



Machine Learning of Thai Vessel Monitoring System (VMS) data

SAFET Conference 2019

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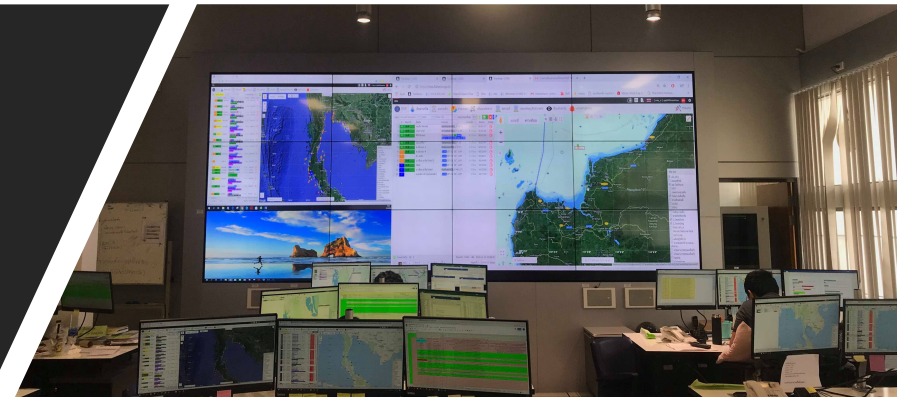


