRA with a total of 38 hours of apparent[6] fishing effort between 2018 - 2020. The 38 hours

[6] 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

were all conducted by two Greek-flagged longliners, a gear type permitted in the zone. No explicit activity by towed dredges or bottom trawl nets that are banned by Recommendation GFCM/2006/3 was detected using AIS in this FRA. Analysis suggests that these two multi-purpose hook and line registered vessels: KONSTANTINOS*III* and CHRYISOPIGI-*TAXIARCHIS* (Table 1), have conducted apparent fishing activity in the Nile Delta FRA for 29 hours and 9 hours respectively, between Aprils 25-26 2019 (Figure 2). According to ICCAT records, these vessels target swordfish, bluefin tuna and albacore.

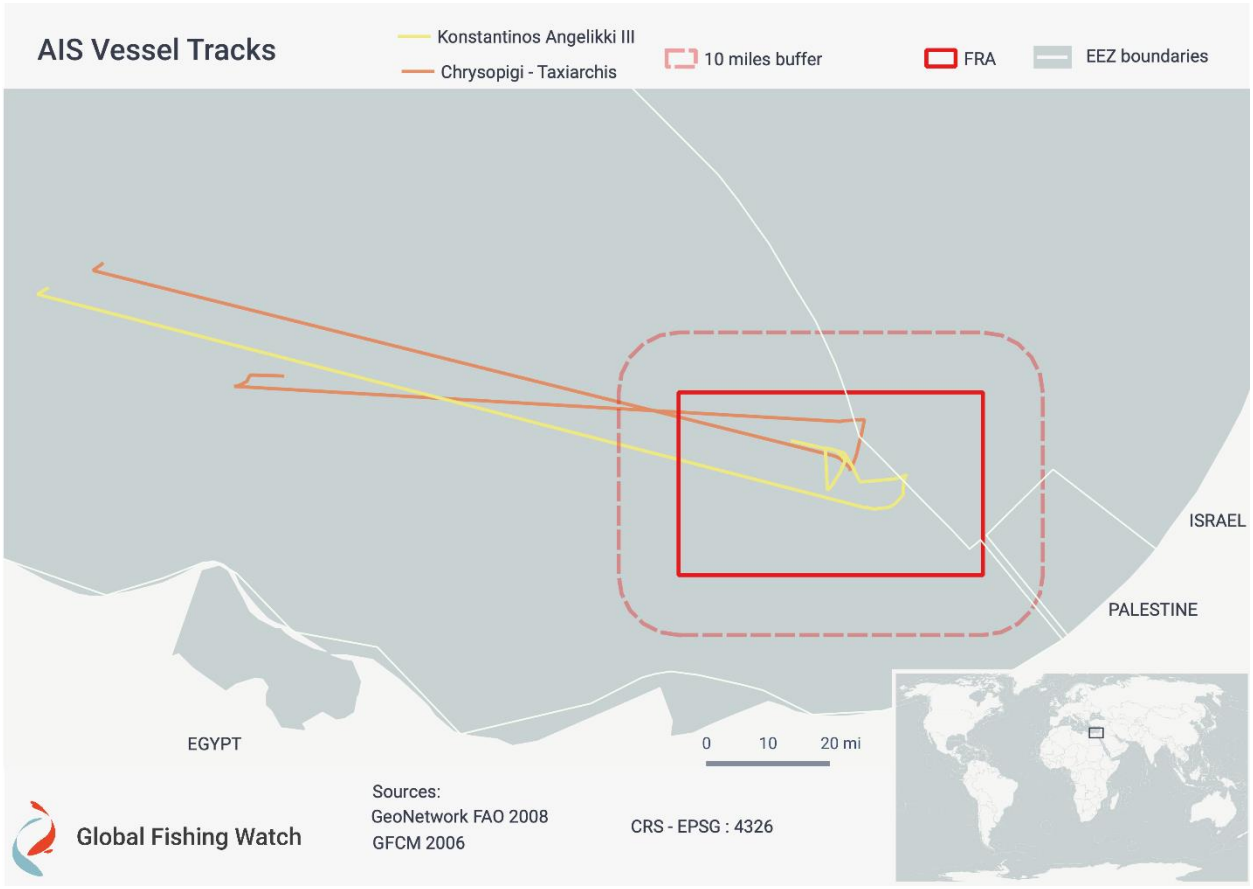

Figure 2. Track of Konstantinos Angeliki III and Chrysopigi-Taxiarchis from April 25-26, 2019. The red rectangle represents the Nile Delta FRA whereas the lighter red dashed box corresponds to a 10-mile buffer around the FRA

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.

The two vessels appear to have been fishing in Egyptian and Lebanese waters in 2017, according to a report by Oceana which analyzed data obtained from Global Fishing Watch. There is no indication of previous offences detailed in any of the publicly available IUU vessel lists (lists of vessels maintained by regional fisheries management organizations and other stakeholders of vessels known to be carrying out or aiding illegal, unreported and unregulated fishing) or in the Spyglass Database[7], and it appears that the vessels had not previously been caught, observed, or suspected of offences.

Table 1. Vessels GFW recorded fishing inside the Nile Delta FRA from AIS records.

