



Netherlands Enterprise Agency

RFASeuro
Explosieven Experts!

Offshore wind energy Netherlands

Unexploded Ordnance (UXO) - Desk Study

Commissioned by RVO.nl

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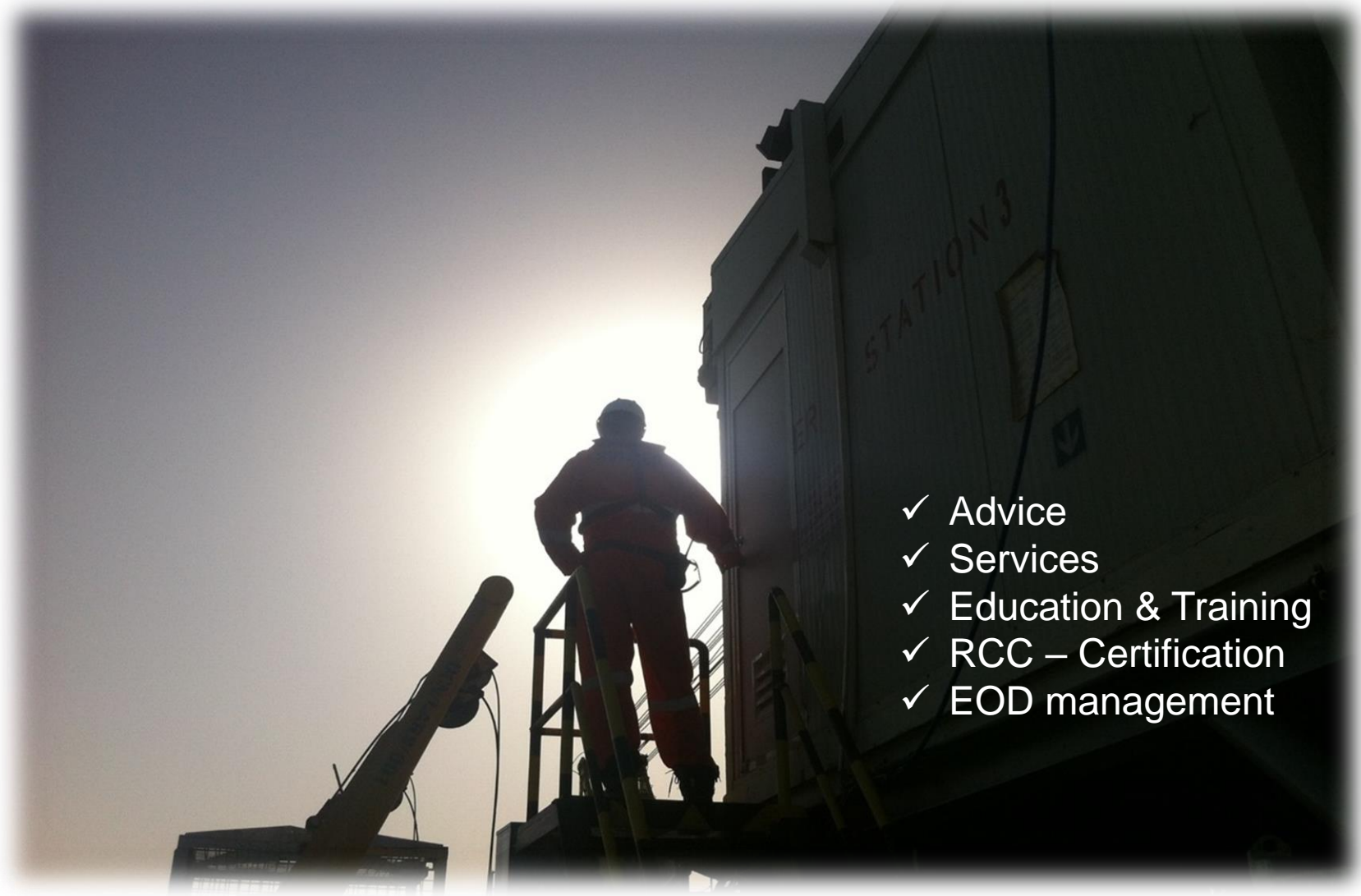
1. Introduction to REASeuro
2. Main objectives Desk Study
3. Historical Research
4. UXO Risk Assessment
5. Regulation and standards
6. Conclusions

1. Introduction to REASeuro

- ❑ Fully specialized on all explosives topics
- ❑ IED and UXO
- ❑ Dutch B.V. and German GmbH
- ❑ Onshore UXO clearance operations
- ❑ Offshore UXO clearance operations
- ❑ EOD management



1. Introduction to REASeuro



- ✓ Advice
- ✓ Services
- ✓ Education & Training
- ✓ RCC – Certification
- ✓ EOD management

2. Main objectives Desk Study

- ❑ Identification of UXO related constraints
- ❑ Identification of areas preferably not to be used
- ❑ Identification of requirements from UXO perspective for:
 - Determining concession zones
 - Safe geophysical and geotechnical investigations
 - Safe Installation of foundations and cables

3. Historical research

❑ Conducted according the WSCS-OCE guidelines

❑ Information drawn from:

- Information derived from RVO.nl
- Literature
- Archives (NL, UK, GER, USA)
- Dutch Coastguard & the Royal Netherlands Navy
- Open source information