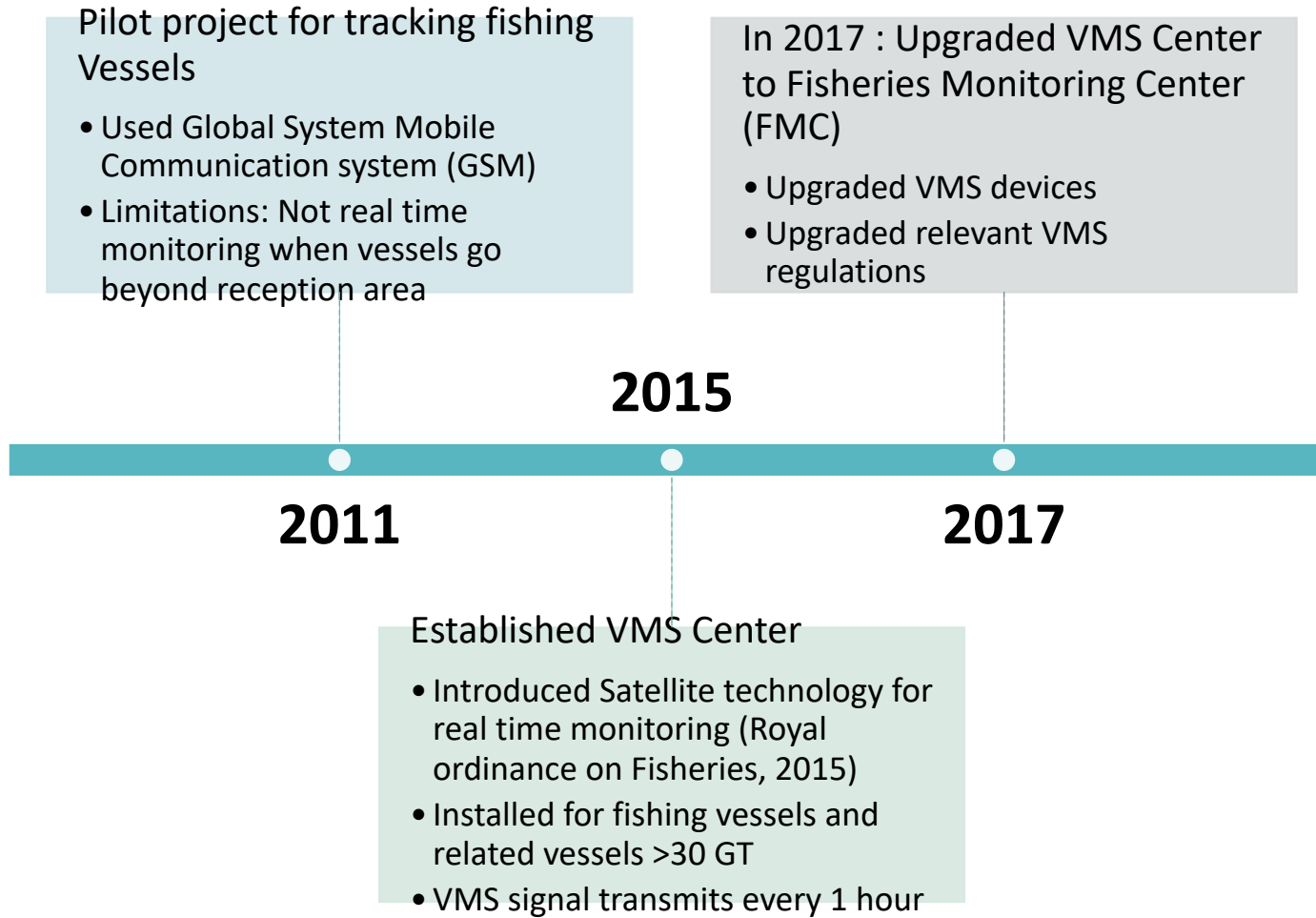
MCS AND VMS DATA

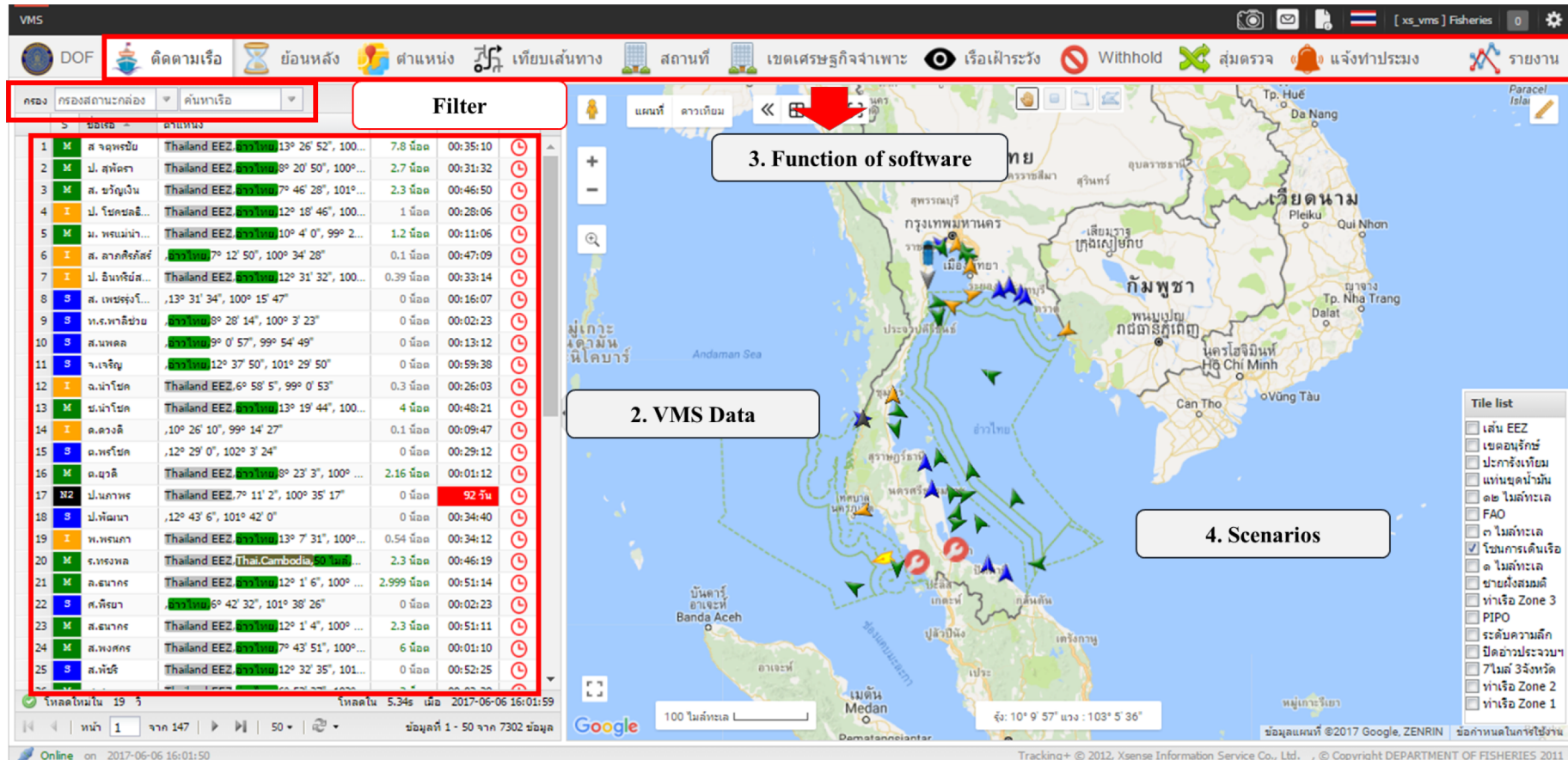
- VMS transmits positional data at regular intervals, including the location, course and speed of vessels.
- Primary way of monitoring vessel activities whilst at sea
- Makes traditional means of surveillance more cost effective