Vessel Name	IMO Number	IRCS	MMSI	Gear predicted from track	Gear in EU fleet register	Secondary gear in EU fleet register	ICCAT authorization	Fishing hours in FRA
Konstantinos Angeliki III	8229987	SVA4009	240994000	LLD	LLD	GNS	Yes - Multipurpose - hook and lines	29
Chrysopigi Taxiarchis	8229949	SY5740	240452000	LLD	LLD	LLS	Yes - Multipurpose - hook and lines	9

3.2 AIS: Vessels Detected within a 10-mile buffer zone

To better understand the level of fishing activity outside the FRA boundaries, Global Fishing Watch extended the AIS analysis to within a 10-mile buffer around the FRA, which was investigated using the same time period (2018-2020). Only one fishing vessel[8] named *SAAR* —registered to the GFCM as a longliner and flagged to Israel—appeared to be fishing within the GFW applied buffer radius between June 7-8, 2018 (Figure 3).[9]

The AIS tracks of the vessel SAAR highlighted apparent fishing activity between 5 and 12 miles from the FRA. At point 2) at 14:50 on June 7, 2018, apparent fishing activity conducted by *Saar* is detected until point 3) at 4:00 on June 8, 2018, when the AIS signal is lost until point 4) at 8:00 on June 8, 2018 when the signal reappeared as the vessel was steaming toward port. Between point 2) and point 3) apparent fishing activity was detected as the vessel speed was consistently under 4 knots.

[7] spyglass.fish

[8] Vessel Name: Saar, MMSI: 428150610.

[9] http://www.fao.org/gfcm/data/fleet/avl/en/.

AIS analysis revealed that no other fishing vessels were present in the 10 miles around the FRA during a two-year review period. These findings are consistent with the fact that there is low level use of AIS in the region and that AIS is not typically used or maintained during fishing operations in this subregion.

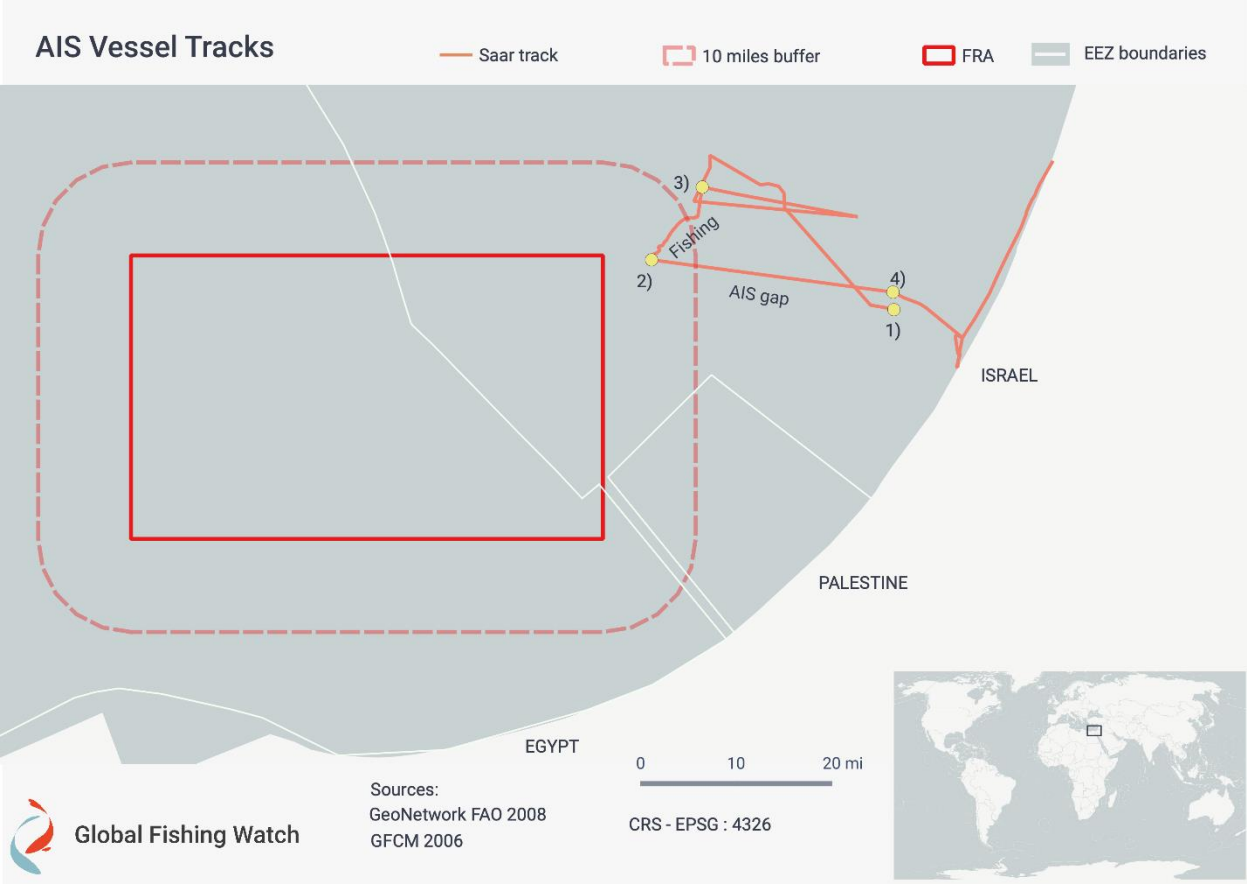

Figure 3. Track of Saar from the 7- 8 06 2018. The red rectangle represents the Nile Delta FRA whereas the lighter red dashed box corresponds to a 10-mile buffer around the FRA.