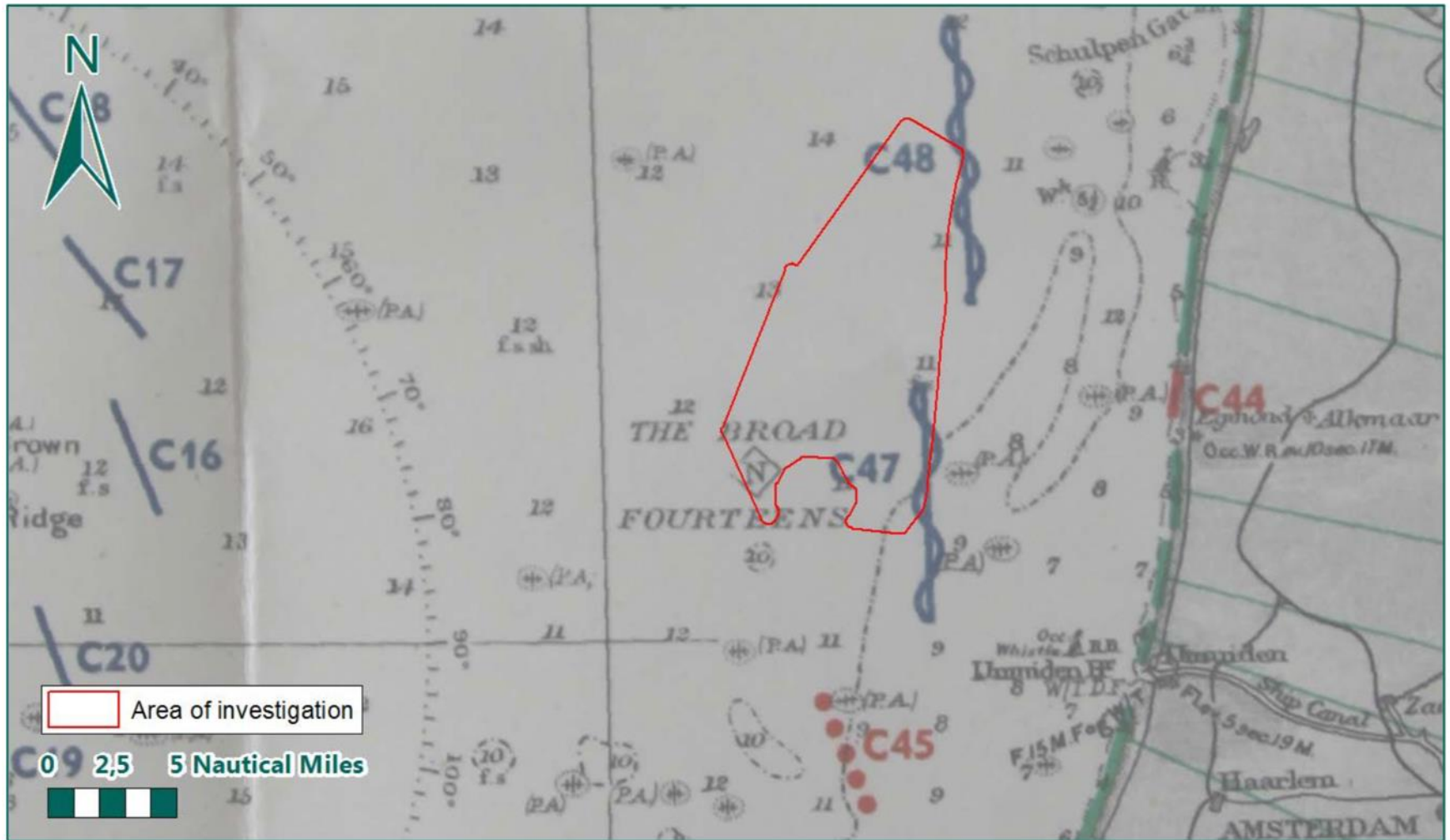
3. Historical research

Maritime warfare on the North Sea

| Naval warfare | Aerial warfare | Post war activities |
|----------------------------------|--------------------|------------------------|
| Laying of mine fields | Attacks on convoys | Artillery firing range |
| Torpedo attacks on ships | Mine laying | AXO dumping |
| Engagement between small vessels | Bomb jettisons | UXO encounters |
| Sinking of (ammunition) ships | Airplane crashes | |