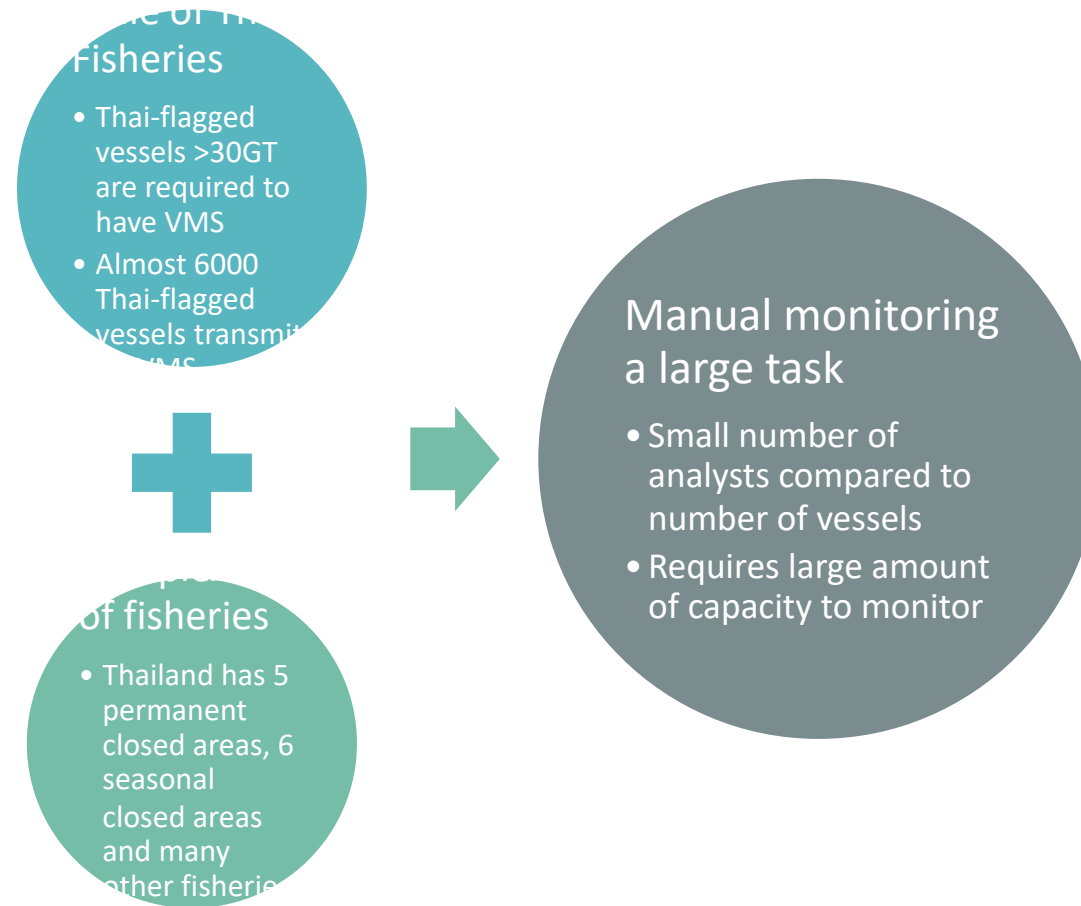
CURRENT STATE OF MONITORING

- The data is mainly managed by the Coastal States and Member States Fisheries Monitoring Centres (FMC)
- Programme simple alerts e.g.
 - When a vessel enter/exits an area
 - When a vessel doesn't transmit for a period
- Typically manual identification of fishing activities - an analyst looking at the data











Aim: to identify suspicious fishing vessel behaviour from Vessel Monitoring System (VMS)
Reduce the burden on FMC by focusing their monitoring and investigative capacity on highest-risk vessels



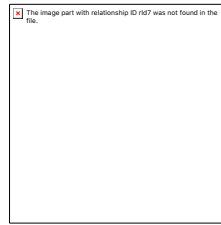
How: develop a Machine Learning algorithm to detect and distinguish between the 19 different fisheries



Fisheries application: The algorithm is applied to Thai regulations to identify compliant and possible non-compliant fishing activity

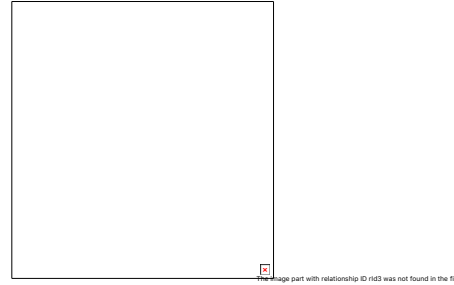


The outputs: a feed of automated alerts of possible non-compliance by Thai-flagged fishing vessels to the DOF

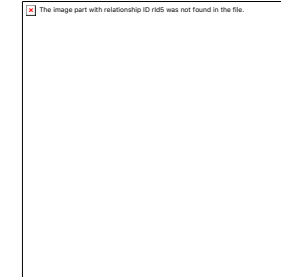


Machine learning is a method of automated data analysis

It is a branch of **artificial intelligence** based on the idea that systems can learn from data, identify patterns with minimal human intervention.



OceanMind used 3 years of historical VMS data from 5828 different vessels across all 19 gear types to train the machine.