4 Remote Sensing Analysis

To gain a better understanding of the activity inside the Nile Delta FRA, remote sensing imagery was used to detect vessels that were not transmitting AIS, but still operating in the area.

4.1 Synthetic Aperture Radar Imagery

Sentinel-1 SAR imagery from the European Space Agency Copernicus program was reviewed for the Nile Delta FRA between March 2019 to September 2020. SAR is a type of radar that provides two dimensional images of a landscape and 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 then matching those detections with the AIS data to identify vessels that are present but not broadcasting on AIS, otherwise commonly referred to as ‘dark fleets’ - vessels that do not publicly broadcast their location or appear in public monitoring systems.

In the Mediterranean, where the Sentinel-1 satellite captures images of the ocean approximately every other day, SAR analysis confirmed 478 likely vessel detections within the FRA between March 2019 and Sept 2020 (Figure 4). Although the detections were concentrated in two main areas of the FRA: the northwest corner and the southeast corner respectively, the north-west area of the FRA is the area GFW focused its analysis on.

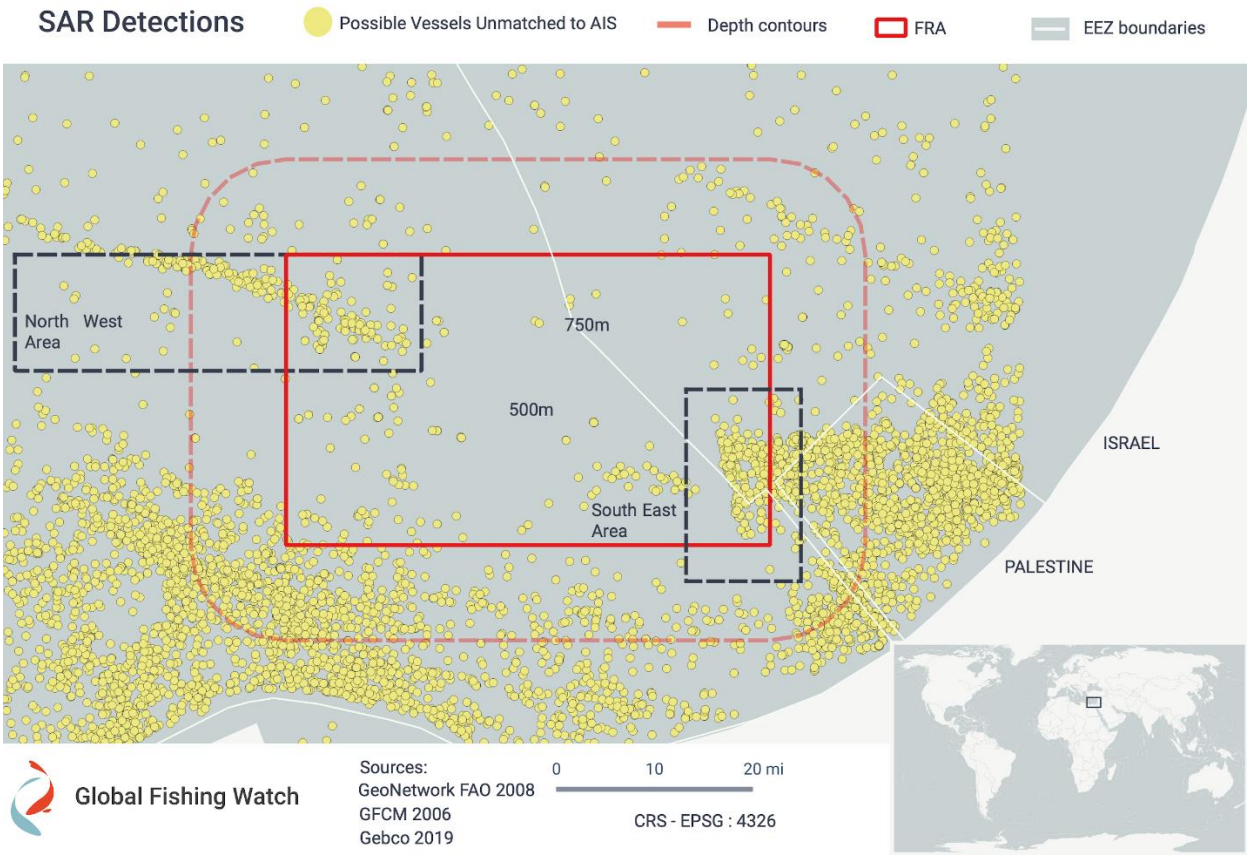

Figure 4. SAR detections that are unmatched to any AIS records for the Nile Delta FRA. The red rectangle represents the Nile Delta FRA whereas the lighter red dashed box corresponds to a 10-mile buffer around the FRA.

Southeast area: The detection using satellite images from Sentinel-1, which provides a reliability of detections of vessels as small as 18 meters - suggests that there are a number of vessels operating in the area within the FRA not broadcasting AIS. Most of the detections in this area where attributed to one month in 2019 and are unlikely to be related to fishing.