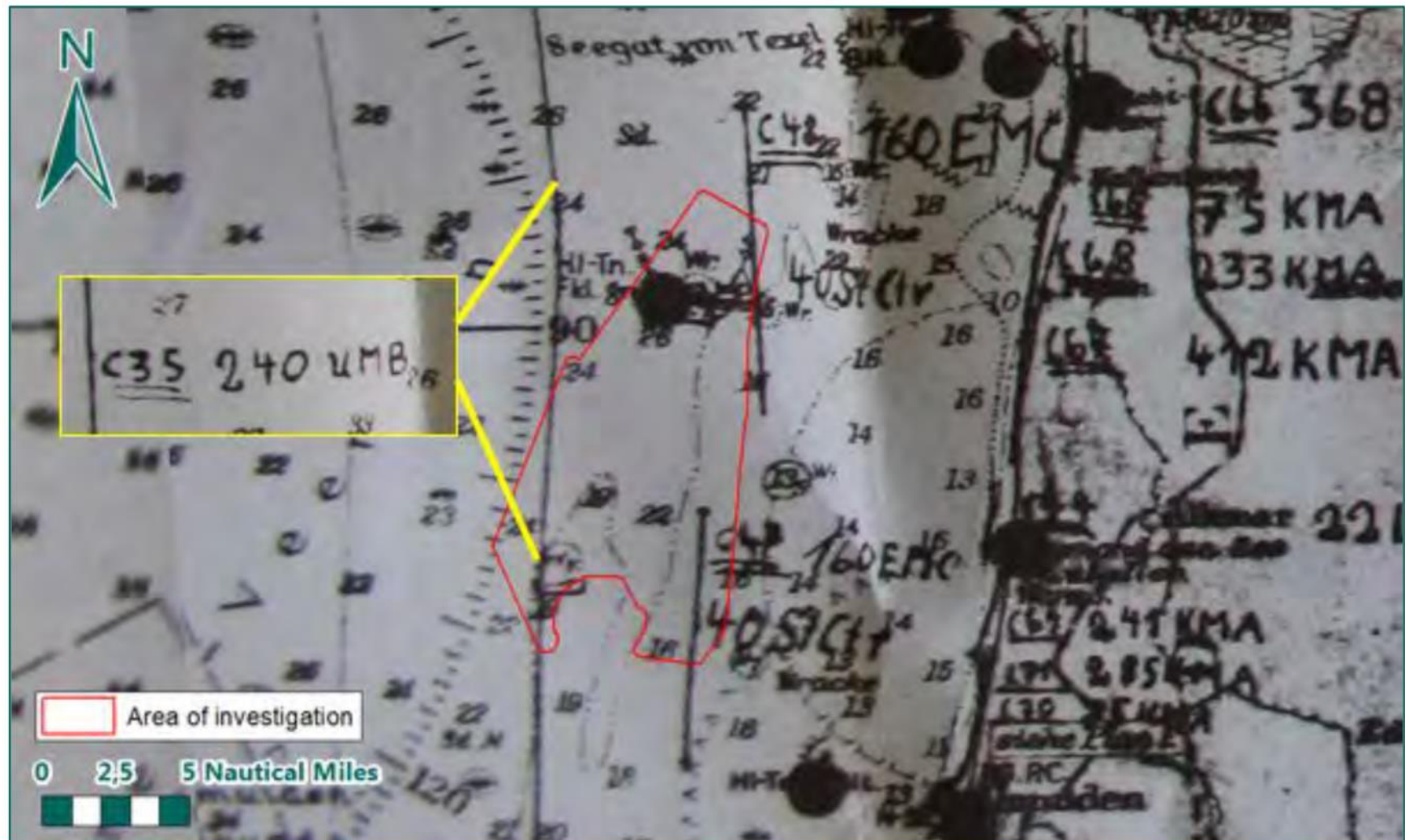
3. Historical research

German Naval mine fields WWII



3. Historical research

German Naval mine fields WWII



Allied Naval mine fields WWII



3. Historical research

Allied Naval mine fields WWII



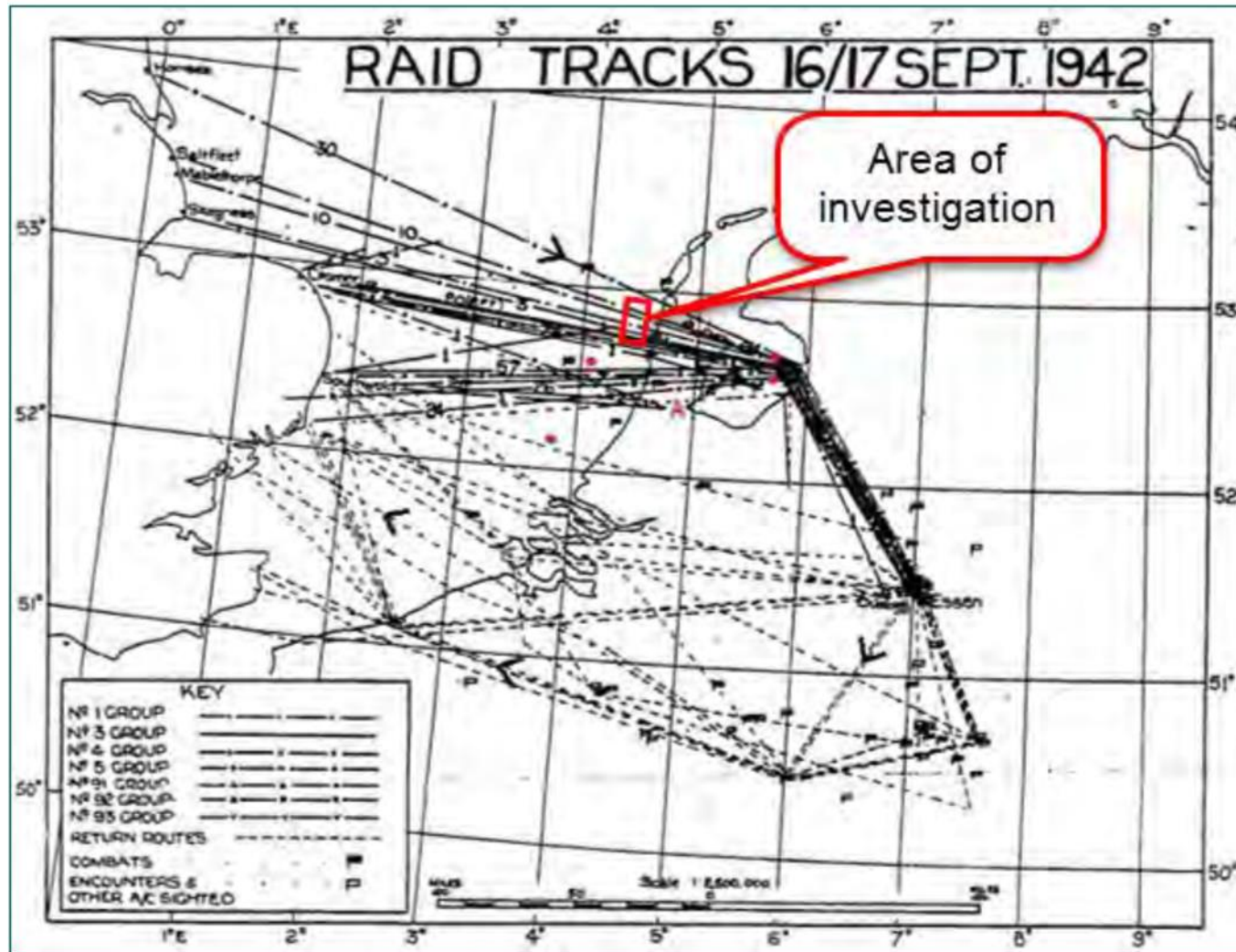
3. Historical research

Aerial attacks



3. Historical research