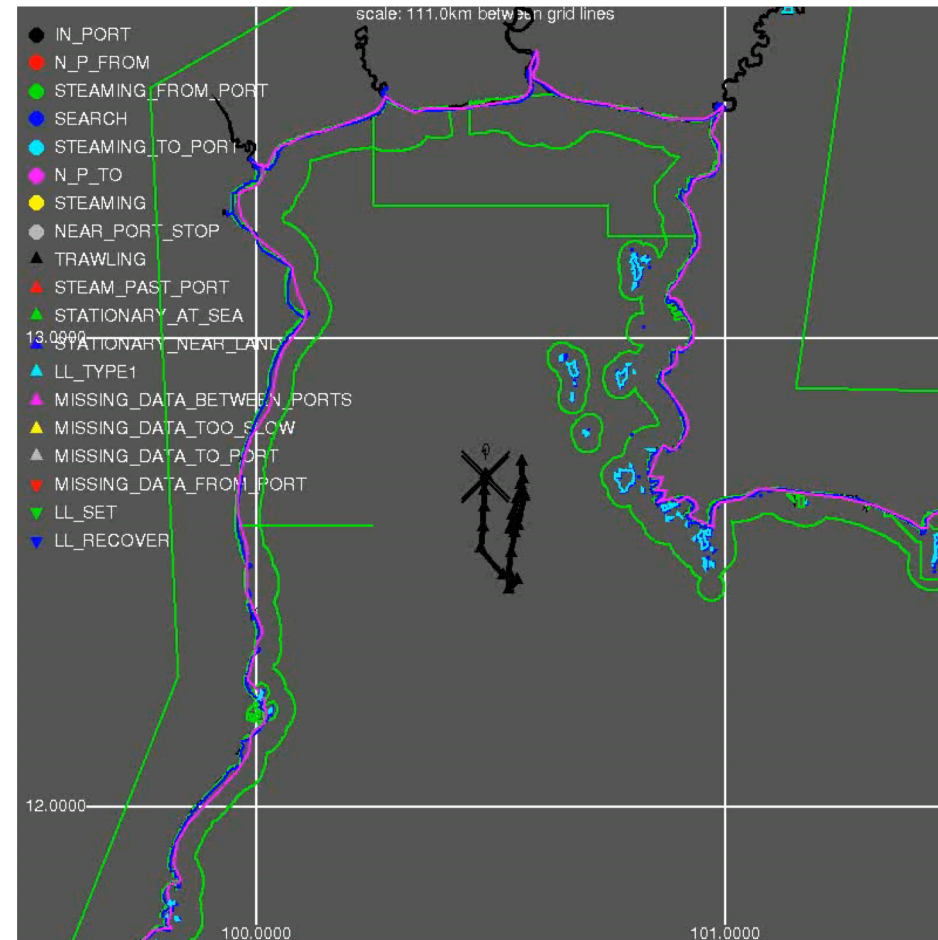
Depth of ocean, distance from port and duration of the fishing trip are also incorporated with the positional data to predict fishing activity and gear type

Track identification

- Tracks segmented to distinguish activity
 - Stationary
 - Steaming
 - Fishing
 - Port call

Gear identification

- Fishing activity portions of track passed through the machine with:
 - location
 - depth
 - distance from port
 - duration of the fishing trip