Northwest area: The findings indicate that there appears to be greater density of vessels between 500-750 meters depth in the northwest of the FRA and also within the northwest corner of the FRA. These findings are in line with a paper published in the Egyptian journal of aquatic research titled "*Deep Sea Shrimp Resources in the South Eastern Mediterranean Waters of Egypt*", which highlights this same depth stratum as having optimal potential for encountering a high density of shrimp species[10]. These findings point towards fishing vessels targeting this specific bathymetry contour, a behavior well documented in deep water fishing.

[10] Ibrahim, Mohamed & Hasan, Mohamed & El-Far, Alaa & Farrag, Elsayed & Farrag, Mahmoud. 2011. Deep Sea Shrimp Resources in the southeast Mediterranean waters of Egypt. Egyptian journal of aquatic research.

The distribution of detections in the northwest area through time highlights peaks of activity (Figure 5) and shows that there were less detections in the first half of 2020 than 2019, which follows a pattern GFW detected as part of a global analysis published in May 2020 that outlined the impacts of COVID-19 on fishing activity.

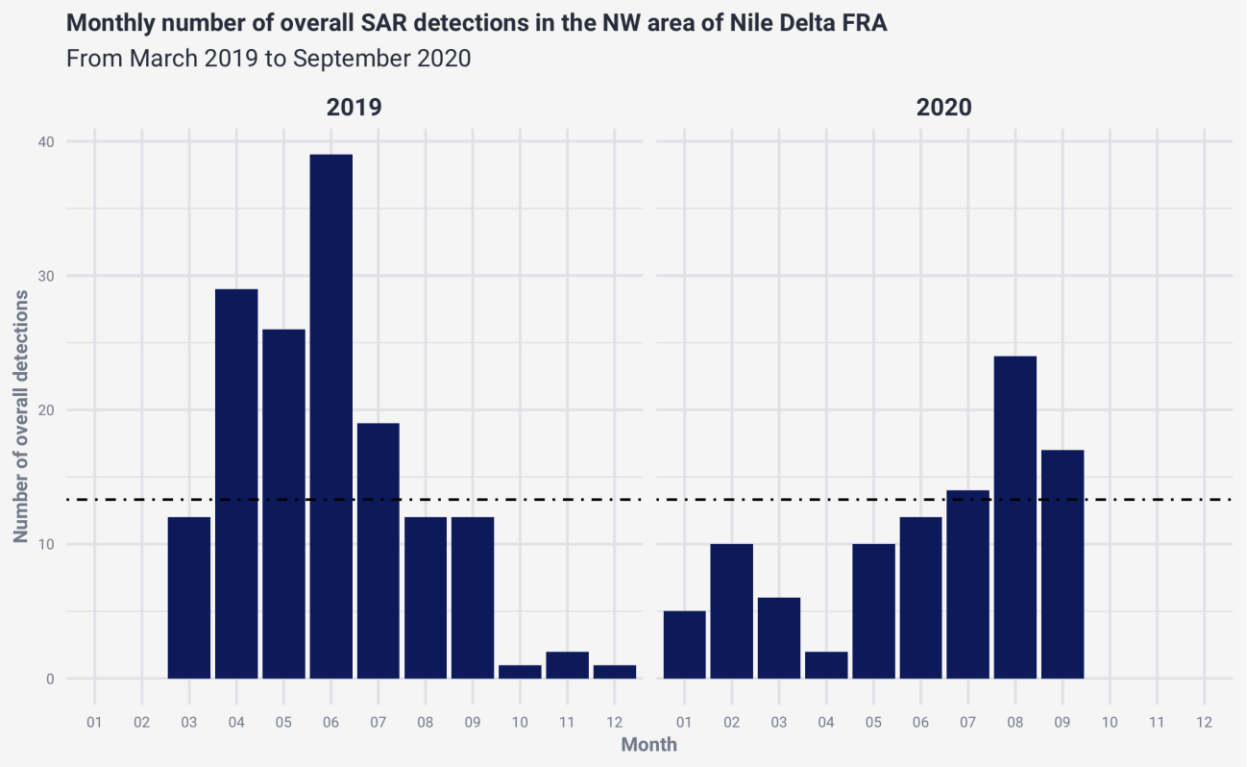

Figure 5. Total monthly SAR detections per image that are unmatched to any AIS records in the northwestern area (Figure 5) of the Nile Delta FRA. The black dashed line represents the average of detections per month from March 2019 to September 2020.