Jettisons



3. Historical research

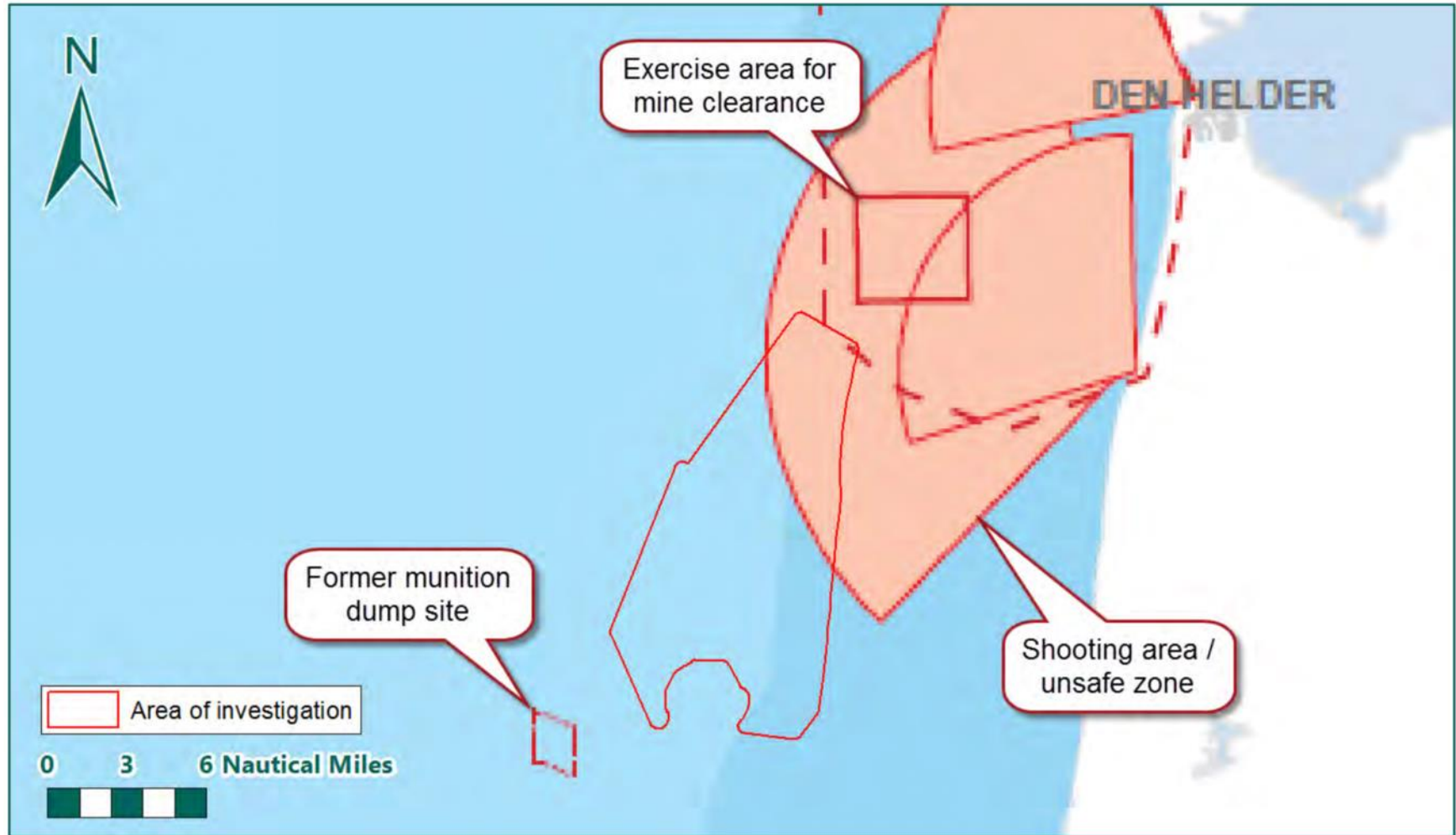
Aerial attacks and jettisons

- ❑ Ships and convoys were attacked on a regular basis
- ❑ Bombs, depth charges and torpedoes were used
- ❑ Several airplane crashes were reported
- ❑ Payload was often jettisoned into sea
- ❑ Air dropped bombs represent >50% of all UXO encounters