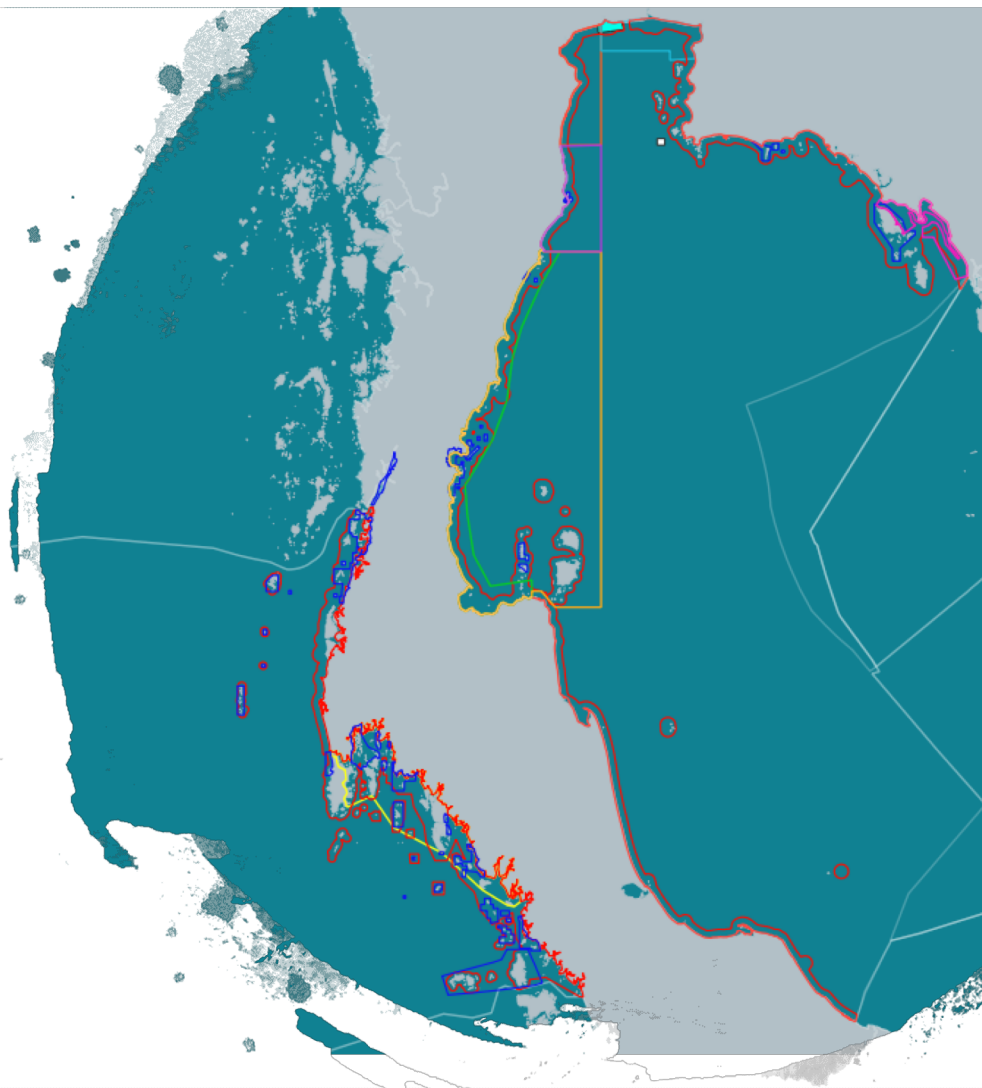


CONFUSION MATRIX

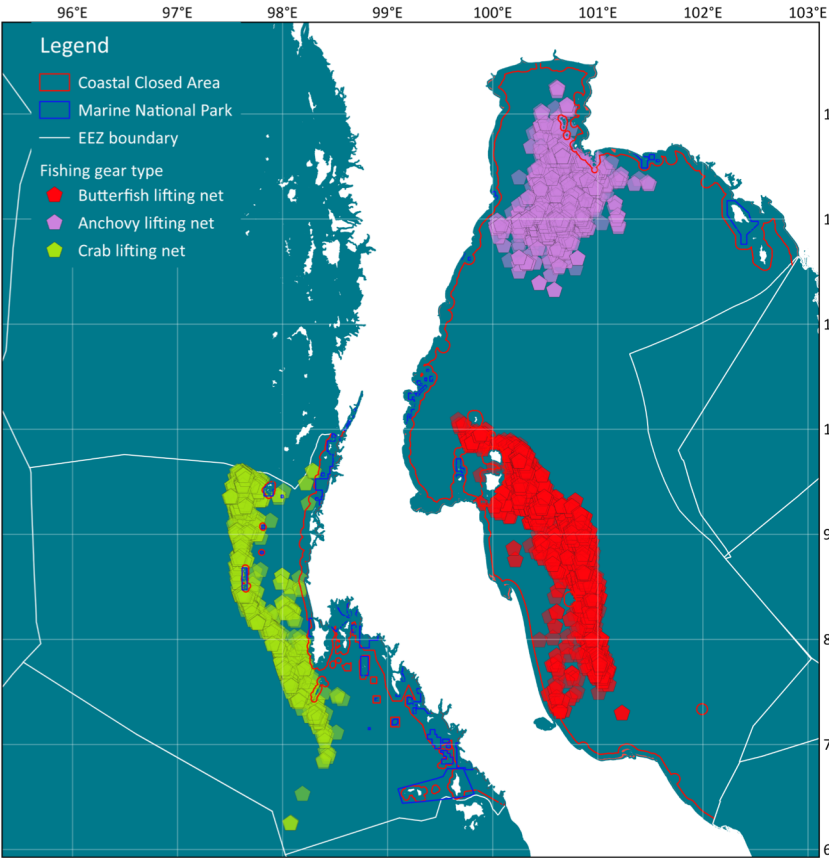
	Anchovy falling net	Anchovy lifting net	Anchovy purse seine	Beam trawl	Butterfly fish lifting net	Crab lifting net	Crab trap	Electric generator	Fish Trap	Gill net	Krill push net	Longline more than 100 meter	Octopus Trap	Otterboard trawler	Pair trawl	Purse seine	Squid Trap	Squid falling net	Surf clam dredge
Anchovy falling net	97.4	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	1.7	0.0	0.1	0.0
Anchovy lifting net	66.9	26.9	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	3.7	0.0
Anchovy purse seine	3.0	0.1	84.0	0.3	0.0	0.0	0.0	1.0	0.0	0.3	0.0	0.0	0.0	0.2	0.2	10.4	0.0	0.5	0.0
Beam trawl	0.0	0.0	0.0	96.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	1.1	2.0	0.2	0.0	0.0	0.0
Butterfly fish lifting net	0.2	0.0	0.1	0.0	99.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Crab lifting net	0.0	0.0	0.5	0.0	0.0	75.7	0.0	1.9	0.0	0.0	0.0	0.0	0.0	1.9	0.0	19.4	0.0	0.5	0.0
Crab trap	1.8	0.0	0.0	0.4	0.0	0.0	73.5	0.0	1.3	4.7	0.0	0.0	0.1	5.4	0.4	11.7	0.0	0.7	0.0
Electric generator	1.8	0.0	2.2	0.1	0.0	0.0	0.0	81.7	0.0	0.1	0.0	0.0	0.3	0.2	0.0	7.9	0.0	5.7	0.0
Fish Trap	3.7	0.0	0.3	0.0	0.0	1.2	0.0	4.1	66.8	3.0	0.0	0.1	0.3	6.9	0.2	12.7	0.0	0.7	0.0
Gill net	0.2	0.0	0.0	1.0	0.0	0.0	0.3	0.0	0.2	90.3	0.0	0.3	1.3	1.7	0.4	2.0	0.0	2.3	0.0
Krill push net	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	96.8	0.0	0.0	0.0	0.2	1.6	0.0	0.0	1
Longline more than 100 meter	3.5	0.0	0.1	0.2	0.0	0.0	0.0	0.6	0.0	7.3	0.0	46.5	0.0	11.3	0.1	30.4	0.0	0.0	0.0
Octopus Trap	0.1	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	94.8	0.5	1.1	0.0	0.0	0.3	0.1
Otterboard trawler	0.1	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.4	4.6	0.2	0.0	0.0	0.0
Pair trawl	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	96.4	0.3	0.0	0.0	0.0
Purse seine	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	99.1	0.0	0.0	0.1
Squid Trap	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	2.6	2.8	0.0	0.0	93.9	0.1	0.0
Squid falling net	1.5	0.0	0.1	0.0	0.0	0.1	0.0	1.1	0.0	0.2	0.0	0.0	0.1	0.4	0.2	1.1	0.0	95.4	0.0
Surf clam dredge	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.1	0.0	0.0	96.3