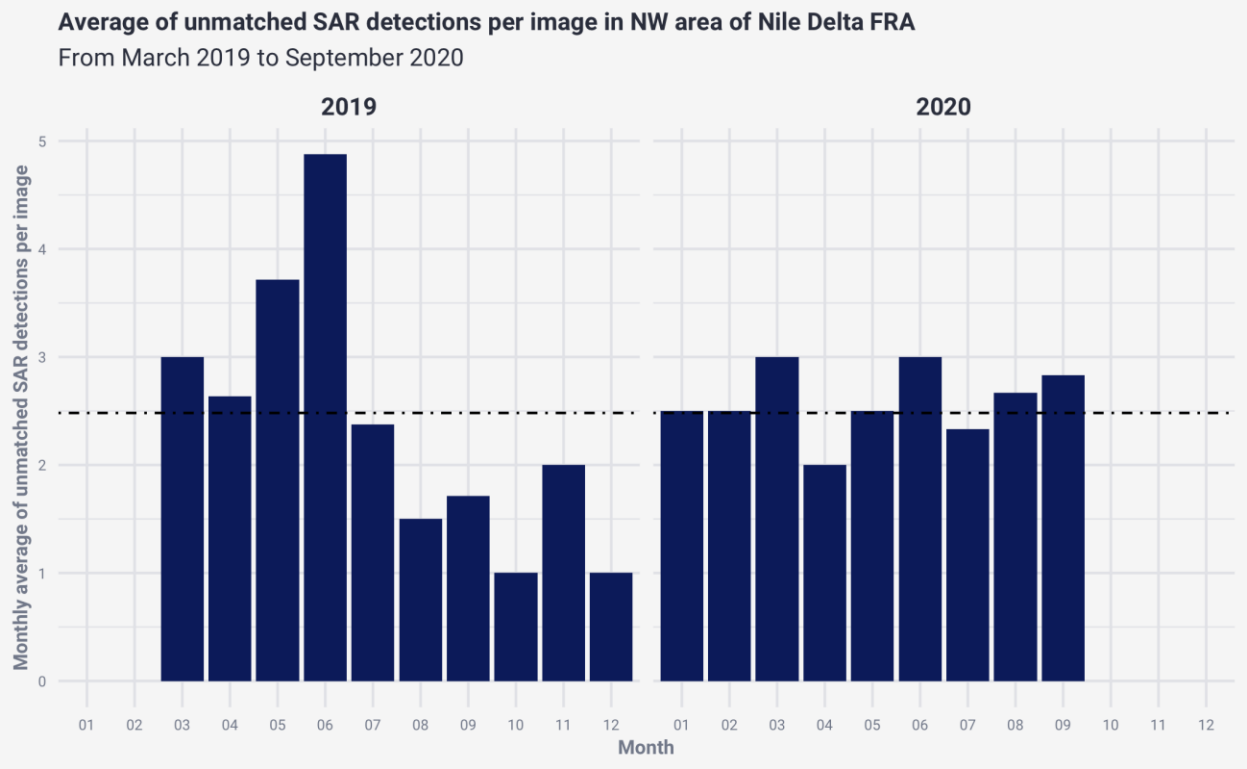

Figure 6. Average monthly SAR detections per image that are unmatched to any AIS records in the northwestern area (Figure 5) of the Nile Delta FRA. The black dashed line represents the average of detections per image from March 2019 to September 2020.

The number of detections seen in each pass of the Sentinel-1 satellite in the northwest area of the Nile Delta FRA does not exceed 13 vessels, which averages 2-3 vessels per month (figure 6).

However, trawling at depths below 300 m requires a specific type of vessel that would likely need an engine horsepower (hp) of at least 500 hp to 800 hp. According to a report by the Food and Agriculture Organization of the United Nations (FAO), "*Implementation of the ecosystem approach to fisheries for the demersal fisheries of the Mediterranean coast of Egypt*," there are 29 vessels that have engine power within that range, and that are larger than 25 meters in length[11].

Egyptian experts consulted for this analysis suggest that there may be "multispecies and multigear vessels" operating within the Nile Delta FRA, and referenced the established presence of longliners and purse seiners. They also commented on the fact that most Egyptian trawlers do not have the technology to fish in waters deeper than 250 meters and that they would require a specific license to do so. The presence of Italian trawlers in the FRA between 2009 and 2011 as the first exploratory deep-water fishing within the FRA, followed by the exploration of the same

[11] Aly, W.E., El-Haweet, A.E.A. & Megahed, A.S. 2019. Implementation of the ecosystem approach to fisheries for the demersal fisheries of the Mediterranean coast of Egypt: baseline report.
FAO Fisheries and Aquaculture Technical Paper No. 645. Rome, FAO. 28 pp. Licence: CC BY-NC-SA 3.0 IGO

500-meter depth by Egyptian trawlers from 2014 onwards demonstrates that this area has a history of (exploratory) trawling. However no current information is available on any current deep-water trawling activities in the same bathymetry.

It is possible that any vessels operating in this area may be fishing for deep water shrimp, which have been reported as present at these depths[12] , however the results of this analysis are unable to confirm vessel type. In addition, experts consulted suggested it is unlikely.

4.2 Satellite Optical Imagery

To shed further light on the type of fishing activity identified in the northwest area using SAR data, Global Fishing Watch reviewed Sentinel-2 optical imagery which is also freely available from the European Space Agency Copernicus program. Unlike SAR, optical imagery does need to be taken in daylight, but it is influenced by cloud cover, however this particular area of the Mediterranean has relatively low cloud cover, making it a good location for the use of optical data.

Manual review of Sentinel-2 and multispectral optical imagery was carried out, with a focus on specific time periods identified in the SAR analysis and where a high number of Sentinel-1 SAR detections had been identified. The objective of the review was to find images that showed examples of the vessels being detected in the Sentinel-1 SAR and help build a better understanding of the types of vessels involved operating with the boundaries of the FRA in the absence of sufficient AIS data.