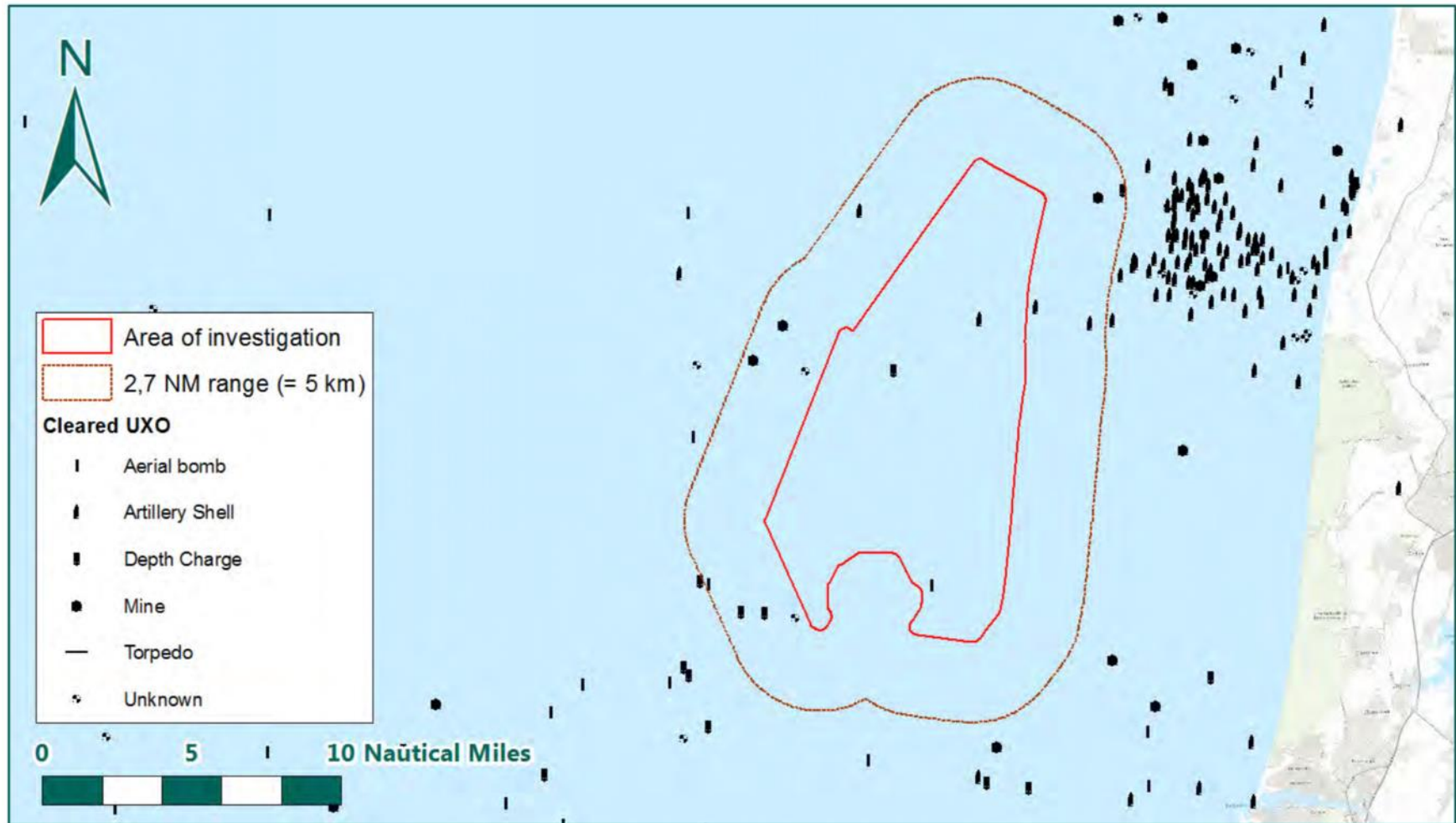
3. Historical research

Post war activities



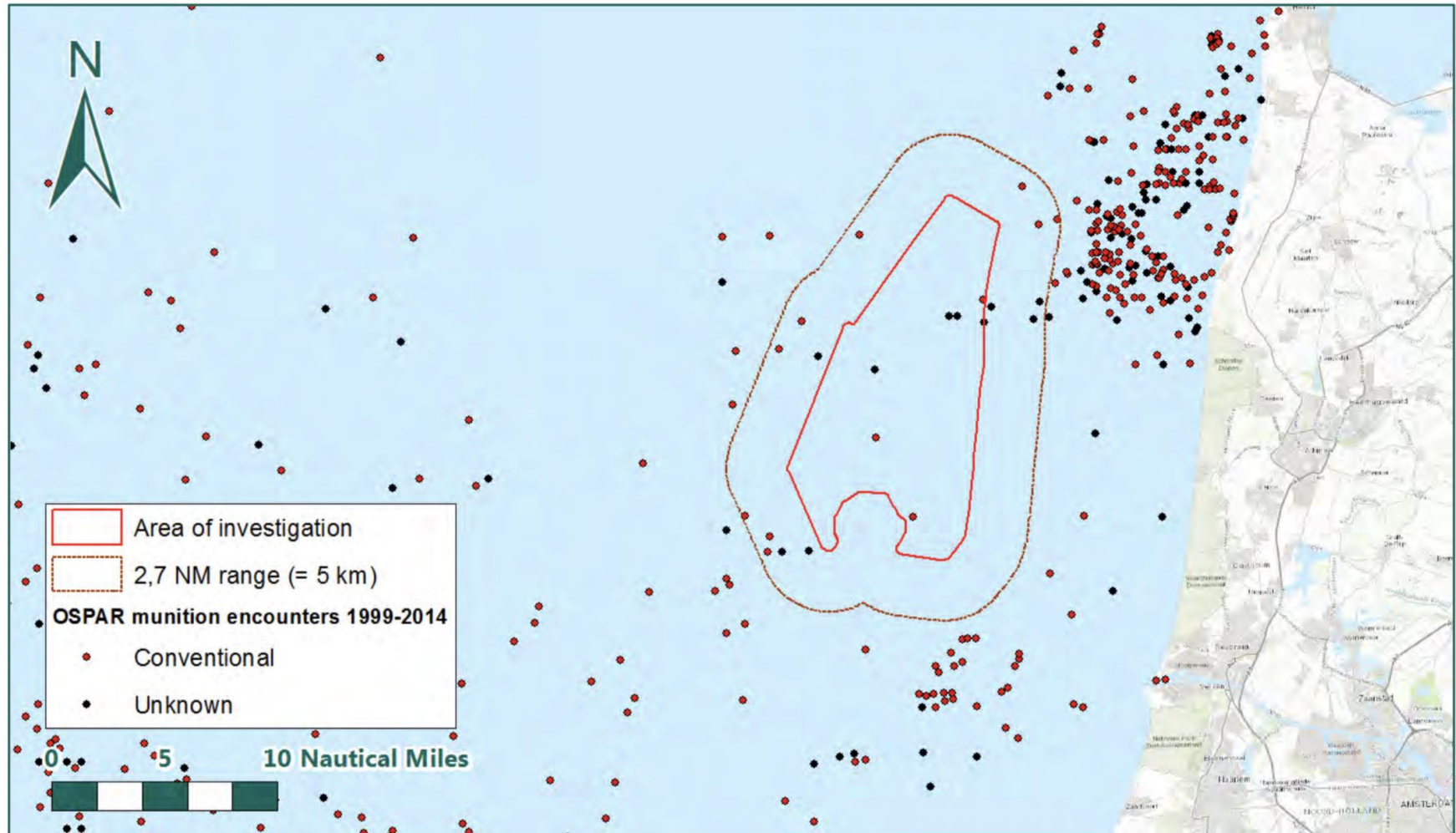
3. Historical research

UXO encounters reported to Coast Guard since April 2005



3. Historical research

UXO encounters OSPAR



3. Historical research

Conclusions

The Hollandse Kust (noord) Wind Farm Zone is to be considered a UXO risk area because:

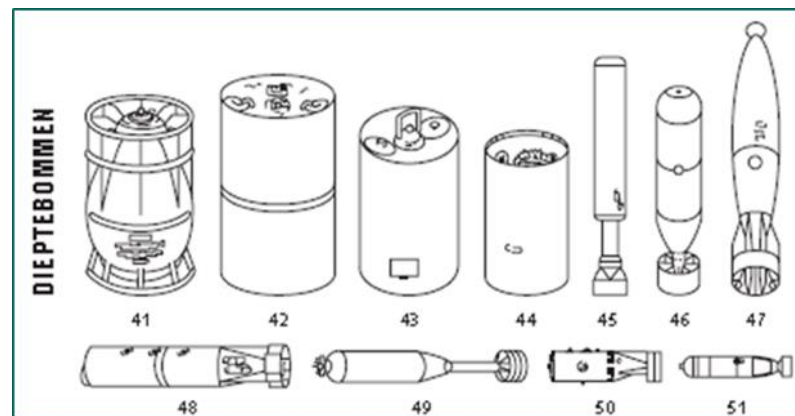