AUTOMATED ALERTS OUTPUTS

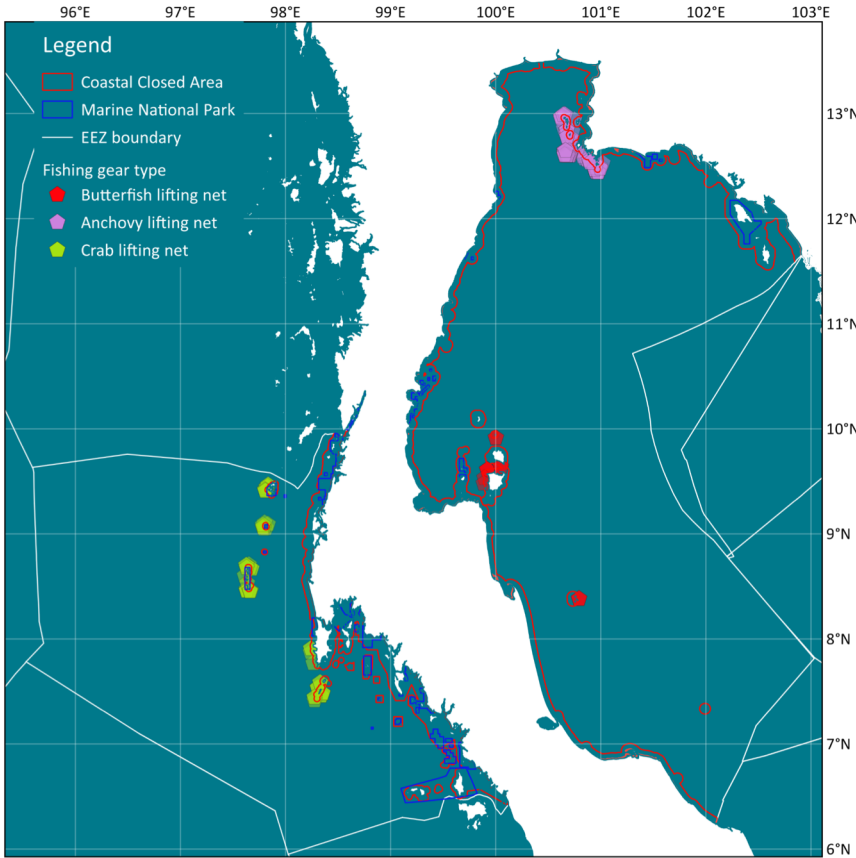
- Fishing detections are applied to known Thai fisheries regulations to produce:
 - compliant 'events' or
 - non-compliant 'alerts'
- **Over 700 regulatory rules were configured and tested**
- If the Machine Learning 'predicted gear' does not match with the 'licensed gear' an alert is produced