One scene recorded on May 14, 2019 revealed potential vessel activity within the FRA, of which seven vessels were inside (A and B in Figure 7) and three were approximately five miles (8 kilometers) outside the FRA (C in Figure 7). From the images acquired, the length of the vessels can be approximated to be between 15 and 25 meters in length and the formations of the vessels operating in clusters along the depth contour is consistent with bottom trawling. Although GFW cannot be certain about the type of fishing gear that was used by these vessels, this analysis further points towards the likelihood there is fishing activity within the FRA that was not detected from the AIS analysis.

[12] FAO: Implementation of the ecosystem approach to fisheries for the demersal fisheries of the Mediterranean coast of Egypt: baseline report

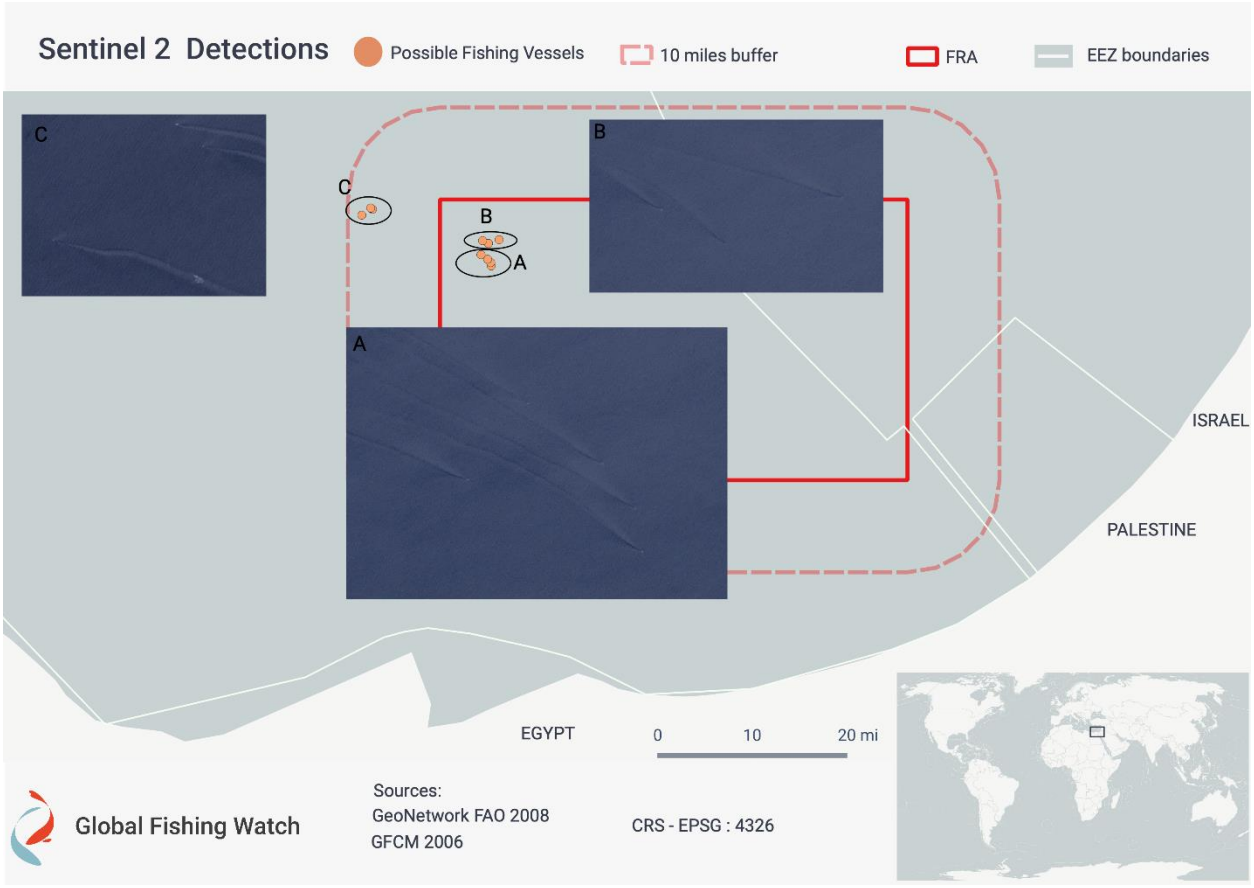

Figure 7. Sentinel-2 optical imagery detections of possible fishing vessels on May 14, 2019 for the Nile Delta FRA. The red rectangle represents the Nile Delta FRA whereas the lighter red dashed box corresponds to a 10-mile buffer around the FRA.

5 Conclusions

When the Nile Delta FRA was established in 2006 as part of Recommendation GFCM/2006/3, the Scientific Advisory Committee of the GFCM recommended that in addition to a ban on fishing activities with towed dredges and bottom trawl nets, "the area should be given a full protection status by avoiding demersal fishing practices."

The findings of this analysis reveal that further information would need to be made available to determine what percentage of the apparent fishing activity captured by SAR is attributable to demersal fishing practices. Such information would be required to evaluate the effectiveness of this Recommendation in protecting the area from the impact of "any other activity jeopardizing the conservation of the features that characterize these particular deep-sea habitats."