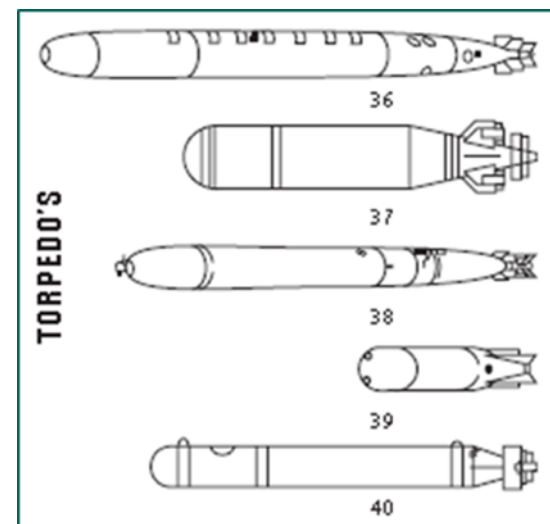
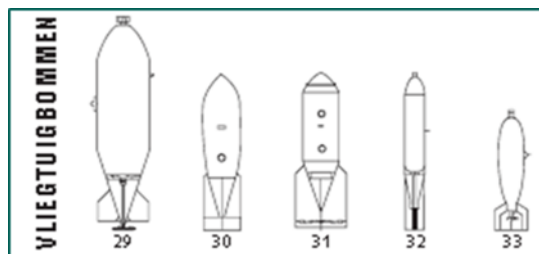
- ☐ Several mine fields were present in the area
- ☐ Ships and convoys were attacked with bombs, torpedoes, depth charges and cannons
- ☐ The Allied airplanes were attacked by German fighters and Flugabwehrkanone
- ☐ The payload of Allied airplanes was often jettisoned in the North Sea
- ☐ Since April 2005 seven UXO were encountered within the Wind Farm Zone