Fishing Events ✓



Fishing Alerts ✕



MACHINE LEARNING ALERT TYPES

Alerts (High risk)

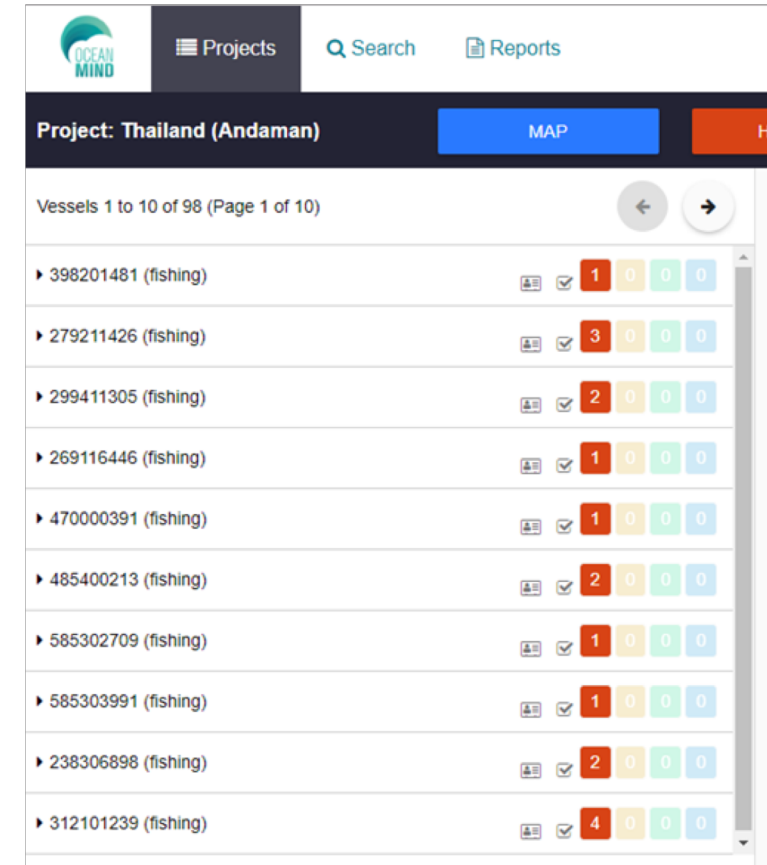
- Fishing in a closed area
- Fishing using a gear type that is not licensed
- Anchovy purse seine fishing at night
- Fishing outside of the Thai EEZ if not licensed





















Warning (medium risk)

- Proximity to another vessel
- At-sea transshipment
- Gaps in transmission

Events (for situational awareness)

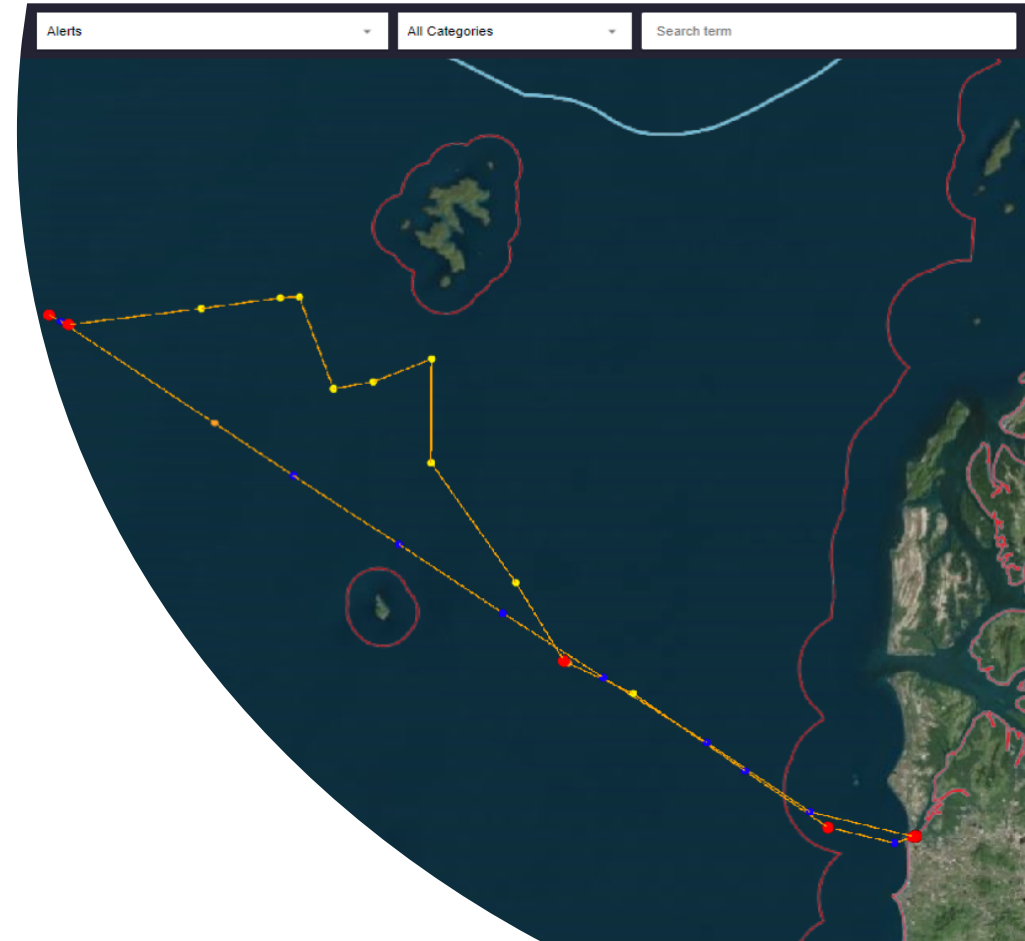
- Fishing (licensed or authorised)
- Stationary at sea
- Steaming to port
- Entry / Exit Area
- Port visit