Between 2018-2020, the difference between the findings of the AIS analysis—which detected only two ICCAT registered vessels conducting apparent fishing activity inside the Nile Delta FRA, and the remote sensing analysis, indicating a persistent level of apparent fishing activity—suggests a need for further investigation by responsible flag and coastal States and greater transparency of fishing activity inside the FRA.

The analysis suggests that vessels apparently fishing within the FRA captured by remote sensing imagery were either not equipped with AIS or chose not to switch it on. There are legitimate reasons why a vessel may not broadcast on AIS including the fact that vessels may not be required to do so under IMO regulations due to their size or, for the case of countries including Egypt and Israel, the flag state does not require AIS on fishing vessels less than 300 GT. Although SAR detections do not confirm fishing activity, they do provide an indicator of apparent fishing activity.

Egyptian experts consulted for this analysis suggest that there may be "multispecies and multi gear vessels" operating within the Nile Delta FRA, and referenced the established presence of longliners and purse seiners. The presence of Italian trawlers in the FRA between 2009 and 2011 as part of the first exploratory deep-water fishing in the area, followed by the exploration of the same 500 m depth by Egyptian trawlers in 2014 points to historic trawling activity in this very defined area of the FRA. However, with no current information available on any current deep-water trawling activities in the same bathymetry, concrete conclusions cannot be drawn from these combined analysis methodologies.

For interested stakeholders seeking a more in depth understanding of potential impactful fishing activities exerted on deep sea sensitive habitats identified by the Recommendation requiring protection, further information needs to be made available including on whether the area within the FRA with a depth range of 500-700 meters is still being explored by deep-water trawlers, as it has been done in the past by Italian and Egyptian trawlers.

This is especially relevant as the addition of remote sensing imagery revealed the potential presence of trawlers operating at depths well-suited to deep-water shrimp fishing in the northwest

of the FRA. The addition of vessel monitoring or tracking data would make it possible to more effectively monitor potentially prohibited activity within the FRA and enhance conservation measures for VMEs.

Although this analysis is not conclusive on whether demersal fishing practices are "being avoided", as recommended by the GFCM Scientific Advisory Committee, or if a complete ban on fishing activities with "towed dredges and bottom trawl nets" is being effectively applied, it seeks to provide more clarity on the level of fishing activity in the FRA and their possible impact on the VMEs this Recommendation was designed to protect.

Furthermore, without the coordinates of the FRA having been transposed into national legislation, fishing vessels operating in the FRA—both Egyptian and from neighboring countries—may not be aware that they could be in breach of the Recommendation, even if they were conducting activities that would be jeopardizing "the conservation of the features that characterize these particular deep-sea habitats."

6 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. A combination of AIS, SAR, optical imagery and expert testimonial can be used to assess apparent fishing activity within data-poor spatial closure zones intended for biodiversity conservation, including FRAs, however findings need to be supported with additional data from verified sources.

3. Analyses which combine all of the above methodologies could provide a cost-effective method of analyzing implementation of the Nile Delta FRA and subsequent protection of vulnerable marine ecosystems in other data-poor areas in the Mediterranean.

4. The GFCM should mandate vessel management system (VMS)/AIS reporting requirements to monitor vessels authorized to conduct fishing activities within and around FRAs.

5. All vessels 15m and above must be included in the GFCM fleet register.

6. 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.

7. 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.

8. Providing demarcation of areas in which fishing is prohibited, or where specific fishing gear is prohibited, may be helpful in enforcing FRAs nationally.

9. All GFCM Contracting Parties and Cooperating non-Contracting Parties including Nile Delta FRA neighboring state Israel, should declare the number of trawlers and other operating vessels to the GFCM country vessel registry.

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 tonnes 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 antennas 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 study by FAO and Global Fishing Watch found that in Mediterranean waters almost 100 percent of 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, where 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 as well as a lack of terrestrial receptors that capture AIS use[4].

Besides the direct use of ICCAT[13] and EU[14] registries the fishing vessels analyzed in this report were also chosen based on the GFW database of fishing vessels. The fishing database is defined in Kroodsma et al. (2018)[15] and includes fishing vessels based on registry database information or as defined by a convolutional neural network. The most commonly transmitted fishing vessel identity information such as name and IMO on AIS were used in this analysis, while vessel flag was identified from a combination of registry and AIS transmission records.

[13] https://www.iccat.int/en/VesselsRecord.asp
[14] https://webgate.ec.europa.eu/fleet-europa/
[15] Tracking the global footprint of fisheries, Kroodsma et al. Science 23 Feb 2018: Vol. 359, Issue 6378, pp. 904-908

SAR and Optical Imagery Analysis Based Methods

To investigate the presence of vessels not using AIS in the Nile Delta FRA, SAR data was reviewed. Images were obtained from the European Space Agency (ESA) Sentinel-1 mission. Sentinel-1 is primarily a land satellite, however the portion of sea that includes the Nile Delta FRA is captured two times a day usually around 6am and 6pm local time.

Pulses of radio waves are sent by SAR covering a scene of the landscape, and the echo of each pulse is recorded 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[16], was used to classify pixels of the radar images that corresponded to possible vessel detections. This included isolating pixels that returned signals that were significantly stronger than the background ocean.