3. Historical research

Conclusions

The following UXO are possibly left behind in the area:

- ☐ Naval mines (only ferrous)
- ☐ Air dropped bombs
- ☐ Torpedoes
- ☐ Depth charges
- ☐ Artillery shells



4. UXO risk assessment

Rationale

- ☐ All encountered targets and positively identified UXO must be considered armed and dangerous
- ☐ Most UXO have a large Net Explosive Quantity
- ☐ Intrusive activities will be needed for wind farm development
- ☐ This may cause a fuze to function, leading to a detonation
- ☐ Personnel may be harmed and equipment may be severely damaged
- ☐ A detonation may form an intolerable risk for personnel and/or equipment
- ☐ UXO risk mitigation measures are needed

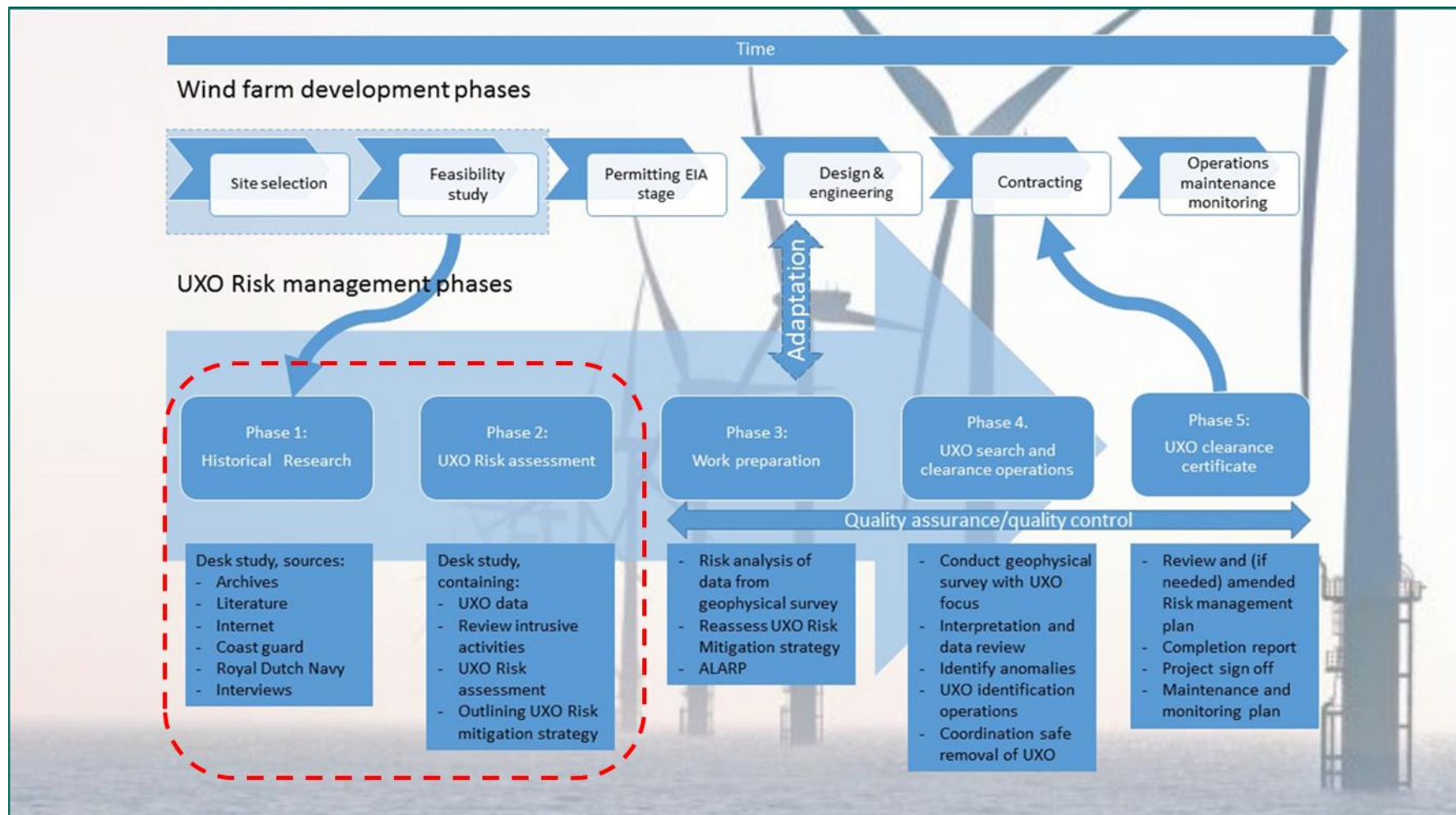
4. UXO risk assessment

Effects of under water detonations

| Effect | Likelihood | Reason |
|-------------------|------------|---|
| Direct damage | Unlikely | Direct contact between vessels and UXO is not to be expected |
| Bubble jet effect | Likely | Dependent on the distance of vessels to the detonation point |
| Shock | Likely | Dependent on the distance of vessels to the detonation point |
| Shredding | Feasible | Divers can be affected up to 2,700 m of the detonation point |
| Fragmentation | Unlikely | Unlikely that lethal fragments are ejected above the surface of the water |