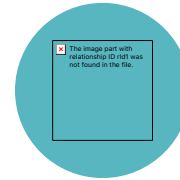
Project: Thailand (Andaman)		MAP	HA
Vessels 1 to 10 of 98 (Page 1 of 10)			
▶ 398201481 (fishing)	 	1	0 0 0 0
▶ 279211426 (fishing)	 	3	0 0 0 0
▶ 299411305 (fishing)	 	2	0 0 0 0
▶ 269116446 (fishing)	 	1	0 0 0 0
▶ 470000391 (fishing)	 	1	0 0 0 0
▶ 485400213 (fishing)	 	2	0 0 0 0
▶ 585302709 (fishing)	 	1	0 0 0 0
▶ 585303991 (fishing)	 	1	0 0 0 0
▶ 238306898 (fishing)	 	2	0 0 0 0
▶ 312101239 (fishing)	 	4	0 0 0 0

ALERT FEED

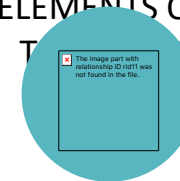
- VMS tracks can be visualised so analysts can then manually check vessel behaviour
- The feed of alerts are split into monitoring areas to align with the teams monitoring areas:
 - Andaman Sea
 - Upper Gulf of Thailand
 - Middle Gulf of Thailand
 - Lower Gulf of Thailand
- Analysts mark the alert ✓ accurate or ✗ inaccurate which is fed back to the algorithm to improve accuracy
- Alerts recorded through time - used to inform targets for patrol.
- Rules can be reconfigured as laws change so alerts stay accurate



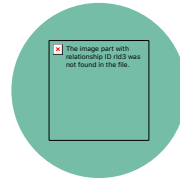
FUTURE CHALLENGES AND OPPORTUNITIES



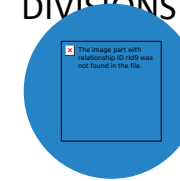
TOO MUCH DATA
MACHINE
LEARNING
QUICKLY
IDENTIFIES KEY
ELEMENTS OF
T



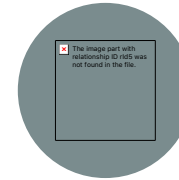
SCALABILITY
CLOUD-BASED
SYSTEM
OTHER
POSITIONAL DATA



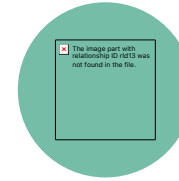
OPPORTUNITIES
FOR FMC TO
QUICKLY SHARE
ALERTS TO OTHER
SURVEILLANCE
DIVISIONS



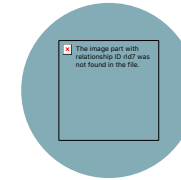
TRAIN THE
MACHINE TO
IDENTIFY OTHER
BEHAVIOURS:
LABOUR ISSUES



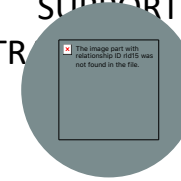
UTILISE THE DATA
FOR OTHER
FISHERIES
MANAGEMENT
APPLICATIONS



MACHINE
LEARNING CAN BE
USED TO INDEX
OTHER
ELECTRONIC
MONITORING



LINK RISKS
IDENTIFIED FOR A
VESSEL WITH
TRACEABILITY
SYSTEMS TO
SUPPORT
TR



LEGAL
CHALLENGES OF
USING VMS DATA
– MUST BE
SUPPORTED WITH
OTHER EVIDENCE



Thank You

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