When the detections are identified they are then matched to vessels that are broadcasting AIS. GFW performs this matching by producing a score that is the likelihood that a given detection could be a given vessel in AIS, and that score is based on an analysis of how vessels move. The most likely matches are then accepted (although, in most cases, each SAR detection matches to only one vessel). The result is a dataset of likely vessels detected from SAR, with some matched to fishing vessels, some matched to non-fishing vessels, and some not matched to AIS, and thus either likely not broadcasting AIS or operating in an area with poor AIS reception.

To better understand the spatial distribution of possible vessels across the time range, the vessel density was calculated from the SAR detections. SAR vessel density is calculated as the average number of vessels detected over a year per km2 (Figure 8). This confirmed that SAR detections within the FRA seem to concentrate in the northwest and southeast corners of the FRA.

[16] Illuminating dark fishing fleets in North Korea, Park et al. Science Advances 22 Jul 2020: Vol. 6, no. 30, https://advances.sciencemag.org/content/6/30/eabb1197.abstract

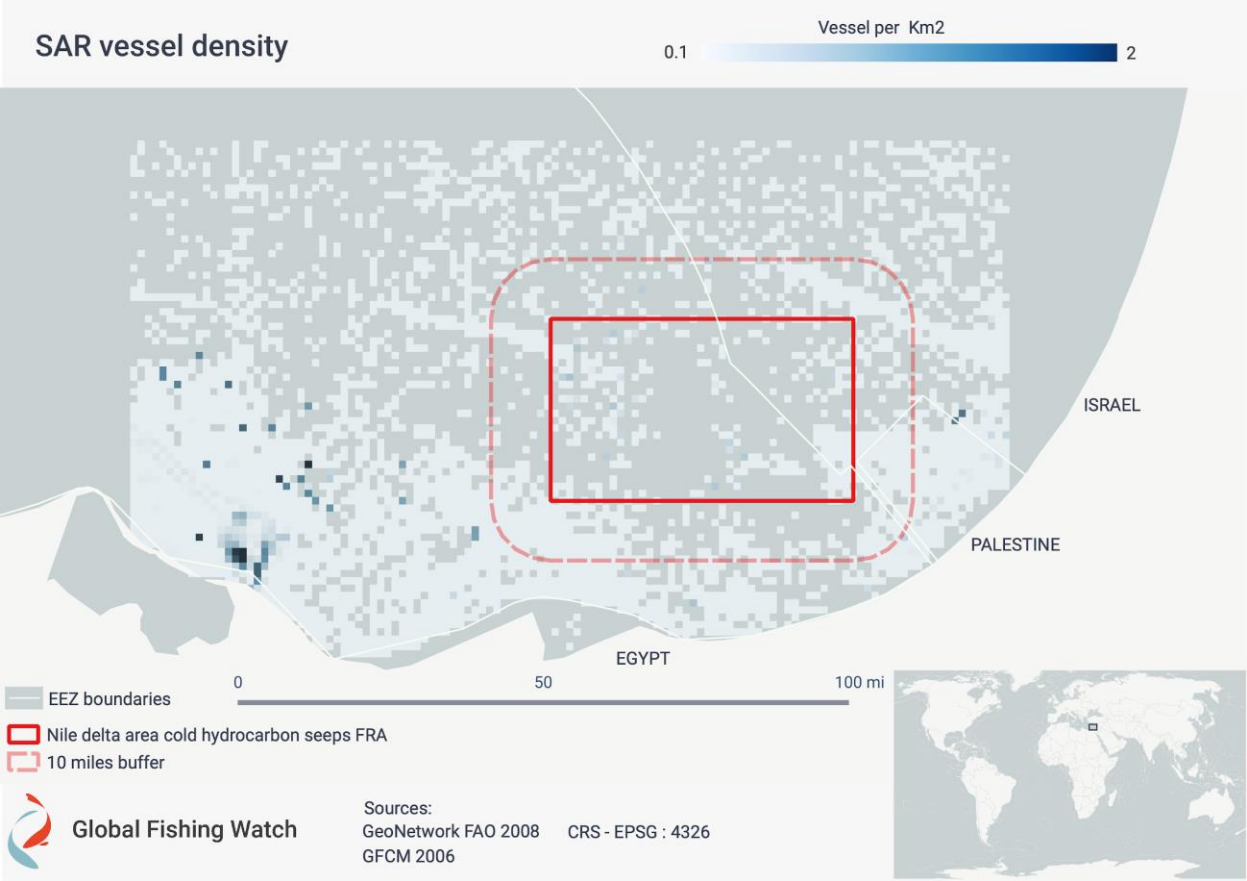

Figure 8. Vessel density for all SAR detections for the Nile Delta FRA. The red rectangle represents The Nile Delta FRA whereas the lighter red dashed box corresponds to a 10-mile buffer around the FRA.

It is not possible to ascertain the vessel type from a likely vessel detection taken from SAR images alone. Estimates of the probable types of vessels being detected by the SAR images are made from additional information including, situational awareness – the other vessels seen in the region on AIS; scientific literature and expert opinion; other data sources including vessels registers, optical images and when made available VMS data. Remote sensing analysis of this type is only intended to identify potential risks for further investigation by the flag or coastal State.

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 vessel detections were made manually in a GIS program to identify examples of vessels found inside the FRA. Sentinel-2 satellites image the Nile Delta FRA every 5 days.