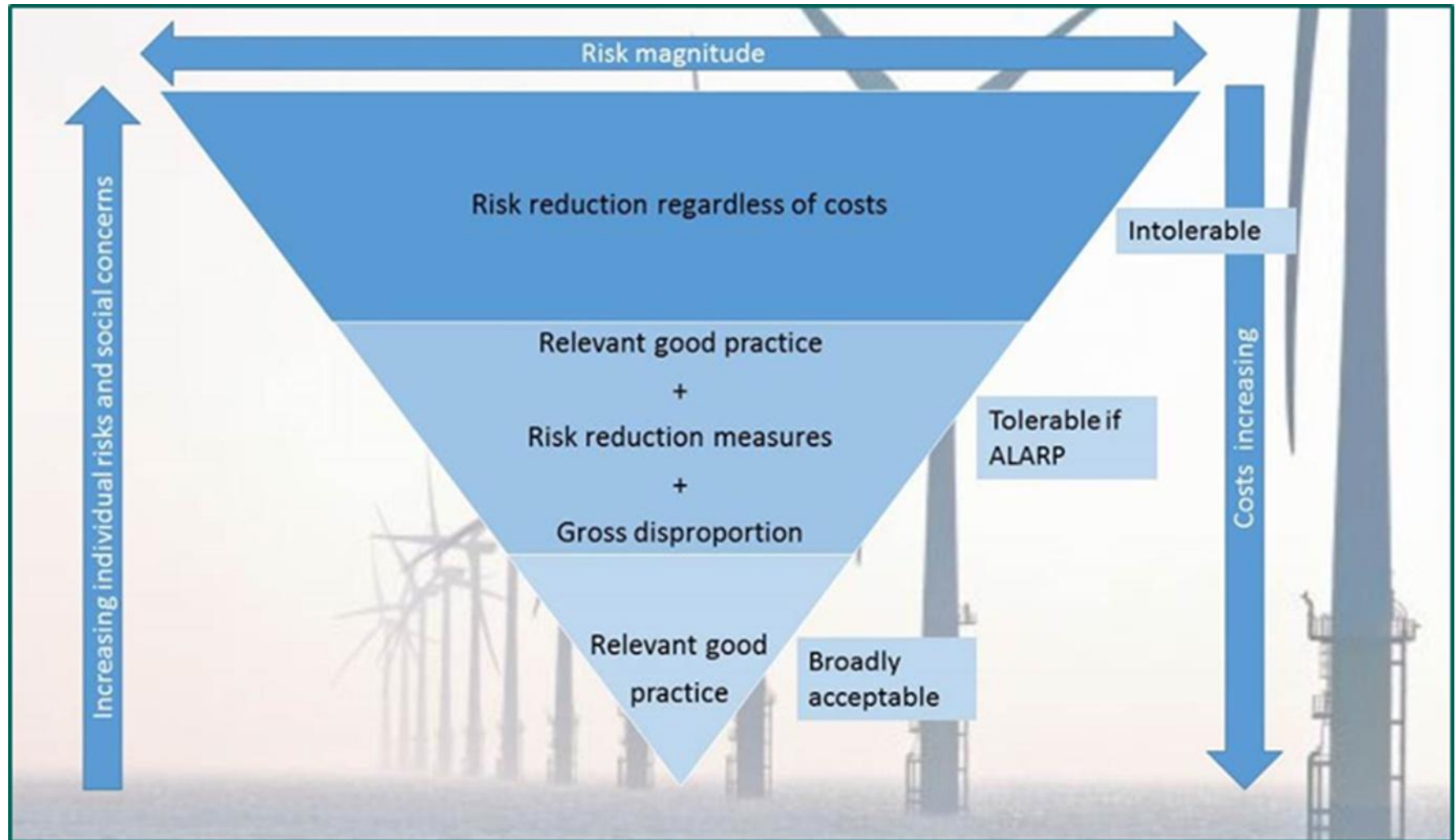
4. UXO risk assessment

UXO mitigation strategy



4. UXO risk assessment

UXO ALARP certification



4. UXO risk assessment

UXO mitigation strategy

1. General awareness on UXO within all participants
2. ALARP assessment based on the Desk Study, environmental site data and further UXO related information in order to determine the threshold criteria (provisional threshold 50 kg ferrous mass)
3. Determination UXO geophysical survey design derived from and based on the ALARP risk assessment
4. Determination survey areas around WTG locations and cable routes
5. Implementation of the UXO geophysical survey

4. UXO risk assessment

UXO mitigation strategy

6. Evaluation of UXO geophysical survey data and determination of targets to be avoided or identified in accordance with defined threshold criteria
7. Identification of targets with ROV and/or divers and qualified personnel
8. Removal of non-UXO objects identified (as required)
9. Disposal of identified UXO by the Netherlands EOD authority
10. Preparation and issuing of documentation and UXO sign-off certificates

5. Regulation and standards

UXO mitigation strategy

❑ Dutch law is applicable:

- Dutch Working Conditions Act
- WSCS-OCE (annex XII of the working conditions regulation)

❑ Close cooperation with EOD authorities is needed (planning and execution of disposal operations)

6. Conclusions

- ❑ The entire wind farm area is to be considered a UXO risk area
- ❑ Naval mines, air dropped bombs, depth charges, torpedoes and artillery shells are possibly left behind
- ❑ A detonation of a large Net Explosive Quantity UXO item forms an intolerable risk for personnel and equipment
- ❑ UXO risk mitigation measures are needed
- ❑ With proper UXO risk management the risks can be reduced to ALARP

Your safety,
our
concern